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Rare Isotopes and the Boundaries of Nuclear Physics By Rory Akin

Abstract

Neutron-rich isotopes are extremely important for the improved understanding of nuclear structure and reactions. The neutron drip line has currently not been probed past a proton number of 8, and knowledge of where it lies helps answer the question of what combinations of nucleons can form a stable nucleus. Neutron-rich nuclei form exotic structures such as neutron skins and halos, and are not accurately described by current models such as the shell model. The improvement of current models and development of new models for describing the behavior of neutron-rich nuclei is essential for the field of nuclear physics. In my review paper, I will investigate our current knowledge about how nuclei are organized, what nucleon combinations can form a bound nucleus, and how those properties relate to structure and dynamical phenomena in the universe.

Introduction

The stability of neutron-rich nuclei is one of the biggest open questions in nuclear physics today. Lurking at the edges of stability, exotic nuclei allow us to test our theories on nuclear structure and probe the properties of nuclei far from naturally occurring nuclear configurations. More generally, nuclear effects are at play at both the smallest and largest scales of the universe. Nucleosynthesis reactions in the hearts of stars and beyond are driven by neutron-rich isotopes, and a more detailed understanding of these nuclei can help us understand how these reactions are driven. Nucleosynthesis reactions are responsible for the formation of every element observed in nature. In addition, neutron-rich matter makes up over 90% of a typical neutron star, the densest form of matter that we can detect in the electromagnetic spectrum. Rare isotopes illuminate nuclear structure at the extremes, and allow us to push our understanding of how the nucleus works past the current limits.

Before we can begin our discussion on rare isotopes, it is useful to define some background and terminology. A key quantity that characterizes a nucleus is the binding energy per nucleon, which is the energy cost to remove a nucleon from a nucleus. In general, a nucleus can be uniquely specified by its number of protons and number of neutrons. An element is determined by the number of protons and an isotope is associated with the number of neutrons in the nucleus. How a nucleus is bound determines whether it is stable or radioactive.

Another very important facet of nuclear physics is the nuclear drip lines. Nuclei within the drip lines are bound to the extent that they will not spontaneously decay via the emission of nucleons. Beyond the drip lines, nuclei cannot bind another nucleon, and will spontaneously emit either protons or neutrons, or in some cases two nucleons at once. The neutron drip line, where extremely neutron-rich isotopes lie, is currently not very well known. However, the proton drip line, where extremely neutron-deficient nuclei lie, is known up to bismuth, with 83 protons.
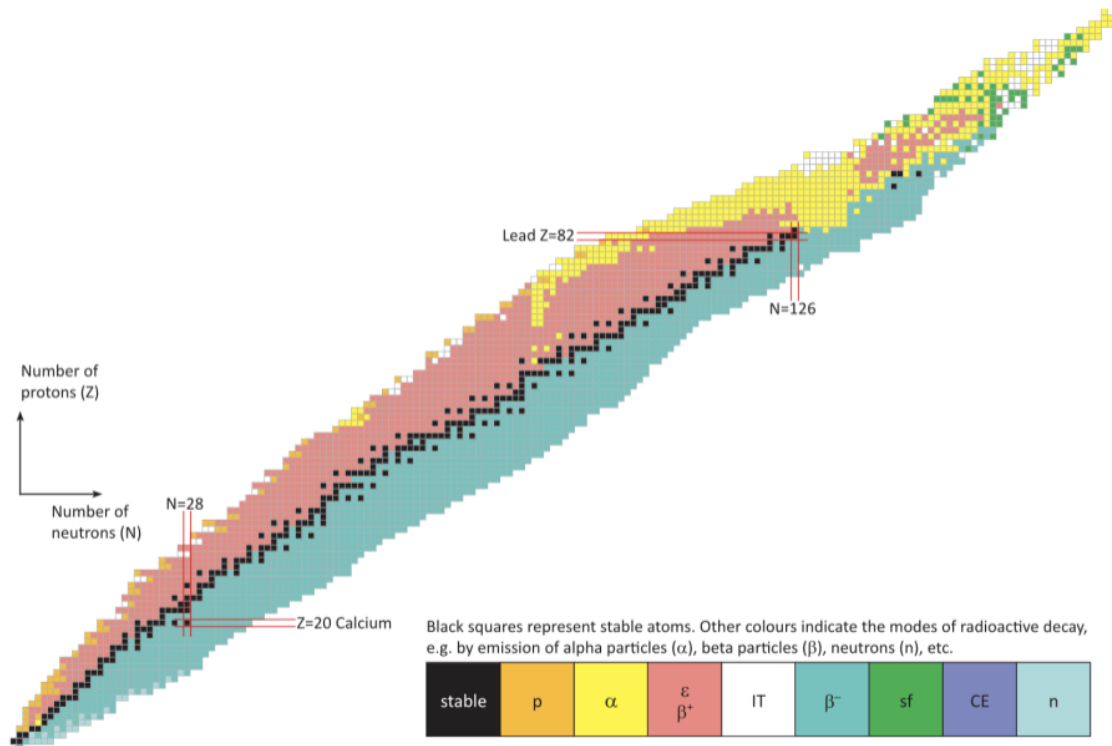
Fig. 1: The chart of nuclides (Sóti et al 2). The number of neutrons (N) is on the x axis, and the number of protons (Z) is on the y axis.

Fig. 1 shows the Chart of Nuclides, which organizes all known nuclei with their number of neutrons (N) on the horizontal axis and number of protons (Z) on the vertical axis. It displays the line of stability, and how isotopes located away from the line will decay. While the drip lines are not marked, isotopes past the drip lines will decay via proton or neutron emission, shown in orange and light blue, respectively. From the decay modes, it is clear that the proton drip line has been reached far up the chart, while the neutron drip line has only been achieved for light elements. Neutron-rich heavier elements decay via β^- decay. Currently, about 3000 stable and radioactive nuclei have been produced in laboratories or been observed in nature. Theoretical calculations predict that there are around 7000 possible nuclides within the drip lines (Watanabe)

Another important phenomenon related to the stability of nuclei is that of magic numbers. This concept will be explained more thoroughly in the next section, but it is intrinsically related to binding energy of nuclei and how nuclei with specific numbers of nucleons have relatively high binding energies compared to neighboring isotopes. Nuclei with magic numbers of nucleons also tend to be especially abundant. For nuclei far from the drip lines, these numbers are 2, 8, 20, 28, 50, 82, and 126. At the moment, 126 is a magic number for neutrons only. Elements past 118 protons have not been experimentally created.

Magic Numbers	Element	Binding energy per nucleon (keV)	Binding energy per nucleon of neighboring isotope (-1 N) (keV)	Binding energy per nucleon of neighboring isotope (+1 N) (keV)
Z=2, N=2	Helium	7073.9038(6)	2572.6650(24)	5481.2(50)
Z=8, N=8	Oxygen	7976.0832981(16)	7463.56(5)	7750.6153(11)
Z=20, N=20	Calcium	8550.8428(21)	8369.197(6)	8546.2563(24)
Z=82, N=126	Lead	7864.725(12)	7867.1251(12)	7845.9335(18)

Table 1: Binding energies of doubly magic isotopes and their neighboring isotopes. Data from Nuclear Binding Energies and Atomic Masses (Schopper a,b).

Table 1 shows the binding energy of several well-known elements with doubly magic isotopes and neighboring isotopes. Helium-4 is a very clear example of higher binding as compared to its neighbors. 4He has a binding energy of over 7000 keV per nucleon, while its neighboring isotopes are only 2572.6650 keV and 5481.2 keV respectively. While the differences are not as pronounced for oxygen and calcium, they are still clear. However, as shown in Table 1, lead-208 does not match the binding energy pattern exactly. This deviation shows the nontrivial nature of nuclear structure.

Beyond nuclear structure, it is also interesting to study bulk properties of nuclear matter, which govern the behavior of a sufficiently large system of nuclear matter in thermal equilibrium. Thermal properties are studied via the Equation of State (EOS). The EOS relates variables such as pressure, volume, and temperature in order to describe the equilibrium state of a substance. A well-known example of an EOS is the ideal gas law, $PV = nRT$, where P is pressure in atmospheres (atm), V is volume in liters (L), n is number of moles, R = 0.082057 $\frac{L \cdot atm}{mol \cdot K}$, and T is temperature in kelvin (K). The EOS for nuclear matter is essential for understanding the bulk structures of nuclear systems, such as the cores of neutron stars. The EOS for nuclear matter can be expressed as the symmetry energy-which measures the change in binding energy in a system as neutron and proton ratios are changed at a fixed number of nucleons (Baldo and Burgio 1)-as a function of density. This quantity also relates to nuclear internal structure properties such as the emergence of deformed nuclei and neutron skins. Thus, the EOS connects two massively different regimes: from the smallest nuclei to neutron stars many times heavier than the sun.

Structure

The structure of exotic isotopes is a very interesting field of study at the moment. While we do not know everything, a substantial amount of progress has been made over the past years. From the original nuclear shell model to neutron skins and halos, many unique structures exist in neutron-rich isotopes. In this section we will discuss the basics of nuclear shell structure, then move on to more complex phenomena such as neutron skins, halos, and clusters.

Nuclear Shell Structure

A pronounced shell structure is observed in electron orbitals, with the probabilities of the locations of electrons following a clear pattern. The quantum state of an electron is determined by four quantum numbers: n, the principal quantum number; l, the orbital momentum quantum number; m, the magnetic quantum number; and s, the spin quantum number. The quantum number n is what is referred to when talking about the energy levels of shells: 4p, 3s, et cetera. The values of l and m both depend on the value of n, but the value of s is always ½ or -½ . Spin is an intrinsic quality of a particle. Particles with a spin of ½ are called fermions. The value of l is what determines the type of electron orbital: 0 for an s orbital, 1 for a p orbital, 2 for a d orbital, and 3 for an f orbital. S orbitals are spherical, but p, d, and f have more complex shapes. P orbitals are often compared to dumbbells. Orbitals are nested within each other, with the final incomplete energy level containing valence electrons. Similar to electrons, the nuclei of atoms also show a shell structure. The reason for this shell structure is the same as for electrons; the Pauli Exclusion Principle prevents two fermions from occupying the same quantum state. As electrons, protons, and neutrons are all fermions, this applies. For electrons, the shell structure is quite straightforward.

However, for nucleons, the shell structure is much more complex. There are many more possible types of shells for nucleons than for electrons, and strong spin-orbit coupling is a feature of the nuclear shell structure. Spin-orbit coupling is the reaction between the orbital momentum (l) and the spin (s). The result of this is the splitting of energy levels into multiple sublevels with slightly different energies.
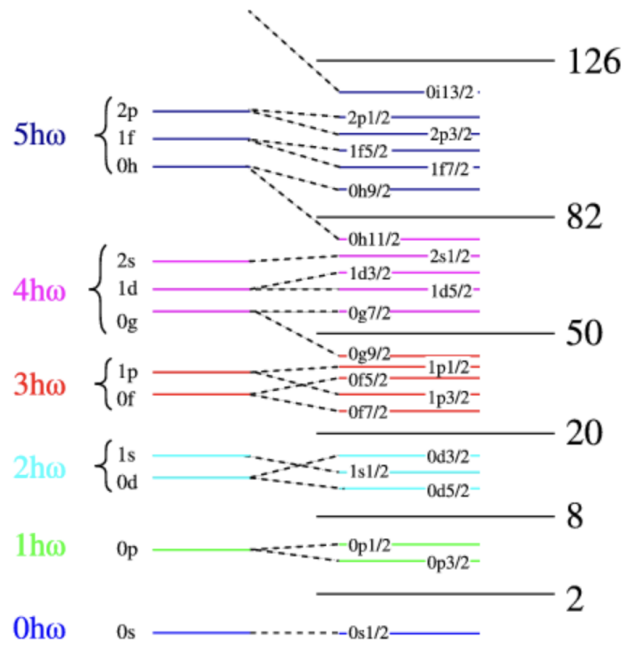
Fig. 2: A schematic representation of nuclear shell structure (Walet). Shells with similar energy levels are grouped together, with gaps shown at magic numbers.

Fig. 2 shows a representation of nuclear shell structure. The splitting of energy levels is clearly shown, for example with the splitting of the 2p shell into 2p1/2 and 2p3/2. The filling of nuclear shells also does not follow as simple a pattern as electron shells, and must be determined experimentally. Fig. 2 also divides energy levels by magic numbers of nucleons. There is a significant energy gap located at each magic number. As noted above, nuclei with magic numbers of nucleons tend to be particularly stable and abundant. Nuclear shell structure can explain this, by showing how nuclei with magic numbers have complete shells of nucleons.

Harmonic Oscillator

A remarkable quality of the nuclear shell model is that its simple assumptions can predict experimentally observed phenomena with a high degree of accuracy. One of these assumptions is that the energy potential which confines nucleons in shells can be modeled as a quantum harmonic oscillator potential. A quantum harmonic oscillator describes motion which follows a parabolic potential, such as a particle oscillating in a parabolic well or a mass attached to a string. The motion of this particle can be described with the wavefunction, $\Psi(x)$, which encodes the probability that the particle is at the point x.
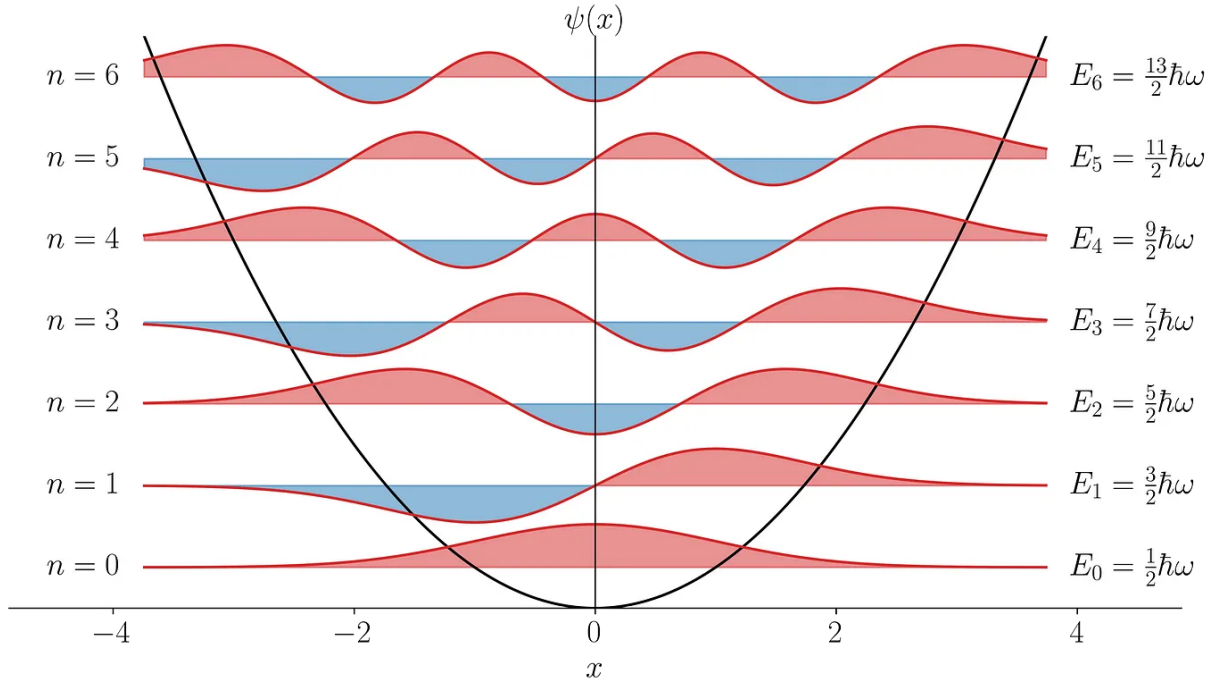
Fig. 3: A plot of the harmonic oscillator wavefunctions (Jackson). The vertical direction represents the energy of the quantized energy levels, and the horizontal direction represents the direction of motion.

The exact form of the wavefunction will depend on the energy of the particle. Fig. 3 shows a plot of harmonic oscillator wavefunctions. The x-axis is the direction of motion, and the y-axis shows the energy levels, with the trapping parabolic potential shown in black. Most importantly, Fig. 3 shows that energy levels do not occur at every possible location. This is due to the quantization of energy, and is also the case with electron orbitals. A particle must gain enough energy to "jump" up to the next energy level. An ideal quantum harmonic oscillator would have infinite energy levels, but in reality they only extend a finite distance and a particle will be able to escape. Fig. 3 also shows how only an integer number of wavelengths can fit within the energy well. Note, however, the boundary of the harmonic oscillator potential is not a hard boundary – it is more of a soft or spread-out boundary. The quantized energy levels of the quantum harmonic oscillator potential are very useful for describing the shell structures that appear in the nuclei of atoms.

The Nuclear Shell Model

Now that we have explained the concept of a quantum harmonic oscillator, we can now move on to the nuclear shell model. The history and shortcomings of the nuclear shell model are a key topic for understanding the current state of knowledge of nuclear structure. In this section, we will discuss the development of the nuclear shell model, its successes and failures, and attempts to improve it.

The original nuclear shell model, developed simultaneously in 1949 by Maria Goeppert-Mayer in the United states and Hans Suess, Hans Jensen, and Otto Haxel in Germany

has been crucial for determining properties of nuclei and explaining the magic number phenomenon. It simplifies calculations, treating a nucleus as a two-body system instead of a many-body system containing potentially dozens of particles. One of the core assumptions of the nuclear shell model is strong spin-orbit coupling (Mayer 1). The nuclear shell model uses a harmonic oscillator potential, which can be solved analytically. However, this treats the nucleus as spherical and therefore cannot be used for many nuclei. The original shell model can become quite complex and computationally demanding for many nuclei, requiring calculations far beyond the capabilities of shell-model codes (Otsuka 2). Though today its flaws are clear, the shell model's successes cannot be understated. The nuclear shell model's explanation of magic numbers helped to explain why some isotopes were particularly stable or abundant. It also explains why all known isotopes with 39 neutrons are unstable, due to the closing of a p shell at Z = 40 (Feenberg and Hammack 3).

There have been multiple attempts to improve the shell model, one being the No Core Shell Model (NCSM). The basic idea of the NCSM is to treat all nucleons as active and solve the equation for that, rather than treating the nucleus as having an inert core forming a closed shell. The NCSM approach avoids issues related to the excitation of nucleons from the core (Barrett et al. 3). In addition, it also correctly predicts the extremely small quadrupole moment of lithium-6, which nearly all other models struggle with (Barrett et al. 19). While it is a significant improvement from the original shell model, the NCSM is only solving a three-body problem. This does not take into account the individual behaviors of all the nucleons in a nucleus.

The Monte Carlo Shell Model (MCSM) is also often used. The main advantages of the Monte Carlo Shell model are that it can describe excitations within the nucleus, and that it can handle many valence particles. The second point is essential for calculations involving heavy elements (Otsuka 7-8). The MCSM simplifies calculations by only considering a few important vectors (particularly for low-lying states) that are dominant in terms of key nuclear properties, making calculations possible (Otsuka et al. 2-3). The major advantage of the MCSM is that dimensions grow gradually with increasing complexity, so it can describe the behavior of nuclei including full valence shells (Otsuka et al. 17). This allows more insight into nuclear structure. Unfortunately, as with all nuclear calculations, significant amounts of computing power and time must be used.

One of the other reasons why the nuclear shell model fails is that the concept of shells tends to break down for some nuclei. For superheavy nuclei, it's not known whether shells work in quite the same way as in lighter, more stable elements (Heßberger 2). For a more detailed and complete understanding of exotic nuclei, sophisticated many-body treatments and experimental programs are necessary.

In reality, nuclei are complex many-body quantum systems, and the non-trivial nature of the interactions between protons and neutrons inside a nucleus can lead to non-spherical nuclear shapes, especially in the case of neutron-rich and heavy nuclei. A comprehensive theory of the many-body interactions within nuclei does not currently exist and none of the methods described in this section have a well-defined regime of applicability beyond spherical nuclei. The quantum

theories that are available are computationally demanding and calculations are often limited by hardware. Therefore significant effort is being directed towards not only the development of new theories that can incorporate the relevant physics, but also hardware and software design. Even current theories which have limited regimes of applicability require experimental input due to free parameters in the theory. Millions of dollars have been put into the Facility for Rare Isotope Beams (FRIB) and other experimental facilities to address this issue.

Neutron Skins

Neutron skins are another major aspect of more complex structure in nuclei, and are common in heavier isotopes. Neutron skin thickness is dependent upon the pressure of neutron-rich matter. With high pressure, neutrons are pushed out to form a thick neutron skin (Horowitz and Piekarewicz 1). Essentially, the neutron radius is larger than the proton radius, so for some, especially neutron rich nuclei, it might be energetically favorable to form a neutron skin due to the complex interplay between coulomb and strong nuclear force interactions. Neutron skins can occur in non-exotic nuclei (such as lead-208), but are significantly pronounced primarily in unstable exotic nuclei (Baldo and Burgio 15).

Two nuclei shown to have neutron skins are calcium-48 and lead-208. Calcium-48, probed with parity-violating electron scattering in the CREX experiment, has been shown to have a thin neutron skin. Lead-208 was shown to have a thick neutron skin in the PREX-II experiment. Due to the small length scales required to describe nuclei, length is typically measured in femtometers (fm), where 1 fm = 10^{-15} m. The width of 208Pb's neutron skin was measured to be 0.283±0.071 fm (PREX Collaboration 5). Calcium-48's neutron skin was measured to be 0.121±0.026 fm (CREX Collaboration 5). Note that 48Ca has a radius of 3.4771 fm, while 208Pb has a radius of 5.5012 fm (Angeli and Marinova 78, 88).

Neutron Halos

Much less understood than neutron skins, neutron halos also pop up in neutron-rich isotopes. Halos appear in very light nuclei because neutrons are more strongly bound in heavier isotopes, causing neutron skins to appear instead of halos. Indeed, as halo structures appear very close to the drip lines, only very light neutron halo isotopes are known.

The halo structure means that these nuclei will present a more tightly bound core with a much more loosely bound valence nucleon or nucleons, resulting in a significantly larger radius than other nuclei with the same number of nucleons. These particles form a low density diffuse "halo" around the core, as they have a higher probability of being farther away from the other nucleons.

The halo occurs due to the quantum tunneling of a few loosely bound nucleons (Shyam and Chatterjee 3). Quantum tunneling describes the observed phenomenon of particles moving through a potential barrier. Classical mechanics cannot describe this phenomenon, which occurs purely due to the quantum nature of nucleons. This is shown very clearly in a halo nucleus, where there is an area near the core with a high nucleon probability density, an area slightly

farther away with a very low probability density, and then the "halo" area with a higher probability density again. The nucleon "tunnels" through the low probability density area between the two high probability density regions to form the halo. Beryllium-11 is an example of a one-neutron halo nucleus, while lithium-11 is a two-neutron halo nucleus (Capel 1-2).

Halo nuclei have very short half-lives, since they are very close to the drip line. For that same reason, halo nuclei are difficult to create and measure experimentally. Facilities like FRIB will help further our understanding of halo nuclei in the coming years.

Clustering

Another important aspect of structure is the clustering of particles in a region of space, giving rise to substructure in nuclei. Alpha-clusters are one of the most common forms of clustering in nuclei, which occurs when two neutrons and two protons form a bound state. This happens due to the very high binding energy of the helium-4 nucleus. 12C and 16O have been modeled as being composed of three and four α-clusters, respectively. This model succeeded in explaining electromagnetic properties that the typical shell model could not (Horiuchi and Itagaki 1). It has been suggested that one state of 12C may be three α-particles arranged linearly, while another has the three particles in an equilateral triangle (Freer et al. 3). Beryllium-8 has also been found to be highly clustered. The isotopes 9Be and 10Be appear to preserve this cluster structure.
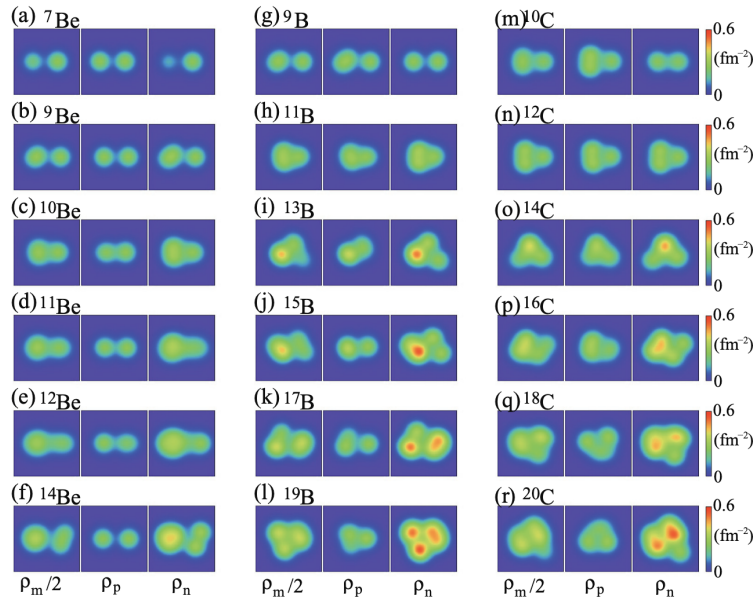
Fig. 4: From left to right in each panel: distributions of proton, neutron, and matter densities for several beryllium, boron, and carbon isotopes (Kanada-En'yo).

Fig. 4 shows multiple excellent examples of clustering from theoretical molecular dynamics calculations. It is a chart of proton, neutron, and matter densities for isotopes of beryllium, boron, and carbon. Note how carbon isotopes appear to form triangular structures at isotopes with 6 or more neutrons. Beryllium displays an elliptical or "peanut-like" shape, caused by the emergence of two regions of higher matter density. Similarly, the lighter isotopes of boron

display elliptical shapes, while heavier isotopes are more triangular due to the emergence of a third cluster. While this prediction is specific to one theoretical framework, the uneven distributions clearly point to strong clustering in these nuclei, a promising signature that can be searched for experimentally.

Shell Gaps and Shell Evolution

Shell gaps are incredibly important in the discussion of nuclear structure, as they encode the energy difference between different shells. At magic numbers, there are very large gaps between energy levels, which points to an intrinsic connection between shell gaps and magic numbers and, thus, the stability of nuclei.

Empirical shell gaps for binding energy E

Proton shell gap
$\Delta_{2p}(N,Z) = E_{N,Z+2} + E_{N,Z-2} - 2E_{N,Z}$

Neutron shell gap
$\Delta_{2n}(N,Z) = E_{N+2,Z} + E_{N-2,Z} - 2E_{N,Z}$
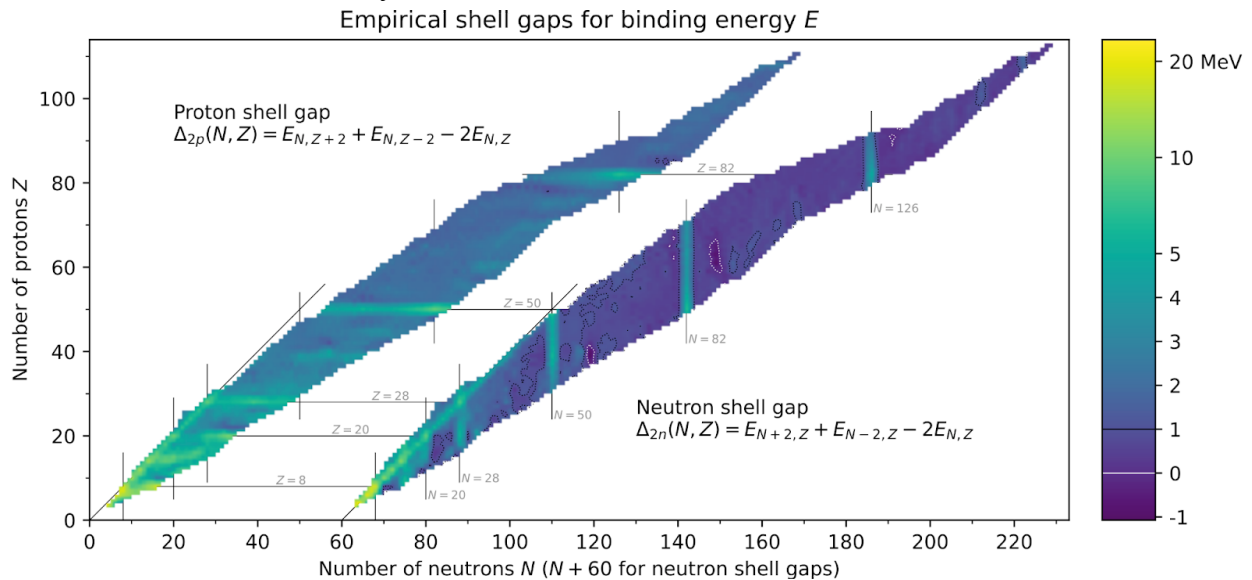
Fig. 5: A chart of proton and neutron shell gaps (Dobson). The left chart shows proton shell gaps, with vertical lines where neutron shell gaps are located as well. The right chart shows neutron shell gaps, with vertical lines marking where each shell gap occurs. Horizontal lines show the locations of proton shell gaps. The line N = Z is marked on both charts.

Fig. 5 is a chart of both proton and neutron shell gaps as function of the number of neutrons (N) and protons (Z), and demonstrates how large shell gaps appear at magic numbers and at the line N = Z. Note that the line N = Z occurs quite close to the edge of each chart, and as it does not line up with the line of stability for long heavier magic isotopes will not lay on this line. However, as previously discussed, magic numbers only tend to hold at isotopes relatively far from drip lines. In less conventional isotopes, more complex effects come into play.

In exotic isotopes, traditional magic numbers tend to disappear and large shell gaps are observed at new energy levels. This is known as shell evolution. For neutron-rich calcium isotopes, magicity has been observed at N = 32 and N = 34 (Brown 2). These are not traditional magic numbers, but due to the phenomenon of shell evolution, these isotopes are unexpectedly stable. The N = 32 sub-shell gap has also appeared in neutron-rich titanium and chromium isotopes. Heavy beryllium isotopes are another example of shell evolution in neutron-rich nuclei. In 11Be and 12Be, the N = 8 shell gap disappeared (Freer et al. 11). These isotopes also show

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evidence of the appearance of a new magic number at N = 6 due to the abnormally small charge radius (Freer et al. 12).

Away from the drip line, shell gaps and shell evolution are poorly understood due to both theoretical and experimental uncertainties. Once again, FRIB is expected to make measurements which will help determine the shell structure of neutron-rich nuclei.

Reactions

Nuclear reactions are extremely important tools for examining the structure of neutron-rich isotopes. For instance, knowledge of halo nuclei would be impossible to acquire without the help of nuclear reactions. That is because individual atoms are too small to be probed by anything in the visible light spectrum (and nuclei are miniscule compared to atoms). In order to access smaller length scales we need high-energy collisions between nuclei, which allow us to resolve individual protons and neutrons inside the nucleus. This section will discuss different types of reactions, the decay of drip-line nuclei, and new facilities that will improve the understanding of nuclear reactions.

Breakup Reactions

Breakup reactions can be described with a participant-spectator model, where one part of the nucleus goes on to interact with a target nucleus but the other continues on in its original trajectory. This type of reaction is well-suited to study nuclei with short lives, such as halo nuclei. In breakup reactions of halo nuclei, the weakly bound halo dissociates from the core by interacting with the target (Valiolda et al. 2). The two mechanisms by which breakup occurs are Coulomb and nuclear interactions, which are distinct fundamental forces. For an accurate model of the breakup of nuclei, both need to be taken into account. This requirement poses a fundamental challenge for the theoretical modeling of these reactions.

Nucleon Emission

Nucleon emission occurs far from the line of stability, where the excess neutrons or protons become very weakly bound and can escape the nucleus. This type of decay contributes to the understanding of which nuclei can exist in bound states, as well as whether states are bound for specific types of nucleon emission.

In neutron-rich isotopes, the induced emission of a neutron following a previous β decay has been observed when the β decay populates excited states where the neutron is not bound. This is also observed in proton-rich isotopes with induced proton emission (Godoy 25).

When the energy required to remove a nucleon becomes negative, nuclei will spontaneously emit a neutron or proton at their ground state. Proton emitters display longer lifetimes than neutron emitters due to the Coulomb barrier constraining valence protons. While proton emission competes with β decay due to its slower pace, neutron emission is the dominant decay mechanism for unstable neutron-rich nuclei (Godoy 26).

Beyond the drip lines, two-nucleon emission at the ground state often happens. Interestingly, near the drip lines even-N beryllium isotopes are bound for single nucleon emission and odd-N isotopes are unbound. Some systems can exist that are bound for single nucleon emission and unbound for two-nucleon emission. Oxygen-26 and beryllium-16 are good candidates for spontaneous two-neutron emission (Godoy 27, 35).

Other Reactions

Other types of reactions are possible, such as knockout, inelastic scattering, and transfer reactions. Knockout reactions allow for the investigation of a nucleus by removing one or a few nucleons from the beam nucleus via its collision with a target light stable nucleus. In inelastic scattering, a nucleus of interest in the beam collides with a stable target (just as in knockout reactions), but no nucleons are removed, which allows us to measure the excited states of a nucleus. Transfer reactions are when nucleons are transferred from one nucleus to another. These reactions are especially useful for determining the structure of halo nuclei.

Facilities

There are many facilities currently studying the reactions of rare and exotic isotopes. Two major facilities active at the moment are the Radioactive Isotope Beam Factory (RIBF) and the Facility for Rare Isotope Beams (FRIB).

RIBF is located at RIKEN Nishina Center, Japan. One of its major advantages is that it can collect widely spread reaction products. FRIB is located at Michigan State University in the United States. It recently became functional, replacing the previous facility at MSU, NSCL (the National Superconducting Cyclotron Laboratory). FRIB is expected to produce about 5000 isotopes, while RIBF can produce about 4000. As well as improving the understanding of nuclei, the study of neutron-rich isotopes helps to illuminate large-scale structures.

Nuclear Structure and Astrophysics

Neutron-rich isotopes have many applications to large-scale structures in the universe. Neutron stars, supernovae, and nucleosynthesis are some of the major areas of study where the study of neutron-rich isotopes applies. In this section we will discuss nuclear matter's relation to neutron stars, supernovae, and nucleosynthesis, as well as the equation of state (EOS) that governs its behavior.

One of the clearest connections between subatomic structures and large-scale phenomena is revealed in neutron stars. Neutron stars consist of a solid non-homogenous crust above a liquid core. The crusts of neutron stars and the skins of heavy neutron-rich nuclei are made of the same essential material: neutron-rich matter at roughly the same density (Horowitz and Piekarewicz 1). In addition, the size of the radii of neutron skins of heavy elements have profound implications on the structure of neutron stars, such as the stellar mass and equatorial radius (Fattoyev and Piekarewicz 12). In addition, the thicker the neutron skin is determined to be, the

lower the density of the transition from crust to liquid of a neutron star (Horowitz and Piekarewicz 9).

As stated above, exotic extremely neutron-rich nuclei are present in the crusts of neutron stars. The environment of a neutron star prevents these asymmetric nuclei from β-decaying due to the presence of electrons (Baldo and Burgio 3). Towards the core of a neutron star, the atomic number increases and the nuclei become increasingly neutron-rich. Such nuclei are extremely unstable and are not available in laboratory environments on Earth. However, in the inner crust of a neutron star, the neutron excess becomes so large that neutrons begin to "drip" from the nuclei and form a neutron gas (Baldo and Burgio 26). The drip point is dependent on the symmetry energy, shell effects, and single particle effects, all of which are key properties of exotic nuclei that we study with experiments on Earth.

In addition to neutron stars, supernovae are also intrinsically connected with exotic nuclear matter. As massive stars collapse during a supernova, their cores collapse until the density reaches the point where nuclear matter is the most strongly bound. After that point, the binding energy starts to decrease with increasing density, the collapse stops as matter bounces, leading to an explosion of massive proportions. The nuclear matter EOS (and symmetry energy in particular) determines at what point in the supernova matter "bounces." The environment of a supernova is quite different from a neutron star in terms of temperature and proton-to-neutron ratios, but both these structures are governed by the nuclear matter EOS.

Neutron-rich matter is also relevant to nucleosynthesis. Reactions and decays of neutron-rich rare isotopes are what drive the processes that synthesize elements. The rapid neutron capture process (r-process) is the process that creates about 50% of naturally occurring isotopes past iron. It is currently poorly understood, but thought to happen at extreme temperatures with a very high density of neutrons (Watanabe 35).

The EOS for nuclear matter is essential for the understanding of the structure and stability of nuclei, the structure of neutron stars, element formation, and whether the core-collapse of massive stars result in neutron stars or black holes (Adhikari et al. 1). Currently, the EOS at high densities (multiple times the densities in heavy nuclei) is not very well known. Constraining the EOS in many different regimes is one of the major goals of nuclear physics and will require input from astronomical observations and terrestrial experiments.

Conclusion

The continued research into neutron-rich isotopes is one of the most important topics in the field of nuclear physics. In this review, we have explored currently known aspects of structure, reactions, and how these apply to the greater universe. More specifically, we discussed that many aspects of neutron-rich nuclei are poorly understood, such as deformed nuclei, clustering, halos, shell structures, and ground states. Though not much is known from either theory or experiment, there are major efforts towards developing new theoretical frameworks (and hardware to support demanding calculations) as well as reaction studies at state-of-the-art facilities like FRIB and RIBF that will offer novel experimental insight in the near future. The

improved understanding of neutron-rich nuclear matter will help us to learn about how the world works at the smallest and largest levels of the universe. Therefore, it is important to support future research to push this understanding even further.

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Telomeres, Telomerase, and Their Implications in Cancer By Aanya Sahu

Abstract

Through telomeres, telomerase, and their involvement in cancer, we can pinpoint indicators for early identification and preventive measures of cancer and potentially help the creation of new possibilities in the medical field. By seeking out the unexplored aspects and establishing connections, this paper aims to underscore the fundamental characteristics of telomeres and telomerase concerning cellular proliferation and regulation. Telomeres are repetitive sequences of DNA at the end of chromosomes that protect them from becoming frayed or tangled. Telomeres get shorter after each cell division, therefore if the telomeres get too short, the cell stops dividing. Telomerase is a protein that is naturally present in cells to help maintain the length of telomeres (Zvereva, Shcherbakova and Dontsova, 2010). While cells use it to avoid telomere shortening, cancer cells exploit telomerase to circumvent limitations to cell proliferation. Cancer cells achieve this by activating the TERT gene that encodes telomerase (Jafri et al., 2016). This paper will provide an overview of the components and functions of both telomeres and telomerase. It will first describe how cells use telomere capping to protect the ends of chromosomes from breaking and how telomere loops are formed at the end of DNA strands to facilitate interactions between different parts of DNA. Then it will describe how the two main components of telomerase - telomerase reverse transcriptase (TERT) and telomerase RNA component (TERC) - work to maintain telomere length.

Introduction

The cell cycle is composed of 4 stages: gap 1 (G1), synthesis (S), gap 2 (G2), and mitosis (M). During the G1 phase, the cell grows in size and synthesizes mRNA and proteins necessary for DNA replication. Following G1 is the S phase, where the DNA is copied and synthesized. DNA is unraveled by helicase, a protein that breaks the hydrogen bonds and thus unwinds the helical structure of the two DNA strands (Cooper, 2000). To avoid the DNA from recoiling, a protein called topoisomerase relaxes the DNA in front of the replication fork. DNA primase is critical for chromosomal stability since it maintains telomeres by helping couple replication and repair (Arezi and Kuchta, 2000). DNA primase initiates the synthesis of new DNA strands by synthesizing RNA oligomers, or primers, on the single-stranded DNA (Arezi and Kuchta, 2000). DNA polymerase III follows the RNA primer, which is a short strand of RNA nucleotides, to go through the template strand and add corresponding nucleotides (ref). Later, DNA polymerase I goes over the replicated DNA and fills in the gaps between Okazaki fragments on the lagging strand. Since human cells have linear DNA, after every round of cell division, some DNA at the ends of the strands are lost. As a result, cells compensate for this nucleotide loss by using telomeres which are repetitive, noncoding DNA, at the ends of the strands. Lastly, the ligase glues the newly replicated strand and the rest of the DNA strand. The G2 phase is when the cell is almost ready to divide. Lastly, mitosis occurs. Mitosis is an especially critical time for the cell since it takes place right after the DNA strands are split and replicated.

Telomeres

  Telomeres are genetic and structural adaptations at the end of DNA strands to protect the genetic material (O'Sullivan and Karlseder, 2010). Telomeres get shortened at the end of every cell division since the RNA primase present on the chromosome is not able to transcribe the DNA sequence on the overhanging part of the chromosome (Maestroni, Matmati and Coulon, 2017). Telomeres are repeated segments of TTAGGG which is noncoding DNA (Colebatch, Dobrovic and Cooper, 2019). Telomere shortening can result in cytotoxic effects such as interfering with tissue replenishment by blocking cellular division (Blackburn, Epel and Lin, 2015). The cell will undergo apoptosis or cellular senescence as the telomeres are shortened in somatic cells (Aubert and Lansdorp, 2008., Shammas, 2011). Shortening is linked with aging and thus increases the likelihood of disease and other cytotoxic related side-effects (Shammas, 2011). When telomeres become shortened, the cell goes into crisis mode which leads to chromosomal instability (Colebatch, Dobrovic and Cooper, 2019). Cells escape crisis through either upregulation of telomerase or other such lengthening of telomere mechanisms (Colebatch, Dobrovic and Cooper, 2019). In the latter process, telomeres are replenished using homologous recombination.

Telomere Capping

  To help prevent deletion, duplication, or translocation of DNA segments on chromosomes, telomeres must be capped. The telomere has at least a few hundred repeating nucleotides that "cap" each chromosome end to avoid activation of the DNA repair pathway (Webb, Wu and Zakian, 2013). This telomere cap protects the ends which look like DNA damage since it is marked by blunt ended DNA. Blunt ends normally signify DNA damage. Repair of critically short or "uncapped" telomeres by telomerase or recombination is limited in most somatic cells and apoptosis or cellular senescence is triggered when too many "uncapped" telomeres accumulate. (Aubert and Lansdorp, 2008). Telomerase activity can be involved in chromosome healing though telomerase-independent processes also appear to be capable of capping broken chromosome ends (Preston, 1997).

  A specific telomere cap is shelterin. Shelterin is a protein complex that shapes and safeguards telomeres (de Lange, 2009). Shelterin prevents telomere ends from being recognized as damaged DNA and thus avoids DNA repair pathways by forming a protective cap around the telomere ends. It also influences the access of telomerase to telomeres and therefore regulates the length of the telomere overhang. Shelterin hides telomeres and chromosome ends from DNA damage surveillance thereby bypassing DNA repair pathways (de Lange, 2009). Shelterin protects telomere ends and also modulates telomerase activity (Lim and Cech, 2021). The core components of Shelterin are TRF1 (Telomeric Repeat-binding Factor 1), TRF2 (Telomeric Repeat-binding Factor 2), POT1 (Protection of Telomeres 1), TPP1 (POT1-interacting Protein 1), TIN2 (TRF1-interacting Nuclear protein 2), RAP1 (Repressor/Activator Protein 1). Shelterin prevents telomere ends from being recognized as damaged DNA and thus avoids DNA repair pathways by forming a protective cap around the telomere ends. It also influences the access of

telomerase to telomeres and therefore regulates the length of the telomere overhang. Shelterin is important to cellular health since any mutations in shelterin can possibly lead to telomere dysfunctions which can lead to genetic disorders and cancer development. These repetitive telomere sequences, when assembled with shelterin, protect the ends of chromosomes from DNA repair pathways that were triggered by DNA damage response (Colebatch, Dobrovic and Cooper, 2019).

Loops

Telomere loops (T-loops), displacement loops (d-loops), and R-loops are all distinct structures formed from the double-stranded DNA (Necasová et al., 2017). These loops are critical to understanding how telomeres find ways to trick the DNA repair pathways that would recognize the telomeres as breakpoints. Each loop has a different function in various cellular processes.

D-loops are structures that form during homologous recombination, a process where the nucleotide sequences are exchanged between two molecules of DNA (Wright, Shah and Heyer, 2018). During homologous recombination, a single-stranded DNA molecule intersects a homologous double-stranded DNA molecule, forming a displacement loop (Cooper, 2000). The invading single-stranded DNA displaces one of the original DNA strands, creating a region of heteroduplex DNA where the two strands are from different parental molecules (Morrical, 2015). This process is essential for repairing DNA breaks, promoting genetic diversity, and ensuring proper segregation of chromosomes during meiosis (Murakami and Keeney, 2008).

R-loops are triple-stranded nucleic acid structures that form when a single-stranded RNA molecule hybridizes, or binds, to its complementary DNA strand, leaving one DNA strand displaced (Belotserkovskii et al., 2018). These structures are formed during transcription when the DNA template strand and the transcribed RNA molecule remain bound together. R-loops can enhance transcription and promote chromatin modifications but can also lead to genomic instability,DNA damage, and replicative stress (Crossley et al., 2023).

T-loops are structures that help protect the chromosome ends from being recognized as damaged DNA (Ruis and Boulton, 2021). This structure is formed when the lagging strand overhang pairs with the double stranded region of telomeric DNA creating a loop (Kan et al., 2007). They also prevent the activation of DNA damage response pathways that could lead to apoptosis or senescence (Nowsheen and Yang, 2012).

In conclusion, D-loops play a role in DNA repair and genetic recombination and R-loops are three-stranded structures formed during transcription with a function similar to D-loops. T-loops are present at the ends of chromosomes to protect them from damage.

Telomerase

Telomeric DNA is often shortened due to degradation or incomplete replication (Harley, Futcher and Greider, 1990). Telomerase is a protein complex that repeatedly adds the TTAGGG nucleotide sequence to elongate telomeres and maintain the length of chromosomes which is necessary to maintain the health of cell (Bonnell, Pasquier and Wellinger, 2021).   It is composed

of telomerase reverse transcriptase (TERT) and telomerase RNA (TERC). Telomerase is naturally present during development in embryonic stem cells and is later repressed in somatic cells (Colebatch, Dobrovic and Cooper, 2019).

TERT

Telomerase reverse transcriptase (TERT) is a protein that gives instructions to make a component of telomerase (Fagerberg *et al.*, 2014). TERT is necessary in controlling telomerase activity in tumors, especially demonstrating the hallmark of neoplastic growth (Colebatch, Dobrovic and Cooper, 2019). TERT is encoded by the *tert* gene, which is found in the cell nucleus. TERT is a naturally present protein yet it is heavily amplified in cancer cells which can be due to telomere dysfunction (Dratwa et al., 2020). *Tert* is generally overexpressed in cancer and stem cells due to the need for cellular proliferation (Wu *et al*., 2022). The most common type of mutation to TERT function are noncoding *tert* promoter mutations (TPMs) (Lorbeer and Hockemeyer, 2020). TPMs occur during tumorigenesis and are a common first mutation in many cancers. TPMs allow for cell proliferation by encouraging telomere growth (Lorbeer and Hockemeyer, 2020).

TERC

Telomerase RNA (TERC) is another genetic component of telomerase (Wu *et al.*, 2022). It is an integral part of the telomerase complex and provides the necessary sequence information for the addition of telomeric repeats to the chromosome ends (Schmidt and Cech, 2015). TERC is a separate gene that serves as a template for *tert*, thus allowing it to be the catalytic component leading to cell proliferation (Gala and Khattar, 2021). Although known as the catalytic component, TERC still regulates cell proliferation since it has functions in cell apoptotic effects and helps protect against DNA damage regarding telomerase activity (Wu *et al.*, 2022).

Taken together, TERT maintains the telomere length and therefore allows cells to avoid senescence since it is still necessary to naturally lengthen telomeres (Dratwa et al., 2020). Expressed in somatic cells with telomerase activity, TERC regulates the pathways using a positive feedback loop to allow for more cell proliferation (Wu *et al.*, 2022). The more TERC present, there is an upregulation of the PI3K-AKT pathway in somatic cells (Wu *et al.*, 2022). This pathway is connected to cell proliferation, survival, metabolism, and protein synthesis (Wu *et al.*, 2022). However, this positive feedback loop plays a role in TERC, which also creates adaptive immune reactions to infectious pathogens and tumor cells (Wu *et al.*, 2022). Conceptually, shelterin creates an equilibrium since it allows for limited access of telomerase to the overhang strand yet also regulates the length of the telomere overhang.

Implications in Cancer

Despite the efficiency of these DNA pathways, cancer is still able to bypass cell cycle checkpoints intended to stop uncontrolled cell growth. To be able to bypass these checkpoints, multiple mutations have to occur to work together to promote cell proliferation.

Now understanding this, it is easier to see the cellular regulations in place to keep a cell healthy by using telomere capping, telomere loops, telomerase, telomerase, TERC, and TERT.

This just shows how most of the components present in the cell, including telomere capping, shelterin, telomerase, TERC, TERT, and T-loops, are all working hand in hand with each other in creating an equilibrium where telomere shortening and cell proliferation is maintained.

As a novel method of targeting cancers, there are many different techniques of inhibiting telomeres and telomerase in cancer killing drugs. GRN163L (Imetelstat) directly inhibits the RNA template of telomerase by antagonistically binding to it. It has been used successfully for initial treatment of breast cancer but long term results are still unknown. Imetelstat is the most widely developed and successful method. A method of inhibition that indirectly impacts telomerase is the silencing of tankyrase 1 (TNKS1), a protein required during S-phase which is required in telomerase activity. Lastly, an alternate method of inhibiting cell proliferation is by targeting TERT. By targeting TERT, cancer won't develop resistance due to the usage of different, unused pathways.

Conclusion

DNA replication is critical for cellular health. Crucial to this pathway are telomeres and telomerase. Telomeres are present at the ends of chromosomes to protect the ends from getting frayed or tangled and get shorter after each cellular division. With telomerase naturally lengthening the telomeres, cancer cells exploit this mechanism to promote uncontrolled cellular proliferation. One way that it can occur is activating the TERT gene that encodes telomerase. Telomeres and telomerase work to create an efficient equilibrium between telomere shortening and upregulation of telomerase within the cell.

Cancer is a debilitating disease without a cure. By understanding telomeres, telomerase, and their role in cancer, we can more fully understand the disease, identify biomarkers for early detection and prevention, and potentially inform novel drug production. By looking for the unknowns and by making connections, this paper set out to highlight the hallmarks of telomeres and telomerase in the context of cellular proliferation and control.

Acknowledgements

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Exploring the Ethical, Cultural, and Scientific Dimensions of Embryonic Stem Cell Research: A Comprehensive Review By Saranya Shiva Shankar

Abstract

Embryonic stem cell research has emerged as a topic of great significance, encompassing not only scientific advancements but also complex political, religious, and moral debates. This review paper aims to shed light on the background of embryonic stem cell research, and the policy and religious debates occurring on this topic. Additionally, this paper explores the potential scientific benefits that can be derived from embryonic stem cell research, highlighting the promising avenues for medical advancements, such as regenerative medicine and disease treatment. Ultimately, this review paper provides a comprehensive anthropological examination of embryonic stem cell research, aiming to foster a deeper understanding of the subject matter within a broader societal context.

Introduction

We all know those pesky little rodents that we find in our attics and leave traps with cheese out for. Mice can be a real nuisance to homeowners, and most of us want nothing to do with them. Yet, for scientists, these creatures are invaluable in that they hold the key to the creation of modern day embryonic stem cells. These cells have reopened multiple possibilities for scientists that were previously unavailable to them thanks to these cells' ability to transform into any cell type. The creation of embryonic stem cells dates back to research done on cells that were originally harvested from mice's fertilized eggs in their early stages, also known as a blastocyst. Based on these findings, scientists would later discover how to extract embryonic stem cells from humans and how to grow them in laboratories (*Chapter Three Embryonic*).

It was these findings that allowed scientists to examine the properties and functions of embryonic stem cells, including two significant features of them. The first is that they are unspecialized cells, meaning that they possess the ability to undergo cell division even after long periods of inactivity, which is uncommon amongst most cells. The second is that these cells are pluripotent, or cells that are able to transform into a variety of cell types. This means that depending on the experimental or natural conditions that they are exposed to, they can become any type of cell: tissue cells, muscle cells, nerve cells, among many others (Nwigwe). Scientists have also found that the ability to differentiate into any type of stem cell is unique to embryonic stem cells. While adult stem cells, the more common stem cell type, can also differentiate into a variety of cells, they still have their limits (Smucker).

Religious and Political Debates Surrounding Stem Cells

Due to the surrounding controversy on the topic, the issue has become increasingly political in recent years. In August of 2001 President George W. Bush enacted a ban on government funding of embryonic stem cell research and prohibited scientists from creating new embryonic stem cell lines (Murugan). This was meant to be a compromise between the two sides

by allowing scientists to still work with previously-available embryonic stem cell lines, while still containing the progress of said research. While it seemed like a fair compromise at the time, this ban ended up having multiple adverse effects such as hindering scientists' abilities to collaborate with each other and forcing scientists to utilize private funds to continue with their research. Not to mention that the previously existing cells lacked genetic and ethnic diversity, which made it more difficult for scientists to study rare diseases which are areas that would often benefit the most from stem cell research(Murugan). Due to the fact that the preexisting cell lines aren't genetically varied there is a lot of uncertainty surrounding the genetic workings of minority groups. Essentially, treatments derived from preexisting cells will pose a larger threat to patients of minority groups since their specific genetic makeups wouldn't have been taken into consideration when creating the medications. Embryonic stem cell research would be able to remedy that issue to help make the healthcare system more inclusive and safe for all people around the world.

For many, the main concern about embryonic stem cell research is the fact that extracting the stem cells from the embryo essentially kills the blastocyst. In their eyes an embryo is equivalent to a human life and that the intentional "killing" of an embryo is the same as murdering a person. This viewpoint tends to stem from religious ideologies, such as the ones preached in the Catholic Church. The Roman Catholic Church claims that an "embryo acquires full human status at fertilization," a belief popularized by Pope Pius IX (Lachmann). Due to the lack of consensus on when exactly life begins, this is a highly contested topic. Everyone has different views, and are entitled to their various beliefs. Another popular belief on this side of the debate is one made claiming that since an embryo is simply a stage that a human being must progress through before becoming a living, breathing person— just as an infant is still a human being in the infant stage— it will eventually become a person and should be given the same respect as a person ("Embryonic Stem Cell Research"). These views are all valid as they are backed by theology, reasoning, or both, which is seen in the arguments stated above.

As mentioned before, there are a spectrum of beliefs on this debate, and on the opposite end is a belief that Harvard professor Micheal J. Sandel advocates. Sandel teaches political philosophy at Harvard University and is well known for his writings on ethics, justice, democracy, and more. During his interview with the Harvard Stem Cell Institute on the topic, Sandel provided the analogy of an oak tree. Sandel stated that "although every oak tree was once an acorn, it does not follow that acorns are oak trees, or that I should treat the loss of an acorn eaten by a squirrel in my front yard as the same kind of loss as the death of an oak tree felled by a storm" (qtd. in "Examining the Ethics"). He compared the tree to a person in order to allow the audience to draw on a concrete concept to aid them in understanding the abstract idea he was attempting to communicate. Sandel demonstrates how even despite the fact that acorns are potential oak trees and embryos are potential people, we wouldn't go as far to call an acorn an oak tree, nor would we claim that an acorn has the same value that an oak tree does. So if it doesn't make sense in regards to acorns and oak trees why are we trying to apply it to embryos and people? We wouldn't say that a squirrel eating an acorn is the same as an oak falling over, so

why would we say that harvesting cells from a blastocyst is equivalent to killing a person? This belief is once again backed by sound reasoning, yet due to the ambiguity of this topic it is difficult to come to consensus on which side is right and answer the question of whether or not an embryo is equivalent to a human life.

Potential Drawbacks of Stem Cells

While the debate around whether or not it is ethical to use embryonic stem cells is the main reason for controversy over this topic, the issue of safety also arises in this debate. As with any new therapy, there are going to be unknown consequences that will arise as patients are beginning to be treated. There is no way to know for sure what types of reactions certain therapies will cause without testing them. Even so, embryonic stem cell therapy is hypothesized to cause varied immune responses due to the fact that they are technically foreign cells that are being introduced into the patient's body. As seen before in organ transplantations, there is always a risk that the patient's body will reject the transplant cells if the patient's body classifies them as a threat. It is a plausible argument that the same could occur with embryonic stem cells; they "might also trigger an immune response in which the recipient's body attacks the stem cells as foreign invaders" ("Answers to Your Questions"). What the body is using to differentiate between its own cells and foreign cells are histocompatibility antigens. Histocompatibility antigens are proteins that act as little tags on cells that immune cells, more specifically T-cells, bind to and evaluate to determine whether or not that cell is compatible with the individual. If not, then the immune system attacks those cells. Should the antigens on the embryonic cells be labeled as foreign invaders by a patient's T-cells, the embryonic cells that were released into the patient's body will slowly start to lose function and will become ineffective after being attacked by the patient's immune system. If parts of or an entire organ be replaced by embryonic stem cells, then the organ could lose function and begin to fail if the histocompatibility of the stem cells are rejected.

To counter this issue a variety of cells with all types of antigens need to be produced in order for embryonic stem cell treatments to be safe for all to use. While it may be counterintuitive at first, creating more embryonic stem cell lines can help to remedy this problem. The creation of a huge number of ESC lines would help to obtain diversity of cells that would lead to the rise of cells with a variety of histocompatibility antigens (*Chapter Three Embryonics)*. The same way that having strong matches between patients and transplants increases the success rate of the procedure, the same is true here. Allowing for a greater diversity of ECS lines will give more patients the chance of finding a strong histocompatibility match and participate in overall safer operations. This would allow for more people to receive the benefits of ECS treatments without having to worry about the possible adverse side effects.

Possible Benefits of Stem Cells

In an effort to take the steps necessary to further stem cell research, on March 9, 2009 President Barack Obama made good on his campaign promise when he signed an executive order

that lifted the ban put in place by President Bush in 2001 and offered public support for the advancement of embryonic stem cell research. He assured the American people that this did not signify the opening of the door to cloning of humans, but rather it opened the door to the promising potential of these cells (Wolinsky). A major benefit outlined in Obama's reasoning for approving the project was that it would enable scientists to gain a better understanding of people and the diseases that affect humanity. A growing field is the study of early human development and the creation of more embryonic stem cell lines create the opportunity to gain a better understanding of this field as a whole. For scientists, it is nearly impossible to understand the earliest stages of human development due to the lack of technology able to view the inside human uterus where the embryo is developing. Yet it's within this mystery that lies a field of unmet needs involving birth defects and pregnancy complications. If scientists are able to understand what occurs in these first stages of development then that would provide "potential clinical significance for preventing or treating birth defects, infertility and pregnancy loss" ("Embryonic Stem Cell Fact Sheet"). Embryonic stem cell research offers a gateway into exploring how to help save more lives, such as the lives of mothers who could be at risk of dying from severe pregnancy complications. It is saving the lives of innocent children who develop diseases and defects just as their lives are beginning. It is saving families that are forced to endure this traumatic experience. Embryonic stem cells can allow scientists to understand various birth defects in order to help make the miracle of birth and the joy of life a possibility for more people around the world.

Stem cells also hold the potential to provide researchers with insights about diseases that would be difficult to study otherwise. Embryonic stem cell research will allow for a more general understanding of diseases and how they develop by watching how the stem cells mature into multiple types of cells: bones, heart muscles, nerves, and other organs and tissue ("Answers to Your Questions"). A specific example of how studying the development of embryonic stem cells has multiple benefits for a field of study is the effects it could have for those suffering from lung diseases. Potential benefits for this specific field include "improving our understanding of developmental and genetic lung diseases as well as of a wide range of adult lung diseases, including asthma, emphysema, lung cancer, fibrotic lung disorders, and adult respiratory distress syndrome" (*American Journal*). While this example seems quite specific to this field, the same concept can essentially be applied to any other disease area. A greater understanding of how these diseases are formed could help offer new types of treatments for these disorders and easing the burden of these conditions that many are faced with. Scientists would be able to create various curative as well as preventative drugs based on the newfound knowledge of where certain diseases stem from. The field of science is all about making sense of ourselves as well as the world around us and embryonic stem cell research will allow scientists to do just that.

Embryonic stem cells are not just useful for studying diseases, but they also provide a new way to test a drug's effectiveness against them. The development of the drug has to undergo multiple phases and trials in order to guarantee the safety and efficacy of the drug. However, in the beginning of this process it can be difficult for scientists to determine which chemical

compounds to include in the drug in order to guarantee its effectiveness. This can be a rather time-consuming process even when scientists have a basic idea of what compounds should and should not work, but testing different chemicals on embryonic stem cells would significantly speed up the process. Scientists would be able to promptly test the effect of certain chemicals on specific cell types by measuring their responses and determining whether or not those chemicals should be included in the development of the drug. In short this method " offers a short-cut to sort out chemicals that can be used to treat the diseases that involve those specific cell types." This type of testing would "permit the rapid screening of hundreds of thousands of chemicals," a much more efficient way than the time consuming process that scientists are forced to carry out currently ("Embryonic Stem Cell Fact Sheet").

Perhaps one of the most exciting avenues of exploration this research offers is the ability to cure rare or complicated medical complications. These aggressive diseases have eluded researchers' cures for decades and continue to plague people all around the world, but embryonic stem cell research provides a long-awaited solution. Medical conditions such as spinal cord injuries, multiple sclerosis, diabetes, Parkinson's disease, cancer, heart disease, Alzhiemer's, and other rare diseases can now be cured with embryonic stem cells (White). These diseases are difficult to treat because their current therapies require the destruction of large numbers of cells that the patient is either unable to regenerate quickly enough or unable to regenerate at all. Consequently, patients are left weakened after these treatments and are at a higher risk to succumb to not only the disease itself, but to other dangerous illnesses as well. For example, in cancer patients not only can "stem cells replace cells damaged by chemotherapy or [the] disease" but they can also be used to form an effective immune system that is able to fight off the cancer cells ("Answers to Your Questions").

Today the use of stem cell therapy has made regenerative medicine one of the most promising areas in the fields of science and medicine (Aly). Embryonic stem cells have taken regenerative medicine to a new height with their potential to cure conditions that were previously deemed as incurable. Recently in Japan, the first stem cell-based treatment for spinal cord injuries has been approved by the government for patient use. Until this point, curing spinal cord injuries hasn't been possible because the nerve cells damaged in that area don't regenerate, so patients lose all mobility there without hope to gain it back. The damaged cells can't be fixed either, meaning the only way for patients to regain mobility is for new, healthy cells to be introduced into the patients system. The team had discovered that "injection of stem cells isolated from the patients' bone marrow aided in regaining some lost sensation and mobility," and while in this case the stem cells were taken from the patients' bone marrow these cells can also be created through embryonic stem cells (Aly). For most patients who suffer spinal cord injuries they are almost always informed that there is little to no chance that they will be able to regain their full range of mobility. However, this novel technology provides these patients with the hope of recovering from these injuries and participating in activities they used to love like bike riding, swimming, and running around with their kids again.

Conclusion

Embryonic stem cell research has the potential to give scientists access to a vast amount of knowledge that can be used as tools to save many lives in the future. This research offers many people a second chance at life with its potential to cure aggressive diseases that have no effective cure, and that is something worth our scientists' time and effort. Continuing with this research would allow us to make huge breakthroughs in the scientific and medical community, and could potentially cure diseases that over 100 million Americans suffer from (White). While this field has great potential there are still many drawbacks, but as science progresses forward we are faced with the question of how we will utilize this new technology, and what it means for not only the religius and politica field but for the science and medical worlds as well.

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The Meaning of Money By Freya Wang

Money is a concept unique to human society and has drawn attention from thinkers due to its role and importance. However, misconceptions often surround the interpretation of wealth. It could be argued that many individuals mistakenly perceive the accumulation of wealth as the ultimate goal, believing that more money equates to higher personal value and increased happiness. This essay challenges such misconceptions and argues that money should be viewed as a means and tool to achieve goals, rather than an end in itself.

Despite many individuals claiming to understand that money should serve as a means rather than an end, their actions often contradict this belief as they continue to prioritize financial gain. The Chinese philosopher Yangming Wang posits that true knowledge necessitates corresponding action. In this context, individuals who primarily pursue financial acquisition fundamentally regard money as an end in itself, rather than a mere tool. Regrettably, such a mindset prevails within our society, contributing to a proliferation of misfortunes and criminal activities. The widespread misconception about the nature of money perpetuates these negative consequences.

Meaning of Money

According to Friedman(1988) money is universally accepted as a commodity that serves as a medium for economic transactions. It functions as a means through which prices and values are communicated, circulating anonymously between individuals and across nations. By enabling trade, money plays a crucial role in facilitating economic transactions and serves as the primary metric for assessing wealth. However, Oswald Spengler (1923) highlights that many money theories often err by starting their analysis with the value-token or material aspects of the payment medium, rather than recognizing money as a conceptual category of thought, similar to numbers and laws (Skidelsky, 2017). Karl Marx expands on the role of money as an intermediary between human needs and the objects that satisfy them, as well as between one's existence and the means by which it is sustained (Marx, 1844). Furthermore, Marx emphasizes the distinct nature of currency as a "perpetual motion machine," signifying its unique status as a universal commodity capable of facilitating uninterrupted exchange of goods (Marx, 1844). By functioning as a medium of exchange for all commodities, money ensures the ceaseless circulation of goods within an economic system. In modern society, with the development of capitalism and consumerism, many individuals perceive money as the ultimate purpose of life, fostering a desire for the acquisition and accumulation of wealth, and even the propensity for exploitation or plundering—a phenomenon known as monetization, which aligns with Marx's theory.

Money assumes a significant role as a fundamental measure of value and wealth in contemporary society. Nearly everything within the social fabric possesses an inherent quantifiable value. The accumulation of substantial monetary resources grants individuals enhanced access to a myriad of social opportunities, including superior educational prospects,

improved healthcare, and an overall better quality of life. Moreover, individuals endowed with substantial financial means have the capacity to employ the labor of others, thereby yielding augmented monetary returns for both themselves and those whom they employ. Consequently, money serves a dual role, acting not only as a potent facilitator of economic "infrastructure" but also as an instrument of "domination" (Mann, 1986, as cited in Ingham, 2004). However, it is important to acknowledge that such power can be appropriated by specific interest groups, fueling widespread aspirations for greater control over financial resources and fostering the belief that the acquisition of money represents a lifelong goal.

Common Misconception: Money As The Final Goal

People naturally tend to want more, often comparing their wealth with others and feeling like they don't have enough. This innate characteristic has been significantly reinforced by the principles of capitalism, becoming a fundamental psychological aspect of civilization as a whole (Skidelsky, 2013). The pervasive influence of capitalist consumerist ideology further intensifies the insatiable nature of human desire. Individuals consistently pursue possessions and experiences with higher monetary value, often without fully comprehending the underlying motivations behind these desires. Consequently, money becomes the primary focus, with individuals mistakenly believing that accumulating more wealth equates to progress in terms of happiness. Paradoxically, upon reflection, individuals may come to realize that their relentless pursuit of money has led them to overlook numerous sources of happiness and contentment. In essence, money is unconsciously established as the ultimate goal, overshadowing other aspects of a fulfilling life. Keynes predicted in 1930 that over the next century, per capita income would steadily rise, meeting people's basic needs, and resulting in a reduced work week of no more than fifteen hours (Skidelsky, 2013). However, in contemporary society, individuals find themselves working longer hours instead. A free market economy grants workers the autonomy to determine their labor hours while simultaneously stimulating our inherent inclination to compete and engage in status consumption. Consequently, people may attain affluence, but capitalism instills habits that render them incapable of deriving satisfaction from their wealth, compelling them to continuously pursue more riches. It is challenging for individuals to recognize that their obsession should not lie solely in money itself but rather in the realization of their own life goals. Distinguishing between a genuine concern for money and an unhealthy obsession with it lies in whether individuals are willing to forsake moral values in pursuit of financial gain or if they have lost sight of their original life goals, treating money as a mere means to achieve those objectives. This can be exemplified by instances of crime, where many individuals exhibit a misguided understanding of money, leading to an unhealthy fixation on it. Lane's (1954) investigation into the root causes of white-collar crime found that the pursuit of financial gain emerged as the predominant motive behind such illicit activities. Businessmen and government officials surveyed overwhelmingly believed that economic motives drove individuals to engage in unlawful practices, primarily motivated by the desire to quickly amass profit (p. 90). Undoubtedly, this yearning for immediate monetary gain also significantly influences more

commonplace criminal acts, including thefts, robberies, and burglaries (Coleman, 1992). In reality, money has transformed society into an "arithmetic problem" (Simmel, 1978), where people gradually cease to contemplate the meaning behind the numbers and instead become fixated on the numbers themselves. This can be observed in the case of Michael Milken. During the 1980s, Milken constructed a vast business empire by selling high-risk, high-interest bonds. His financial success reached extraordinary heights, reportedly earning him over $500 million in personal income within a single year. However, achieving such immense wealth came at a cost, as Milken engaged in numerous illegal activities. At the time of writing, he had pleaded guilty to six felonies and was serving a federal prison sentence (Paltrow, 1990). Interestingly, despite his substantial riches, Milken resided in the less fashionable area of Los Angeles' San Fernando Valley and drove an outdated car (Bruck, 1988). Thus, it becomes evident that money assumes a significance in human society that extends beyond its mere exchange value, transforming into a goal in and of itself (Coleman, 1992).

The pursuit of wealth can drive individuals to engage in immoral actions, as evidenced by the presence of clinical psychopaths in the financial industry and the correlation between wealth and dishonest behavior. A recent study revealed that 10 percent of individuals working on Wall Street exhibit psychopathic traits, lacking empathy and displaying exceptional manipulative abilities. Furthermore, research indicates that individuals of higher socioeconomic status are more likely to engage in lying, cheating, and illegal activities(Deresiewicz). In their relentless quest for money, these individuals lose sight of their true desires and aspirations, risking their freedom and moral compass. It is crucial for society to recognize the potential consequences of such obsession with wealth and to reevaluate the values and priorities that guide individual pursuits.

Money As a Means And Tool

It is crucial to raise awareness among individuals that money serves as a means rather than an end. It is important for people to always keep in mind their life goals and aspirations. Money holds no intrinsic value unless we assign significance to it. In contemporary society, the realization of life's value is closely intertwined with monetary considerations. Having a strong economic foundation facilitates the attainment of personal goals and the realization of life values. However, if individuals lack their own aspirations and life values, money becomes a mere abstract symbol devoid of concrete meaning. Hence, money can only serve as a tool and a means, and should not become an ultimate objective in itself, as it would be rendered meaningless. This viewpoint aligns with Weber's perspective (1946) that money is "the most abstract and impersonal element that exists in human life" (Coleman, 1992).

According to Aristotle, the pursuit of happiness is the ultimate purpose in life, signifying that all human actions are driven by the pursuit of happiness. Nevertheless, as Whillans (2020) argues, the pursuit of money solely for the sake of happiness may result in accumulating more wealth but not necessarily greater happiness. Over time, this pursuit may even diminish one's happiness, as individuals begin to compare themselves to wealthier individuals and find

themselves with less time. Conversely, perceiving money as a means to achieve goals allows for wiser financial decisions. In reality, all human desires and aspirations are fundamentally oriented towards the pursuit of "happiness." While a sense of self-worth is essential for attaining genuine happiness, money itself does not provide such a sense. However, it can be utilized as a tool within the capital market to exchange elements that fulfill one's sense of self-worth.

Deci and Ryan (year) posit that self-efficacy serves as the foundation of human happiness. They propose three fundamental psychological needs, namely autonomy, competence, and relatedness, which drive human behavior and contribute to psychological well-being and a sense of happiness. These needs are universally inherent and when fulfilled, individuals exhibit increased intrinsic motivation in pursuing their goals. In alignment with self-efficacy theory, Seligman (2002) asserts that pursuing authentic happiness generates the strongest motivation and highest satisfaction. Similarly, when individuals have the autonomy to choose their own goals, they experience heightened motivation and increased satisfaction. Extensive research conducted by psychologists consistently demonstrates that individuals supported by a sense of autonomy exhibit greater creativity, resilience in the face of challenges, pursuit of self-determined goals, and overall well-being.

However, the presence of extrinsic factors such as rewards and money tends to diminish intrinsic motivation. While rewards are commonly perceived as effective in reinforcing motivation, Lepper, Greene, and Nisbett's (year) drawing experiments with children reveal an intriguing phenomenon. Although the children who received rewards initially spent more time drawing with markers compared to those who did not, when the rewards were later removed, the previously rewarded children lost interest in drawing. The reward had undermined their intrinsic motivation, transforming the marker into a mere object of desire when a reward was available. This outcome arises from perceiving the reward as an end in itself, where behavior and motivation become externally driven by the reward. Similarly, in society, if individuals mistakenly view money as an ultimate goal, life can lose its meaning and purpose.

According to Barbon's Nominal Theory of Money, money is merely a symbol, a ticket, a nominal presence, and a tool facilitating exchange. In modern society, physical currency constitutes a minor portion, prompting a deeper inquiry into the nature of money. MacLeod's (1844) work, The Elements of Political Economy, emphasizes that the primary purpose of money is to measure and record debts, facilitating their transfer from one individual to another. Money retains its essence as long as it serves this purpose, regardless of the form it takes, be it gold, silver, paper, or any other material. Therefore, we can establish the fundamental concept that money and negotiable debt are interchangeable terms, signifying that anything representing a negotiable debt qualifies as money. Money can consist of any material representing a negotiable debt and holds no intrinsic meaning beyond its function in facilitating social transactions, as substantiated in the field of economics.

Conclusion

This study critically examines the essence of money and the intricate relationship between humans and money within contemporary society, drawing insights from the realms of philosophy, psychology, and economics. It reveals that with the growing influence of capitalism, an increasing number of individuals mistakenly perceive money as an end in itself, disregarding its inherent meaninglessness as a mere abstract concept. Instead, money should be understood as transferable debt, devoid of intrinsic value.

It is essential for individuals to recognize that the pursuit of money is, in reality, a pursuit of the happiness and sense of worth that money can potentially provide. The true objective should be the accomplishment of personal life goals, leading to genuine happiness. Money can serve as a vital tool in this pursuit, owing to its substitutive nature within the free economic market. It enables individuals to fulfill certain material and even spiritual needs. However, individuals must always remain mindful of their ultimate life purpose and refrain from engaging in morally and socially detrimental activities solely driven by monetary gain.

The wider society must also grasp this fundamental understanding; otherwise, all endeavors that prioritize money as the ultimate goal will ultimately yield nothingness and lose their significance. Moreover, if the notion of "money as the ultimate goal" continues to be reinforced, crime rates will persistently surge, and the moral boundaries of humanity will progressively deteriorate. Socioeconomic conditions will stagnate, hindering true human liberation since money will cease to serve as a means to fulfill human needs.

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In Surveys Conducted in the United States, Significantly More Than Half the Respondents Reported That They Believed Themselves to Be More Attractive Than the Median Person in Their Country. How Might We Account for This? By Hanxi Hu

Our society's emphasis on physical attractiveness leads male and female people to focus more on their appearance. How would you know how physically attractive you are? This question often sparks a lively discussion among people of different genders, backgrounds, ages, and cultures. To justify the statement "significantly more than half the respondents reported that they believed themselves to be more attractive than the median person in their country", the Better Than Average Effect (BTAE) needs to be introduced first, which is the tendency for people to perceive their abilities, attributes, and personality traits as superior compared with their average peers (Kim 1-2). In addition, this paper will define the word "attractive" by limiting its reference to "physical attractiveness", referring to the fact that human beings have preferences about other people's physical appearances, particularly concerning their facial features and body proportions (Jhangiani and Tarry 391-410; ch. 7). In this context, the writer believes that the BTAE in the US can be analyzed from cognitive, biological, and sociocultural aspects. Questions over the validity of this survey will be raised and the biological and sociological investigations on the two sexes will be discussed to rationalize this result.

Biologically, people's sexual hormones play an unneglectable role in over-confident feelings. Anxiety is one of the common feelings in human life nowadays, and unlike other negative emotions, anxiety triggers a unique association with temporal self-appraisal; this means that anxious individuals tend to have a positive self-view or overconfident feelings about themselves (Sokol and Rosensweig). The female hormone estrogen is responsible for causing anxiety in women. At the same time, estrogen is also observed to be involved in mood disturbances (Hoffman, webmd.com); anxiety may peak in periods of estrogenic fluctuation such as puberty, menstruation, pregnancy, and menopause (Stachel, *everlywell.com*). In this case, the female hormone estrogen sometimes makes women more volatile in emotions and exposes them to anxiety, which may contribute to temporal self-appraisal that leads them to consider themselves more attractive than the "average" person.

Despite the biological evidence contributing to females' BTAE, Reinhard et al. also discusses the biological factors that lead to males' temporary self-appraisal. Narcissism is "a personality trait that is characterized by grandiosity, an inflated sense of self-importance, and overestimations of uniqueness" (Reinhard 2). Non-clinical narcissists overestimate their physical or mental attractiveness (Rhodewalt, *semanticscholar.org*). Reinhard et al. examines the role of participants' over-confidence and sex play on basal cortisol concentrations (2). The participants were made up of 106 undergraduate students, with 79 males and 21 females and a mean age of 20.1 years old. The participants' confidence levels are measured by the Narcissistic Personality Inventory and their cortisol concentrations are examined by the saliva samples collected in laboratories. The researchers used the data collected to construct a regression line to find a correlation between them. As a result, the researchers found that "unhealthy narcissism was marginally related to cortisol in females" but "significantly predicted higher basal cortisol in

males". Male hormones can strongly influence narcissism and self-perception of physical attractiveness. The study suggests a link between cortisol levels and male overconfidence, but more research is needed to understand the role of hormones in this phenomenon.

Meanwhile, sexual hormones also play key roles in people's physical appearances, which shape their perceptions of their bodies. Kerstin et al. investigate the relationship between women's menstrual cycles and their selective preferences for their body parts (1). 16 female participants who had normal menstrual cycles and 19 female participants who used hormonal contraception were involved in this research (Kerstin 2). The researchers gave the participants several sets of questionnaires and rated their levels of depression and attractiveness. As a result, women with natural menstrual cycling felt less attractive and spent more time gazing at their less attractive body parts (Kerstin 7).

The study by Kerstin et al. shows that female hormones impact women's perceptions of physical appearances significantly. Conversely, male hormones' influences on men's physical attraction are supported by Ray et al., a study determining the relationship between men's masculine traits and their levels of attraction (1). Eighty-one heterosexual female participants were included in the study and the researchers detected their eye movements (Ray and Jennifer 3). Comparing the result to previous studies, the researcher concluded that facial masculinity attracts women more than femininity attracts men (Ray and Jennifer 8).

This conclusion reveals that male hormones increase men's levels of attraction to others. More appreciation received from others, better moods, and higher confidence a person will have (Peter 3), thus contributing to the BTAE. Kerstin et al. and Ray et al. provide strong evidence that sexual hormones lead to BTAE, while female hormones change women's appreciation of their body parts and male hormones affect men's attractiveness to others and alter men's personal recognition of themselves.

By arguing about the study's methodology, this study's validity can be questioned from a cognitive perspective. Different experimental methods can lead to various outcomes, especially imperative to clarify the word "median" for respondents. According to *Merriam-Webster*, "Median" means "a number, value, or amount that is in the middle of a series of numbers, values, or amounts."

To complete this study, the researchers need to either locate "the attractiveness of the median person" for the respondents or give them the freedom to reach the answer based on their schema of "median" attractiveness. Both alternatives have drawbacks and lower internal validity. If the researchers decide to locate the "median person in the U.S." on their own. For example, use technology to conclude the common facial features of a median person and present the image to the respondents- they have to acquire a wide range of U.S. citizens' facial data that requires extensive authority, and the outcome may still be inaccurate due to population loss and unregistered citizenship.

As a result of the incorrect location of the "median person", participants may be confused and given a wrong standard of response, which decreases the study's validity. While if the researchers let the respondents determine the "median person" on their own, the outcome might

be even more diverse; it is generally acknowledged that people possess a variety of aesthetic tastes and that people's cognitive bias forms based on their social groups. Furthermore, the concept of "average" in the BTAE in people's schemas is also distinct.

According to *Merriam-Webster*, "average" as an adjective can refer to "not out of the ordinary", which is a typical standard or a mediocre or relatively low standard. On the other hand, It also means "a standard level that is considered to be typical or usual" in the Cambridge Dictionary. In *Encyclopedia Britannica*, "average" can be defined as an even more vague concept: "not unusually good or bad" and "not unusually large or small". This shows that different dictionaries define "average" in various ways. As dictionaries are the fundamental object people use to acquire knowledge of a vocabulary, their varying definitions will affect people's schema of "average". While different people make different interpretations of the word "average", the conclusion of the study in this question might be inaccurate, or even invalid as the control factor (definition of "average") is not fully controlled in the first place.

Moreover, although it is challenging to believe, people prefer ordinary or mediocre faces over unique ones (Zebrowitz and Montepare 2). Damon et al. support this statement with a study investigating human preferences for ordinary faces (1). Researchers in this study intend to determine whether infants prefer human adult female faces closer or farther from the normal female face. Twenty-nine 12-month-old human infants were involved in this study and were shown eight sets of portraits of woman adults. The researchers then recorded the infant participants' total time spent looking at each portrait.

As a result, infants spend significantly more time looking at faces closer to the prototyped face. This experiment concludes that humans tend to prefer average physical appearances even when young. The study by Damon et al. shows that no matter how people understand "median" and "average", they still have a natural preference for "average" physical appearances and take "average" appearances as a footstone to judge their aesthetic appreciation. BTAE can be shown and supported by self-enhancement bias, which is people's tendency to describe themselves more positively than they are perceived by others (Krueger 4). Factors contributing to self-enhancement bias are further investigated by Kwan et al., concluding that a high target effect- individuals being positively perceived by others- contributes the most to self-enhancement. The study by Kwan et al. shows that people's recognition of themselves highly depends on others. As people favor average faces (Damon 15), there is no wonder that respondents rate themselves higher than average. While the survey has several limitations that may lead to internal disabilities, it provides insights into people's perceptions of "median" and "average".

Accounting for this phenomenon from a sociological perspective also helps justify people's recognition of their attractiveness. In social psychology, the spotlight effect is "the phenomenon where people tend to overestimate how much others notice aspects of one's appearance or behavior" (Calderaro, *cabrini.edu*). It is a popular psychological phenomenon that overly emphasizes self-consciousness when engaged in social activities (Dewra, *bootcamp.uxdesign.cc*).

When a person is engaged in social activities, such as being asked to stand up and answer a question in class or being exposed to public attention due to some silly actions, he or she may feel overly guilty or embarrassed because he or she is over-sensitive to others, making the person feel like everyone is paying attention to him or her (Miles, *betterup.com*). BTAE partially accounts for such a feeling, in which people think their public image is better than what they are (Strickhouserz 1). The spotlight effect can show people's over-recognition of their public image which is reflected in their embarrassment or guilt when people think they have done something wrong or undesired by the public.

Another explanation for the survey's results from a sociological perspective is that people do not want their figures to be seen as inadequate or uncompetitive. Most of the time, it is true that unattractive people are commonly considered to be less socially competent because interpersonal interactions decrease expected behaviors (Snyder et al. 3). What is more, faces that are less than average often create more negative social impressions such as lower sexual responsiveness, diminished social power, lower intelligence, and poorer health (Zebrowitz and Montepare 10-11). As a result, people are more willing to identify themselves slightly above the average baseline of physical appearances, showing their conformity to acknowledge themselves as socially competent individuals.

In conclusion, there are plenty of reasonable and justifiable reasons to explain the better-than-average effect, including cognitive, biological, and sociological factors. The survey has a limitation on the definition of "median", yet several previous studies investigating the BTAE can still explain the results. Looking from a grand view, although the survey contributes to inspirational ideas about people's self-recognition and the BTAE, its results are difficult to apply in other places worldwide, weakening the validity of the BTAE theory. The survey does not clarify the time frame; as people's thoughts develop and change rapidly nowadays, the survey in the past may not represent the situation now.

Moreover, as the survey is conducted specifically in the United States, its results may not apply to other countries due to cultural and social norms differences. People's recognition of their sex is also hugely affected by culture because estrogen and testosterone produced are strongly modulated by culture (Pletzer 1); This means the account for this survey's results may have been limited due to cultural-biological factors. Although these survey results have been accounted for the BTAE in the scope of biology, cognitive and sociological, the unprovided information and undefined limitations prevent its results from being fully explained to a wider application, thus impeding the results to become definite proof.

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An Evaluation of the Current and Possible Methods of Treatment for Parkinson's Disease
By Nimali Krishnakalyan and Aleena Ann Joseph

More than 10 million people worldwide live with the neurodegenerative disorder Parkinson's Disease(PD), battling symptoms such as motor disabilities, imbalance, tremors, mental health issues, and more. While no cure has been found, various treatments including medications, surgery, and behavioral therapies are being used to reduce the effect of the disorder on patients, which often tend to be expensive. The market for PD treatment was even valued at 5.87 billion USD in 2022 and is expected to reach a value of 12.5 billion USD by 2032. But to what extent are these pricey treatment choices making an impact?

This article aims to evaluate the advantages of the current and developing options available for the treatment of Parkinson's.

What is Parkinson's Disease

Parkinson's disease is a progressive disorder that affects the nervous system, prompting changes in movements, physical coordination, and balance, caused by the deterioration of dopamine-producing neurons in the substantia nigra located in the brain. It's characterized by five distinct stages, with the severity of its presentation varying from mild tremors and posture issues, to requiring 24/7 care. Its symptoms can be classified as motor(including slow movement and rigidity) and non-motor(such as speech disabilities and depression)[2]. The origins of the development of PD are complex and vary from person to person. Genetic factors, environmental triggers, and the presence of Lewy bodies are some of the causes of the disease. Age, heredity, sex, and exposure to certain toxins can all influence the risk of developing Parkinson's: the majority of onset PD-afflicted patients are aged 60 and above[5], and, while males have twice the susceptibility risk females do, females have a faster rate of progression and higher mortality rate[6]. Once diagnosed, Parkinson's disease can be treated with drugs, surgeries, and behavioral therapies, and possibly with new technology, like gene therapy and nanomedicine, in the future.

A diagnosis of PD is made by assessing a person's detailed medical history and performing a thorough neurological examination. Various imaging and diagnostic tests are used to help reach a diagnosis, such as blood tests, CT scans, genetic testing, MRIs, and PET scans. These tests can help detect and measure the presence of any abnormalities related to the disease, and provide valuable information about the progression of the condition. Furthermore, they can help to rule out other potential diseases or conditions that may have similar symptoms. Ultimately, all the information gathered from these tests and examinations is used to determine if the patient is indeed suffering from PD, and what treatment paths can be administered.

Treatments–*Drug Therapy*

Drugs like dopaminergic medications (dopamine agonists, for example) are commonly used for treating motor symptoms, particularly in early-onset PD, since the root cause of the disease involves a lack of dopamine. Levodopa(L-DOPA) is a dopaminergic agent used to treat

late-onset PD, holding an advantage over dopamine due to its ability to cross the blood-brain barrier. It brings about responsiveness in 80% of idiopathic patients, reducing the effects of bradykinesia and rigidity. L-DOPA, nonetheless, is ineffective in alleviating other symptoms, and agonists lose their early advantage quickly.

Inhibitors and antagonists are often used as adjuncts to other treatments. Monoamine oxidase inhibitors(MAOIs) and Catechol O-methyltransferase (COMT) inhibitors prevent L-DOPA from prematurely converting into dopamine, reducing peripheral loss before it reaches the brain. It is given in less frequent doses in later stages to reduce tremors or dyskinesias. Cholinesterase inhibitors help treat hallucinations or cognitive decline that arises in advanced PD. Putative N-methyl-D-aspartate (NMDA) receptor antagonists prevent disease progression by synergizing dopaminergic agents and enhancing the release and turnover of dopamine in striatal neurons. However, Parkinson's can cause NMDA to over-activate, worsening dyskinesias.

Anticholinergics act as antagonists at choline receptors to reduce the activity of acetylcholine, aiming to restore the balance between dopamine and acetylcholine that was disrupted by Parkinson's. It plays a greater role in tremor-predominant PD but is typically prescribed in combination with medications like L-DOPA. In fact, anticholinergics have been widely replaced by L-DOPA and other centrally targeting dopaminergic agonists, particularly when they cause higher intolerance in the elderly, with the possibility of increased risk of confusion.

Small natural proteins known as neurotrophic factors(NTFs) help maintain neurons' functional and morphological phenotype. An example is GDNF, an NTF with a potent trophic action on cultured dopaminergic neurons and, hence, is associated with PD. GDNF plays a vital role in the survival of adult catecholaminergic neurons, and the loss of dopaminergic neurons and the onset of PD has been connected to GDNF signaling failure. Accordingly, administering a patient with such NTFs is another type of treatment.

Surgical Therapy

Surgery may be conducted as a near last resort for patients who have exhausted their medications for Parkinson's symptoms (particularly tremors), or those who experience extreme motor difficulties.

The oldest implemented surgical treatment is ablative surgery. There are three types: pallidotomy(involves destroying the globus pallidus interna, or GPi, in the brain), thalamotomy(destroys the brain's thalamus), and sub-thalamotomy(a lesioning surgery that targets the subthalamic nucleus, or STN, of the brain)[14]. Ablative surgery attempts to lessen hypokinetic PD symptoms by creating lesions in the aforementioned regions of the brain to stop the overactive pathways of excessive inhibitory output – a direct effect of hyperactivity in the substantia nigra caused by loss of dopamine. This type of surgery has lost prevalence due to its high risk of side effects, yet it is still a viable option when deep brain stimulation is unavailable.

Deep brain stimulation(DBS) is an established treatment for improving motor symptoms in advanced-stage PD and was developed as an alternative to ablative surgery, remaining similar in terms of its action pathways and symptom mitigation. It is thought to be successful only in idiopathic PD, and is conducted in cases where the patient is under 75 years old and the life expectancy is considerably higher; and when they have no distinct brain atrophy, chronic immunosuppression, or severe psychiatric disorders. DBS involves the surgical implant of wires in the brain that send high-frequency electrical impulses, blocking the faulty symptom-causing signals. In the surgical process, small holes in the skull are made to insert electrodes into brain tissue, while a stimulator battery(or pulse generator) is inserted under the skin in the patient's chest. Thus, DBS requires careful assessment of the 'risk vs benefits' ratio, and for patients to pass a simulation test and be capable of self-operating their controller[18].

Conventional DBS is an open-loop stimulation process, having implants delivering continuous impulses without feedback. The major targets of the stimulation (GPi and STN) are part of the movement circuitry affected by dopamine loss and display common motor benefits in several large and randomized controlled studies[17]. DBS does not slow disease progression, but it does reap the advantage of decreased dysarthria, rigidity, slowness of movement, and cognitive and mood effects. Of course, the procedure maintains surgery-related complications, including cerebral hemorrhage.

There are hardware malfunction cases, including lead breakage or malfunction of the battery. It has resulted in infections in 1.8%–15.2% of patients occurring in the area around the battery, which is a large variability range and prompts the improvement of devices used. New devices for DBS on the market are looking at contactless programming capabilities with Bluetooth-like connectivity, and improved controllers and generators. They are offering the ability to record brain activity, while sustaining user-friendliness and fewer simulation-caused transient side effects(tingling, double vision, dizziness, etc.).
Furthermore, professionals are currently working on closed-loop DBS[16] – its next big advancement. It would allow individuals to read actual brain activity and determine how much simulation would be needed at a given time, allowing simulation adjustments and improving the success of DBS.

Stem cell transplantation is an innovative surgery being widely explored as a treatment that can repair and replace damaged dopamine-producing cells and regulate dopamine levels. Until induced pluripotent stem cells(iPSCs) were discovered, the only stem cell therapy possibilities for PD required the use of embryonic stem cells, which gave rise to multiple ethical and practical challenges that hindered research. Now, ongoing research is focused on directly introducing iPSCs to the affected areas of the brain, where they can transform into brain cells and benefit PD treatment by replacing damaged dopamine-producing nerve cells. Trials are primarily testing delivery methods – like intravenous infusion and topical application – and the procedural safety in the number of doses and usage of the medical devices[20].
This form of therapy is showing promising results, as a published study from a 2019 journal proved on transplanting mesenchymal stem cells (derived from bone marrow) into the brains of

10 Parkinson's-afflicted patients. Results showed improvements in motor function and reduced the severity of other symptoms, even proving the likelihood of the procedure's safety. Further preclinical and clinical studies show a reduction in inflammation and oxidative stress in the brain, and an improvement in immune system functioning, leading to condition stabilization[19]. While stem cell therapy shows short-term side effects of nausea, headaches, etc, they resolve independently within a few hours of treatment. Indicating reduced tremors, rigidity, bradykinesia, dyskinesia, and postural inability, stem cell transplantation proves competency as an option in treating PD by increasing patients' energy and mobility.

Behavioral Therapy

Behavioral therapy plays a major role in assisting PD-afflicted patients, as not everything may be controlled by drugs, and side effects may occur. It is critical in helping one manage daily struggles and symptoms. Commonly known therapies implemented are physical, speech, cognitive, and even occupational therapy.

Physical therapy is one of the most crucial aspects of maintaining and treating the health of PD patients. Aerobic exercise can notably improve balance, motor action, and gait parameters, while treadmill training, studies show, increases the probability of improving gait hypokinesia and may overall reduce PD symptoms.

The purpose of occupational therapy is to maintain their work, self-care, and leisure activities for as long as possible, and to be able to adapt to changes in their physical and social environment and life as the disease progresses to further stages. It often works in sync with physical therapy in order to overcome physical limitations. Still, the chances of success largely depend on personal and environmental factors, including anything that may motivate or demotivate the patient.

Considering that speech disorder is a common Parkinson's symptom, speech therapy can prove most useful. The Lee Silverman Voice Treatment (LSVT) is used to enhance vocal volume and communication skills and various other factors associated with speech and expression. That being said, interestingly, while up to 89% of patients experience speech difficulties, only 4-5% receive speech therapy, due to high costs and inaccessibility.

Cognitive behavioral therapy is being reviewed as a possible solution for many non-motor symptoms, like insomnia, depression, and impulse control, and as an alternative to drug therapy for different sleep-disturbing behaviors. Nevertheless, CBT can only focus on the management of one symptom and requires more testing to prove effectiveness.

Future Developments

With the causes of PD varying from patient to patient, finding a cure can prove arduous. Yet, with technological developments, it may be possible to boost treatments and their efficacy.

Nanomedicine is an aspect of science that is yet to reach human trials and come into existence but is being evaluated for improving drug-delivery systems in terms of their circulation levels, bioavailability, and half-life. Efficient delivery approaches can significantly reduce side

effects, upgrading brain specificity and patient compliance, and transporting drugs across a blood-brain barrier(BBB) is one of the greatest challenges in treating PD. It is necessary in cases of anti-PD drugs, including levodopa and dopamine agonists, but the protective barrier only allows small lipophilic molecules, and hydrophilic charged molecules, to pass through to the brain easily, reducing drug efficacy[25]. So, nanomedicine may be able to bring BBB-compliant tactics and significantly improve the function of the drugs.

Strategies discussed for improving the brain-targeted delivery across the barrier can be categorized into three: harnessing physiological characteristics to develop transport options of transcellular lipophilic, carrier-mediated, receptor-mediated, or nasal delivery; coating nanoplatforms with endogenous biofilms to 'cheat' the BBB; and using external treatments that utilize external magnetic fields, focused ultrasound, and infrared-mediated effects to direct nano brain delivery[24]. The implemented nanoplatforms need to be non-toxic/low in toxicity, stable in blood, and prevent drug leakage or early release before it reaches the brain. They can be organic, inorganic, or hybrid in nature, but those with larger surface areas and a particle size under 200 nm are thought to be better for drug delivery to the brain parenchyma. That is when the precision, efficiency, and flexibility of advancing nanomedicine and nanotechnology may improve the lifestyle and life expectancy of patients and result in innumerable developments in prospective advanced treatments.

Gene therapy is an emerging surgical treatment aiming to slow disease progression and involves multiple trials for utilization. The primary clinical approach of oral treatment with L-DOPA is only a symptomatic treatment that cannot halt disease progression and gives rise to many side effects, which is what gene therapy aims to benefit. Genetic treatments are categorized into disease-modifying(revolving around lost neuron regeneration and preventing cell death from PD) and non-disease-modifying(attempting to neutralize irregular firing of basal ganglia), targeting gamma-aminobutyric acid(GABA) and dopamine synthesis pathways respectively[23]. Utilizing gene therapy would require viral or non-viral vectors to deliver the synthesized gene, but viral ones tend to be preferred due to improved safety and transduction efficiency due to the decades gone into their development.

Multiple gene therapy strategies are currently being studied, one of which introduces a gene for glutamic acid decarboxylase(GAD) – an enzyme that stimulates the production of GABA – into the subthalamic nucleus to increase the amount of GABA in the brain and reset abnormal circuitry brought about by PD. An early study done in a rat model tested subthalamic GAD and proved it capable of tolerance and reducing parkinsonian motor synonyms, but a subsequent study showed less tolerance, despite improving motor symptoms, and so gave incentive for improvement[21]. Other gene therapies include the use of aromatic amino acid decarboxylase(AADC) and neurturin(NTN), and several studies in both cases show improved symptoms. In fact, AADC in non-human primates showed a decreased need for medication, and NTN – a subject of attention – shows to exert protective effects on midbrain dopaminergic neurons.

All three of these factors have also been under research with an adeno-associated virus(AAV) used as a vehicle, which theorizes greater success in gene therapy: AADC showed to decrease the effectiveness of L-DOPA, yet on being delivered to the brain via AAV, levodopa's therapeutic potency might be restored. Meanwhile, AAV-2-NTN deals with the goal of further restoring neuron function and preventing more degeneration[22]. Overall, these therapies focus on making levodopa treatment more effective, increasing dopamine production, supporting neuron survival, etc, and they all hold the potential to revolutionize the efficacy of treatment and disease progression rate.

Conclusion

Parkinson's disease, the widely known neurological disorder, has several motor and non-motor symptoms, with various drug, surgical, and behavioral therapies to help minimize their impact on a patient's physical and mental health and lifestyle. Treating it utilizes a working flow of therapies, starting with rehabilitation and medication, moving onto restorative exercises and health maintenance, and surgery as a final resort. Medications can work hand-in-hand, as particular dopamine agonists and antagonists do, to generate maximum results. As time progresses, up and coming developments in the medical field find improvements in processes like deep brain stimulation and stem cell therapy. Therapy continues to assist patients in dealing with changes in their lifestyles. With technological advancements and recent research studies and countless trials, upcoming treatment options can one day prove substantially effective in treating patients with Parkinson's disease, paving new pathways in the field of medicine, neurological disorders, and assisting afflicted individuals in leading a closer-to-normal life.

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To What Extent Does Turbidity Change With Depth in the University Club Pond? By Slade Jindal

Abstract

The problem of non-point water pollution, the contamination of water or air that is not the result of a single, identifiable source, affects bodies of water globally. This project investigated a neighborhood pond, the University Club Pond, located in Baton Rouge, Louisiana, to study how water quality changes with depth, revealing the effects of pollution. Water was tested daily using a turbidity tube for fifteen days at three different depths, during which time rainfall data was also monitored. The data strongly indicated that water turbidity increases with depth, showing that surface water contained the lowest turbidity numbers. With this information, big picture conclusions were drawn, as non-point water pollution is not a problem solely in Baton Rouge but rather an international obstacle with large implications.

Key terms: water quality, turbidity, eutrophication, rainfall, pond, non-point water pollution

Introduction

The research question, "To what extent does turbidity change with depth in the University Club Pond?" was asked in order to explore the relevant environmental issue of non-point water pollution through runoff. Non-point water pollution arises from numerous widely dispersed origins (Patterson et al. 2013). Non-point water pollution directly harms the biodiversity in any body of water (Xue et al. 2023). The study pond, the University Club Pond, is located in South Louisiana, specifically in Southeast Baton Rouge, close to Saint Gabriel. The University Club Pond is quite significant in the neighborhood, as their main function is to keep the community from flooding. In order to increase the pond's capacity to store more water and prevent floods, builders frequently dredge. Because of this, the pond's water level, without a way to get rid of extra precipitation, will rise and fall. The University Club Pond does not have sufficient drainage, therefore the water level fluctuates seasonally in accordance with Baton Rouge, Louisiana's subtropical environment. In Baton Rouge, the winters are brief and chilly, while the summers are lengthy, hot, and humid; it is always rainy with an average annual precipitation of 1449.07 millimeters (Climate Data 2023). Without a way to circulate extra rainfall, the University Club Pond is susceptible to non-point water pollution and its effects. Because the pond is located in a neighborhood on a golf course, it is surrounded by a plethora of pollution sources, such as cars, runoff, golf carts, and fertilizer. Therefore, the University Club Pond is home to high amounts of non-point source pollution and is an adequate place to study its effects. A significant source of pollution for the pond is the chemical fertilizer used weekly to take care of the grass surrounding it. Fertilizer along with other sources of pollution contributes to runoff in the pond leading to the death of many plants and animals through eutrophication, which will be explained further (Kunimatsu et al. 1999). This fertilizer, along with other sources of pollution, is forced into the pond due to runoff from rainfall. Consequently, collecting rainfall

data was essential for this study. This research paper will help to investigate the impact of non-point water pollution on the pond by discovering how the turbidity of the water changes with depth.

To investigate this, turbidity was used since it is a major water quality test. Turbidity is one way to measure water quality quantitatively. The lower the turbidity, the clearer the water is; the higher the turbidity, the more opaque the water is. More turbid water implies there is higher sediment content, which corresponds to higher nutrient concentrations and means there will be an exponential growth of plants. Consequently, this will lead to their death which will cause the bacteria population to explode, taking all the oxygen from the fish and causing them to die (Cloern et al. 2013). This is the process of eutrophication, when a body of water becomes enriched with nutrients and minerals. The water's turbidity as the depth increases directly showed the extent of the effects of non-point water pollution in the University Club Pond. In order to measure how exactly pollution affects the pond, the turbidity was measured at several depths over time.

Figure 1: Google Map Image of University Club Pond
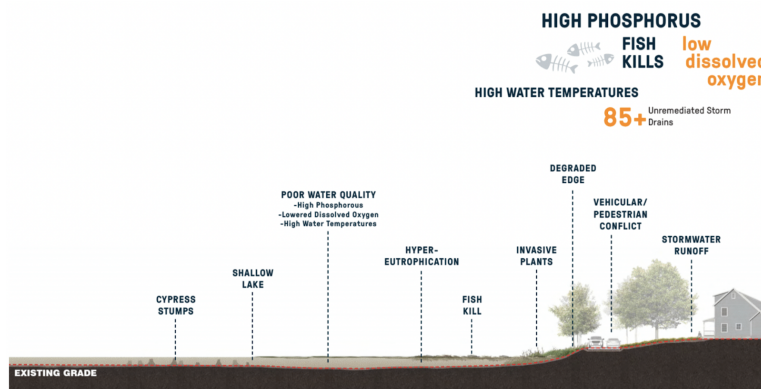
Figure 2: The Eutrophication Process (Baton Rouge Area Foundation 2022)

The graph above shows the exact relationship between runoff and the effect on the biodiversity of the pond. As the rainfall drains into the pond, as shown in *Figure 1,* a multitude of negative effects occurs, as shown in *Figure 2*.

III. Materials and Methods:
Independent Variable: Depth of Water
Dependent Variable: Turbidity

Figure 3: Turbidity Tube (Utah Water Watch 2022)

Turbidity information was collected for fifteen days (March 3rd-17th, 2023) using an industry standard turbidity tube in the University Club Pond (as shown in Figure 3). All safety protocols and local jurisdiction were followed when collecting data. According to the United States Environmental Protection Agency, one must gather at least fifteen days of turbidity data in order to get an accurate average turbidity. In order to get the numeric value for turbidity, pond water was poured into the tube until one can no longer see the black cross at the bottom of the tube. Once that level is reached, the person can read the turbidity in measurements of nephelometric turbidity units (NTU) off the outside of the tube. A single turbidity test was taken at three different depth levels in the pond each of the fifteen days. One test was taken directly off the surface, one .61 meters (two feet) deep and another 1.219 meters (four feet) deep. Rainfall data was also collected alongside the days that turbidity was measured (Local Conditions 2022).
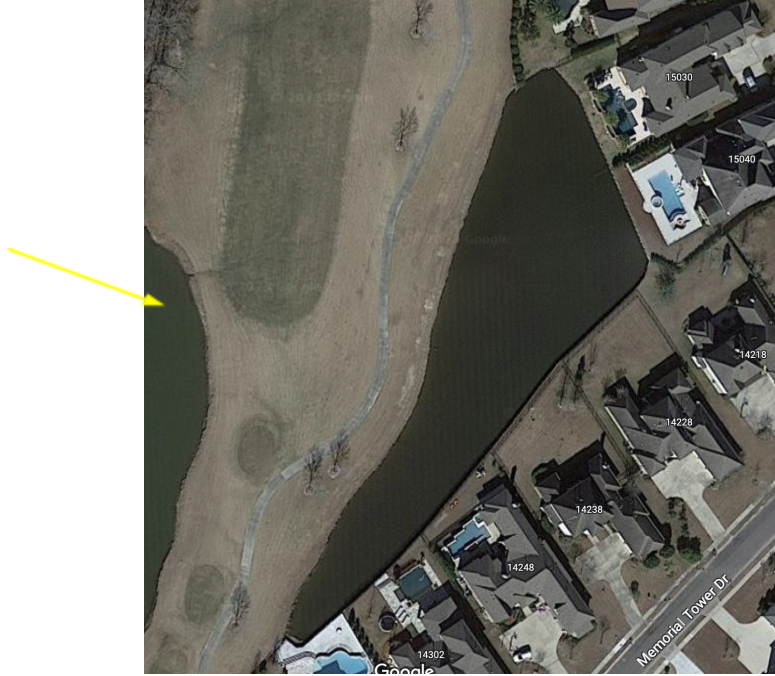
Figure 1 (Copy): Google Map Image of the University Club Pond

IV. Results

Depth of Water (m) vs. Average Turbidity (NTU)

Trendline for series 1 R² = 0.962
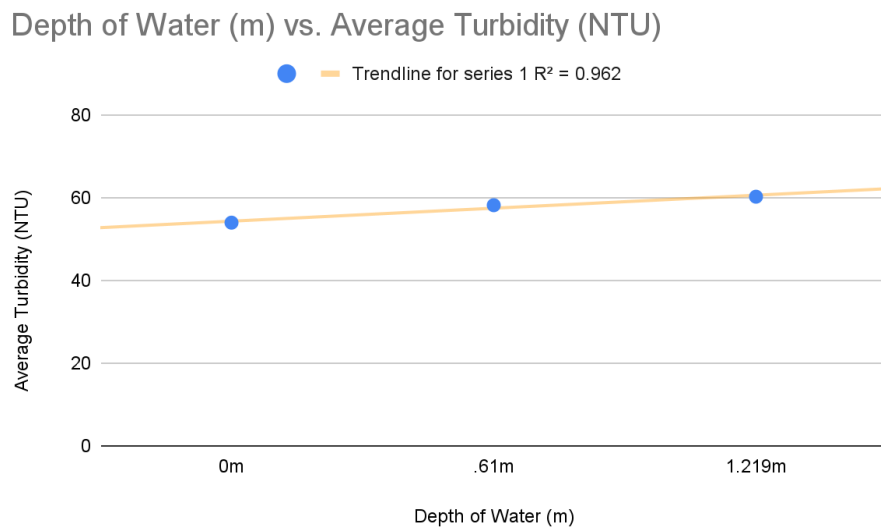
Figure 4: University Club Pond Depth (m) vs Average Turbidity (NTU) from 3/3-3/17, 2023
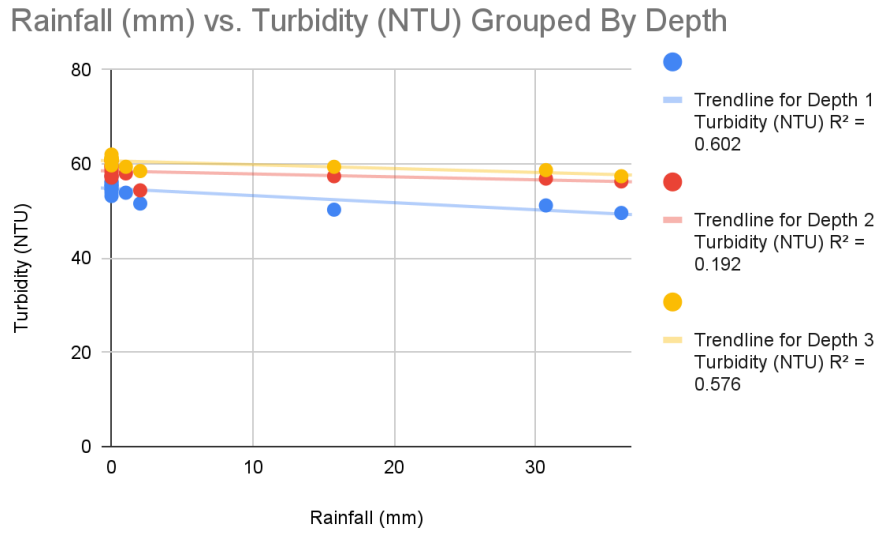
Figure 5: University Club Pond Rainfall(mm) vs Turbidity (NTU) from 3/3-3/17, 2023
Table 1- Turbidity and Rainfall from the University Club Pond from 3/3-3/17, 2023 at 0m, .61m, 1.219m

		Turbidity (NTU)		
Date	Rainfall (mm)	Depth (0m)	Depth (.61m)	Depth (1.219m)
3/3	15.748	50.3	57.4	59.4
3/4	0	54.5	59.3	61
3/5	0	55.6	60.7	61.3
3/6	0	54.7	58.9	60.9
3/7	0	53.9	58.3	61
3/8	0	53.2	59.6	60.5
3/9	36.068	49.6	56.3	57.4
3/10	0	56.3	57.1	59.7
3/11	0	55.4	57.5	61.2
3/12	2.032	51.6	54.4	58.5
3/13	0	57.4	59.6	60.8
3/14	0	56.1	60.7	62
3/15	1.016	53.9	58	59.4
3/16	0	55.3	57.6	61.3
3/17	30.734	51.2	56.9	58.7

Figure 4 compares the average turbidity from each site compared to the depth of water. The greater the number of turbidity in the data, the less turbid the water was. As nephelometric turbidity units (NTUs) increase, water clarity increases; as NTUs decrease, water clarity decreases. This graph in itself answers the research question: does the depth of water affect turbidity. As shown in the graph, these two variables are heavily correlated, with a .962 r-value to be exact. R-value is a correlation coefficient, which gauges how strongly two variables are related. The closer an r-value is to 1, the stronger their correlation. The data shows that as the depth of water from the surface down to 1.219 meters decreases, the average turbidity increases by about ten NTUs.

Figure 5 shows the relationship between rainfall (data was collected from *Local Weather and Traffic Reports)* and the turbidity of the water from different depths. Depth 1 represents the turbidity on the water's surface; Depth 2 represents the water's turbidity at .61 meters deep; and Depth 3 represents the water's turbidity at 1.219 meters deep. The graph shows the same trend between the two variables: as the rainfall increased, the turbidity decreased. Depths 1 and 3 offered stronger correlation values with .602 and .576, while Depth 2's correlation was only .192, which is a weak correlation. Nevertheless, the same pattern of each graph points to the conclusion that rainfall negatively affects turbidity in the pond.

Discussion

The data does provide insight into the relationship between water turbidity and depth in the University Club Pond. Because the data shows how the turbidity is less at the surface of the water and continues to increase as the depth increases, it can be best evaluated that the sediments from runoff directly cause this. This data proves that as rainfall comes through, runoff causes the sediments surrounding the pond to pollute the pond from widely dispersed origins. Because the pond does not have any system in place to circulate this rise in water from rainfall, the pollutants stay in the water longer which could potentially harm the ecosystem. This coincides with the environmental issue of eutrophication. As extra sediment comes from runoff into the pond, plants consume it and their population booms. When they die, decomposers eat on these plants and their population grows exponentially, which removes all the oxygen in the pond, finally causing the water to become anoxic so animals in the pond die. The conclusion from the data indicates that runoff from rainfall is causing pollution; with this knowledge, a proper solution can be found. The effects of non-point water pollution are significant, as it is killing the ecosystem with its poor water quality. Without the sediment from the runoff removed, the pond turns into an ecological liability. The nutrients in the runoff is from things like construction projects, nitrogen and phosphorus from fertilizers, oil from vehicles, and garbage from humans. More impervious surfaces around the pond means more runoff of these resources, which means a decreasing population in the pond.

The efficiency of the method used is a major strength overall. One could find the turbidity of water at different depths in a timely manner. One major area for improvement of this method is that the turbidity data was only taken for a mere fifteen days. To truly understand the

exact numerical relationship between the two variables and their effect over time, one would have to consistently measure the pond for an extended period of time. A limitation of the method is the fact that from the numbers gathered, it is impossible to find how this water quality affects the animals specifically. These numbers imply that the ecosystem is regressing, but actual evidence of life affected by it is not present. One modification in the future would be to measure the pond throughout different seasons of the year to see how the relationship between rainfall and turbidity is affected throughout different times of the year, not just in February.

Applications

Based on the findings in the study, one way to fight this environmental issue would be to create a system of treatment wetlands, diversion structures, and sediment basins in order to divert the sediment from the pond system. The primary issue in dealing with this non-point water pollution is the fact that the pond has no circulation to other places in order to filter the pollutants on the surface. Eutrophication has been a major problem affecting the pond for a while as plants and fish continue to die. On top of this, to reduce the amount of sediment as a whole, setting up awareness campaigns for humans that live around and benefit from the pond would help greatly. This solution would have major positive impacts on the pond environment, as the water quality would increase and the animals in the pond would be healthier. Humans need to be more aware of their environmental impact, specifically with the sediment they produce which goes into the pond as a result of runoff from rainfall.

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Discovering the Number of Genders By Qin Yuanzhi

Introduction

How should a team of scientists discover the number of genders there are? To answer this question, one should first consider this question: can the number of genders be the subject of scientific discovery? If the answer to this question is no, then there would be no way for the team to discover the number of genders.

Therefore, it is essential to first give a clear definition of "scientific discovery". In this paper, it refers to the process of successful scientific endeavor in two contexts: conceiving and generating a theory, and justifying it, which involves the assessment of the validity of the theory via empirical data (Schickore). Following this definition, if the number of genders could be the object of scientific discovery, all of the following conditions need to be satisfied: firstly, gender needs to be defined clearly and solidly. In other words, the inquirers should know what qualifies as gender, and this definition needs to fit into our intuition and the general usage of the word "gender." Secondly, such a definition should be universal, that it remains true in all time and places, for otherwise it would be impossible to summarize its general properties. Thirdly, under such a definition, the number of genders should remain constant, which is the precondition for the team to justify their theory with empirical evidence.

With the definition of scientific discovery clarified and the possibility of gender to be its subject premised, this paper will first examine theories about the nature of gender that are based on empirical observations, which lands on the argument that any such theories are reductive and thus could not be universal. Then, it will examine Judith Butler's gender performativity theory, and conclude that although it provides a universal and valid definition of gender, the team of scientists could not arrive at any meaningful conclusion under said definition. Following the claim, this paper will land on the conclusion that the team of scientists cannot proceed.

Empirical Theories of Gender

This section will examine three theories of gender that are based on empirical evidence: biological determinism, social constructionism, and gender spectrum.

Traditionally, gender is defined under the biological determinist framework: a person's gender equals his/her biological sex. Hence, the number of genders is considered to be two. Biological determinists hold that the distinction between the dichotomy of gender is a natural, physical phenomenon (Buchanan). Under biological determinist theory, which is based on sexual dimorphism, gender is defined by different anatomical and hormonal features prescribed by sex chromosomes.

However, as many have argued, biological determinism is flawed in its belief that sexual dimorphism is intrinsic to human beings (Kirchengast 130). While biological features, such as the dimorphism of sex chromosomes, are natural, tangible facts, articulations of these features in terms of gender and sex can be constructed in vastly different ways from society to society. Even in Western history, sexual dimorphism was not popular until the 18th century, before which the

one-sex model was the dominating view: female and male are of the same sex, possessing the same genital directed inward and outward respectively (Laqueur 8). The fact that biological evidence can be interpreted to form distinct perceptions of nature shakes the validity of biological determinism: sexual dimorphism is not necessarily the corollary truth, but rather a continually constructed or challenged framework in which the differences between the sexes were emphasized. In fact, sexual dimorphism was not true as proven by the population of intersex people. As current scientific evidence suggests, many people are biological hybrids, such as a 94-year-old woman who possesses XY chromosomes, and a 70-year-old man who has a womb (The Editors).

Even if we were to take human sexual dimorphism as an objective fact, in today's society, a person's gender could no longer be defined through their biological sex. Take the case of transgender--people who identify with a gender that is different than the one indicated by their sex. The phenomenon invalidates biology determinism, since in these cases, people can identify as a gender while their biological features are androgynous or of the so-called "opposite" sex (for example, a self-identified transwoman who has not changed any biological feature of her body, or a transman who has re-assigned male's genitals but still possess XX chromosomes).

In conclusion, although biological determinism of gender provides a clear definition in which the number of genders is static, its binary premise is arbitrary, and it fails to encompass the case of transgender, hence it is neither valid nor universal.

Having acknowledged that gender cannot be defined solely on biological basis, it is necessary to consider gender's broader social contexts. When Beauvoir claimed that "one is not born, but rather becomes a woman" (Beauvoir 273), she meant that what conventionally constitutes women -- shared femininity such as delicacy, motherhood, domesticity, etc -- is predominantly dictated by societal rather than natural prescriptions. This theory is usually referred to as social constructionism of gender. If gender can be quantified by social variables, then the scientists could proceed the discovery by setting a set of consistent criteria to distinguish one gender from another; if rules could be established in order to include people identified as one gender and exclude those who don't, the commonality thus defined would automatically be something shared only among the people who identified themselves as belonging to a certain gender, thus elevating itself as the essence of such gender.

However, essentialism ultimately leads to reductive conclusions (Mikkola). Always circumscribed by a particular group of people at a certain time period, the inquiry of socially defined gender, under a veil of universality, cannot be carried out without inevitably marginalizing and excluding those who display different traits than the majority who get to define the gender.

Consider this example: second-wave feminists in the US attempted to redefine gender women by a shared experience of womanhood instead of biological features which imply female inferiority. When the second-wave feminists, most of whom were white middle-class women, tried to understand womanhood and women in a social context, their reflection of such women was limited to their own gendered experience as white middle-class women. While recognizing

gender on the basis of social experience instead of biological facts, they decontextualized the construction of gender from certain social realities, for example, racial and ethnic inequalities, and falsely proclaimed the womanhood of white middle-class women as an essential, universal womanhood.

This is problematic because, in fact, females become not simply women but particular kinds of women (Spelman 133). The experiences of womanhood are very different among different groups of women. For instance, while middle-class women in the 1960s experienced their womanhood through the societal expectation of domesticity (Friedan 37), many less affluent women or, say, women of color, had no choice but to find a job to sustain their families, which led them to have a different experience of womanhood.

The understanding of womanhood also changes through time. While the cult of "True Womanhood" emphasizes women's dependence, and consequently prescribes women the housewife role to uphold morality in domestic spheres, the concept of "Real Womanhood" emerged, encouraging women to be independent and self-sufficient, thus diversifying the notion of womanhood -- what women are, and what they should become (Cruea 191).

The essence of womanhood, if anything, should be shared among all women and effectively includes all who identified as women; but under the criteria set by and derived from one group or limited groups of women, for those others who failed to meet some of the criteria as a result of social and cultural differences, their gender would become unintelligible. They even risk being defined as something "less than" women. Furthermore, there is the same quandary when defining every gender, not just women, since the a posteriori procedure requires scientists to conclude from the dataset of a group of people whose number is ultimately limited to be inclusive enough and whose understanding of self would change over time. In other words, if the group of scientists chooses to proceed under any form of social constructionism of gender, their conclusion would ultimately render some of their subjects without gender.

Therefore, although the social constructionism theories of gender sound appealing in terms of clarity and validity, it fails to be universal because it is not only limited to a certain time and place but also to certain social groups.

Another seemingly plausible approach to defining gender is to adopt a gender spectrum based on conventional notions of masculinity and femininity. Within the seamless gender spectrum, all genders fall in between the two endpoints of masculinity and femininity (Duignan), which allows it to embrace non-binary genders such as the third gender, whose gender is neither man nor woman, bigender whose gender combines characteristics of man and woman, agender as whose gender falls outside of the characteristics of both man and woman, etc. But such supposedly "non-binary" spectrum still conforms with a binary framework, because it limits the conception of gender within the heterosexual matrix, defining gender with the help of the notions of masculinity and femininity, as if these notions are objectively true. However, as argued in the last section, the notions of masculinity and femininity themselves are empirically constructed and thus are not universally valid.

All of the above theories of gender assume that gender is internally true to people. To arrive at the essence of the presumably inherent gender, these theories attempted to define gender through empirical data—biologically through observing sex chromosomes, or socially through observing social experiences of shared "masculinity" or "femininity." However, the inherently reductive empirical approach to gender would ultimately fail to be universal.

Gender Performativity

Judith Butler proposed in their *Gender Trouble* that gender is not a "stable identity", but an identity "instituted... through a stylized repetition of acts" (Butler 179). Gender does not result in gendered expressions and experiences, but rather, it is the expressions and experiences that constitute gender. This is what Butler calls gender performativity (Butler 177). We are not inherently gendered bodies producing gendered experience; it is by experiencing the world in a gendered way that we manifest gender through our bodies. Before the female-sexed bodies begin to recognize themselves as women, they have already been taught to behave "womanly"— to like pink dresses, to be attracted to men, etc. But these acts that signify their gender are not coherent in themselves (it would be absurd to think liking pink necessarily means liking man), nor do they have any inherent significance, since the constituents of gender vary in different cultural contexts. Nevertheless, these acts that are internally discrete and random are habitually practiced so that it creates an illusion of "being" a gender, and it creates notions such as masculinity and femininity. Just as performing a character on stage, the state of being such a character or gender is just a reinforced illusion, and there would be no such thing as the character, masculinity, femininity, or gender itself if one ceased to perform in certain assigned, stylized ways. Thus, there is no such thing as gender in itself.

Gender performativity indicates that by altering gendered performances, one's illusion of being a gender could be altered and even constitute a varying gender in oneself. This is the most clearly stated and universal definition of gender so far because it describes gender as any set of acts that are assembled and integrated into a notion created by society or individuals, whether the notion is man, woman, or Walmart bag. However, if the scientists were to adopt this definition, they would be left with an infinite number of proliferating genders, thus unable to empirically test the hypothetical number of genders or reach any meaningful conclusion.

Conclusion

This paper holds that the scientific discovery of the number of genders cannot proceed because gender cannot be defined under a valid framework in which each individual is encompassed without being marginalized. Even if Butler's gender performativity theory provides a universal definition for gender, no meaningful conclusion can be derived under such a definition because the number of genders would be infinite.

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The Impact of Political Ideologies on Renewable Energy Adoption By Anushka Ghorpade

Abstract

Renewable energy technologies have become increasingly popular as a source of energy, due to the growing urgency of climate change. Differing perceptions along party lines on the urgency of climate change may result in a slower rate of adoption of renewable energy technologies. This study explores the belief that Republican states are less inclined to adopt renewable energy technologies compared to their Democratic counterparts. To test this hypothesis, overall renewable energy production was analyzed across two blue states (Washington and California) and the two red states (Texas and Florida). Their results were compared using the two statistical tests: correlation analysis and t-tests. The goal was to examine overall energy production and determine if Democratic states had higher production levels and a faster growth rate than their Republican counterparts. Contrary to the initial hypothesis, however, it was concluded that there was no observable correlation between political ideologies and renewable energy adoption, with Texas, a red state, showing the fastest growth rate and producing extremely high levels of renewable energy. These findings indicate that factors beyond party lines are probable to influence state-level decisions regarding renewable energy sources. Understanding this is critical for creating policies to combat climate change and drive renewable energy adoption worldwide.

Introduction

Renewable energy technologies have become increasingly popular in the past decade due to growing climate change concerns. The increase in atmospheric carbon dioxide and nitrous oxide levels has resulted in the intensification of the greenhouse effect, contributing to the overall warming of the planet. The urgent need to address this issue has resulted in the growing emphasis on the development of renewable energy technologies worldwide. However, transitioning from nonrenewable forms of energy to renewable forms of energy requires political will, new technologies, investment, and widespread support from the community.

There have been a growing number of renewable energy initiatives aimed at producing 100% clean energy throughout the United States. Cesa, the Clean Energy State Alliance, is a coalition of public organizations that are working together to advance clean energy. According to Cesa[1], currently, 22 states have established targets to achieve 100% clean energy by 2050. Out of these 22 states, 15 have Democratic affiliations. Conversely, only two Republican-affiliated states hold the same goals, Nebraska and Louisiana. The remaining five states are swing states and have varying affiliations throughout the years. At its surface, the larger number of Democratic states setting clean energy goals may demonstrate their preference for renewable energy production in comparison to Republican states.

The aforementioned disparity can likely be attributed to a political divide regarding the perception of climate change and can thus affect the adoption of renewable technologies. A survey conducted by the Pew Research Center[2] in 2019 revealed that 90% of Democrats agree

that the government should be doing more to address the impacts of climate change. However, within the Republican Party, there is a more significant division based on ideological, gender, and generational lines. Moderate Republicans tend to believe that the government is not doing enough to reduce the effects of climate change, while only 24% of conservative Republicans share the same view. Half of conservative Republicans believe that the government is doing enough, while 26% believe that the government is doing too much. In addition, 46% of Republican women are more likely to believe that the government is doing too little for climate change whereas 34% of Republican men hold the same view. Additionally, 52% of younger Republicans (Millennials and Generation Z) believe the government is not doing enough for the climate. In comparison, 41% of Generation X and 31% of Baby Boomers within the Republican party share this sentiment. Overall, Republicans have a greater difference in opinion on the impact of climate change and view it as a less urgent issue while Democrats view it as a more pressing issue.

The perceived lower sense of urgency regarding climate change amongst conservatives may result in red states being less motivated to use renewable energy technology and instead relying on traditional nonrenewable energy sources. One reason could be the relative abundance and accessibility of nonrenewable energy sources. Due to the fact they have existed in the market for longer than renewable energy sources and have more established infrastructure, they are easier to access and can be more affordable. In addition, the greater enthusiasm to implement renewable energy technologies in Democratic states may indicate a higher level of incentive and commitment to renewable energy adoption in comparison to Republican states. Based on this data, it was hypothesized that red states would be less inclined to adopt renewable energy technologies than their blue-state counterparts.

To test this hypothesis, the overall renewable energy production was gathered across four states: Washington, California, Texas and Florida. Of those four, Washington and California were politically aligned with Democrats and Texas and Florida were politically aligned with Republicans. To compare the production and identify similarities and differences between the four states, the statistical tests of correlation and t-tests were used. The aim was to identify if Democratic states produced more renewable energy than their Republican counterparts. This study concluded that there was no observable effect of political ideologies on renewable energy adoption.

Methods

To understand the impact of political ideologies on adopting renewable energy technology, it was necessary to define goal-framing questions that could break the research question down into less complex parts. These questions would allow for the systemic analysis of the more straightforward questions, thus creating a definitive conclusion.

The primary question that needed to be answered was if there was an overall upward trajectory in renewable energy production in the past thirty years. By looking at the overall trajectory of the production of each state, it would be possible to analyze if certain states

progressed at a faster pace than others. This analysis would allow the grouping of states by similar trends, which could be used to see if there were similarities in their sourcing of renewable energy. For example, if one finds that Florida and Washington have similar growth trends in renewable energy production, the next logical question would be to ask which source of energy they produce. It is also necessary to note that there could be various factors that could affect the adoption of renewable technology outside human beliefs, like environmental factors, access to technology, and the availability of technological advancements in specific locations.

To determine the relationship between states and their trends, the statistical analysis technique of correlation analysis was employed. Correlation analysis determined the strength and direction of the relationship between two sets of data, indicating if they were heading towards similar outcomes. The analysis aims to find the dependence between the two sets of data and is used as a predictive measure for future outcomes. The correlation coefficient r measures the strength and direction of a linear relationship and ranges from the values -1 and 1. Strong positive linear relationships have a value closer to 1, meaning there is a higher correlation between both sets of data. In comparison, strong negative linear relationships have a value closer to -1. Values close to zero indicate a weaker relationship between the datasets[3].

Correlation analysis is an insightful but incomplete measure to compare the data. Once the trend is understood, it is important to understand if the data driving that trend is similar. Although the trends can be increasing in nature, two states might have substantially different levels of energy production. T-tests can be utilized to assess the likelihood of two data sets originating from the same population. Since this test was used to determine the difference between the two populations, a two-tailed t-test was used[4]. The likelihood of the two populations being similar can be obtained by p-value, an output of the t-test. Specifically higher p-values would indicate greater similarity in the underlying data sets, in this case annual renewable energy production.

To better compare the renewable energy production trends of various states using t-tests, it is necessary to normalize these production numbers prior to doing the t-test. In this case, the production values were normalized based on their surface area in order to deduce the amount of energy produced per square mile. This would address the disparity caused by variations in state sizes. By accounting for the area, it ensured a fair comparison of renewable energy production between all states which allowed for an assessment of the production levels relative to the land area available.

For this analysis, data was analyzed for the past thirty years, from 1990 to 2020. This provided enough time to establish long-standing trends. The specific renewable energy sources classified in the dataset included Solar Thermal and Photovoltaic, Pumped Storage, Wind, and Other Biomass. These are referred to as solar, hydropower, wind, and geothermal energy respectively in this paper.

To investigate the impact of political ideologies, two traditionally Republican "red" states, and two traditionally Democratic "blue" states were selected: Texas, Florida, Washington, and California. The two blue states chosen were Washington and California, while the two red

states chosen were Texas and Florida. Since 1988, Washington has voted in favor of the Democratic party in the presidential election[5]. Similarly, since 1992 California has also voted for the Democratic presidential candidate[6]. On the other hand, Texas has voted for the Republican presidential candidate since 1980[7]. Since 1980 Florida has mostly voted for the Republican presidential candidate, with the exceptions of 1996, 2008, and 2012 elections[8]. This selection included states with varying surface areas and populations, allowing for a comprehensive comparison. Texas and California, being larger in size and population, might have different production levels than Washington and Florida. Thus, normalizing the data based on the surface area was essential.

To gather necessary data, information was collected from the US Department of Energy's comprehensive records[9], which document all energy produced in the United States categorized by state and energy type. This dataset allowed for the extraction of raw data on total renewable energy production based on each state for every year of production.

Results

To conduct the analysis, the initial step involved examining the renewable energy generated over a 30-year period (from 1990 to 2020). The renewable energy sources considered were Solar Thermal and Photovoltaic, Pumped Storage (hydropower), Wind, and Other Biomass. This analysis focused on four states: Washington, California, Texas, and Florida. Washington and California were chosen to represent blue states, while Texas and Florida were chosen to represent red states. Furthermore, California and Texas were selected due to their larger size and population. The correlation analysis focused on six pairs: Washington and California, Washington and Texas, Washington and Florida, California and Texas, California and Florida, and Texas and Florida.
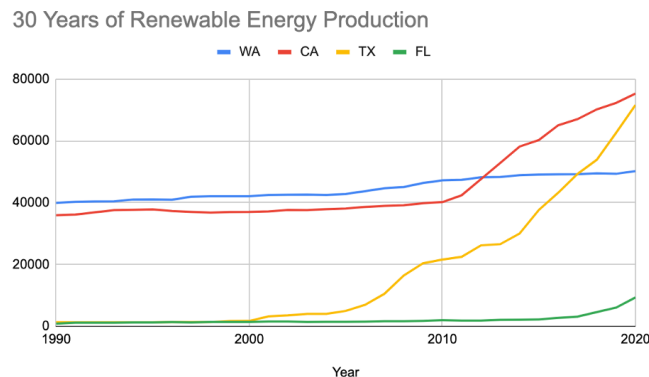
Figure 1. Total renewable energy production in Washington (WA), California (CA), Texas (TX) and Florida (FL) from 1990 to 2020. The x-axis shows the years, and the y-axis shows the total nameplate capacity in Megawatts.

Based on Figure 1, initially, Washington and California exhibited notably higher energy production, starting at around 40000 megawatts. Both began with substantial energy output, but Washington displayed the highest level of production. However, their production levels remained rather stagnant, not experiencing any significant growth. In 2010, California started showing signs of more substantial increase, while Washington showed a slight increase in production. In comparison, Texas witnessed remarkably rapid growth starting around 2007, progressing at a much more accelerated pace than the other three states. While it did not begin with the high levels of production like California or Washington, it ultimately caught up to both, even surpassing Washington's production around 2016. On the other hand, Florida stood as an outlier, generating considerably less energy than the other three states, and displaying minimal growth throughout the past three decades.

Table 1. Outcome of correlation analysis for thirty years across states of interest

State	Correlation Analysis Value for 30 years
CA x WA	0.857428899
TX x FL	0.86652746
CA x TX	0.968692859
CA x FL	0.830904966
TX x WA	0.912636835
WA x FL	0.658973931

The correlation analysis (Table 1) revealed that California and Texas exhibited the highest correlation, indicating that Texas was closing in on California and Washington in terms of energy production. Furthermore, Washington and Texas demonstrated a higher correlation than California and Washington. Texas, identified as a "red" state, demonstrates a stronger correlation with two "blue" states than they do with each other. This could suggest that political factors may not be influential in the production of renewable energy. It is also clear that any analysis done with Florida yields a lower correlation value, most likely due to its extremely low production in comparison to the three other states.
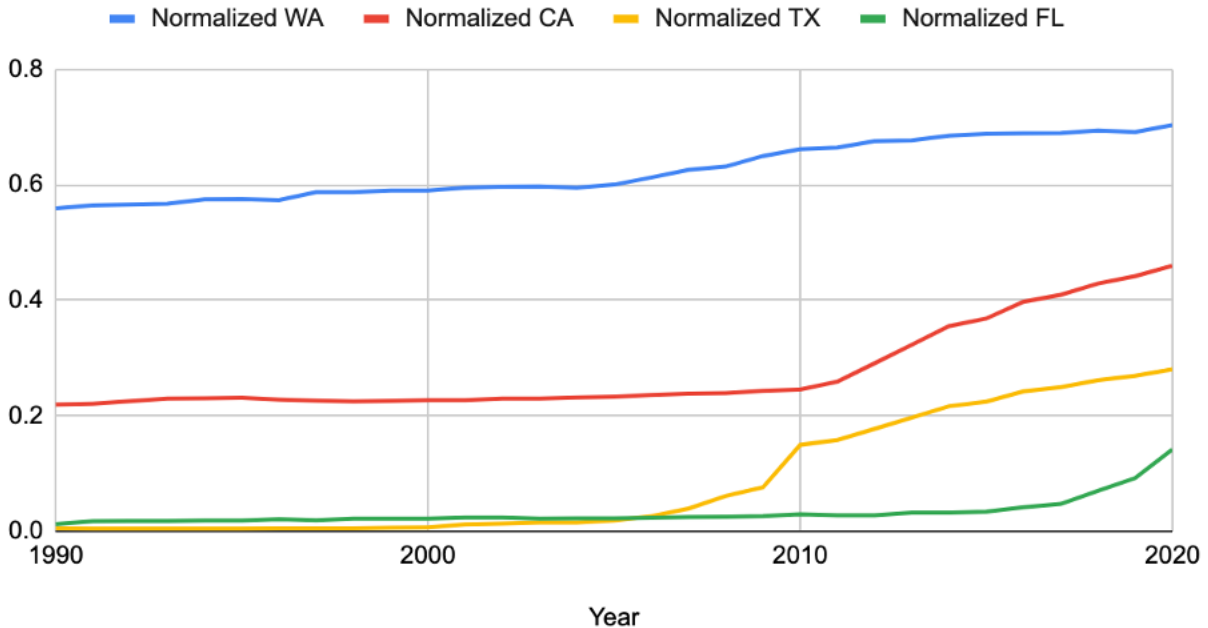
Figure 2. Renewable energy production from 1990 to 2020 years normalized to the surface area of Washington (WA), California (CA), Texas (TX), and Florida (FL). The x-axis shows the years, and the y-axis shows the normalized value in megawatts per square mile.

After normalizing the total production of each state by their respective surface areas (Figure 2), it became evident that Texas initially had extremely low values due to its large surface area and comparatively lower production. However, as its production increased, Texas achieved higher normalized values. In comparison, Washington had the highest normalized value, indicating a more efficient utilization of its surface area for energy production. California, although matching Washington to some extent, still did not reach the high values observed in Washington. Florida, once again, remained an outlier with a consistently low normalized value despite its surface area.

Table 2. Outcome of t-test for thirty years across the states of interest

State	T-Test Value for 30 years
CA x WA	7.9001E-30
TX x FL	0.002208865
CA x TX	1.8038E-11
CA x FL	1.52534E-24
TX x WA	1.18932E-34
WA x FL	2.25401E-55

Subsequently, t-tests were conducted to compare the values between each pair of states. The resulting values (Table 2) were found to be extremely low, indicating that the likelihood of the data being derived from the same population for each state pair was highly improbable. This implies that there was little to no overlap in terms of energy production patterns between the states, further supporting the notion of distinct differences among them.

Based on these findings, it can be concluded that during the initial ten years, there was minimal change in energy production, and all states experienced a relatively stagnant phase. Furthermore, Washington's high production levels were primarily attributed to hydropower, as a significant portion of their renewable energy came from this source. It is important to note that the establishment of dams in Washington began in the 1950s for the purpose of energy generation, rather than as a deliberate effort towards renewable energy.

To gain a deeper understanding of the impact of political mindset on renewable energy efforts, the subsequent analysis excluded hydropower. By excluding hydropower, the focus shifted to other renewable energy sources, allowing for a clearer assessment of the influence of political factors on renewable energy production. In addition, the first ten years of the analysis were stagnant, and thus skewed the data. Production neither drastically increased nor decreased, so the time frame was shortened to twenty years (2000-2020).
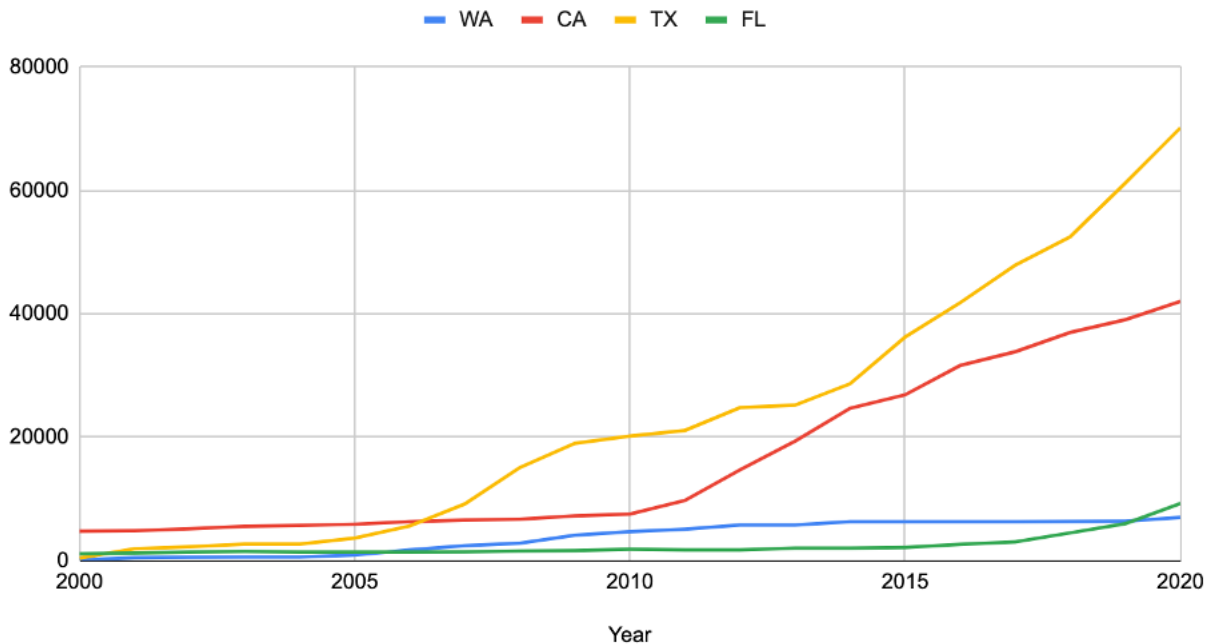
Figure 3. Total renewable energy production excluding hydropower in Washington (WA), California (CA), Texas (TX) and Florida (FL) from 2000 to 2020. The x-axis shows the years, and the y-axis shows the total nameplate capacity in Megawatts.

In the subsequent analysis, the timeframe was adjusted to cover 20 years (2000-2020), and hydropower was excluded from the renewable energy sources considered. Without the inclusion of hydropower, the total production of renewable energy significantly decreased, and Washington no longer maintained a lead over the other states (Figure 3). In fact, following the removal of hydropower, Washington fell behind both California and Texas in terms of renewable energy production. Once again, California started off with a higher production, but Texas surpassed it by 2006. Overall, Texas had the highest production levels, which disproves the belief that a "red" state would produce less renewable energy than a "blue" state.

Table 3. Outcome of correlation analysis for twenty years excluding hydropower across states of interest

State	Correlation Analysis Value for 20 Years no Hydropower
CA x WA	0.832058325
TX x FL	0.862390385
CA x TX	0.965278793
CA x FL	0.813935205
TX x WA	0.884530111
WA x FL	0.588078397

The correlation analysis once again highlighted that Texas and California exhibited the highest correlation values (Table 3), indicating a strong similarity between their renewable energy production patterns. On the other hand, Florida and Washington showed the lowest correlation values, suggesting a potential impact of political beliefs on renewable energy implementation. Notably, Washington and Texas displayed a higher correlation than Texas and Florida, indicating that the two "red" states had a weaker correlation in production compared to a "red" state and a "blue" state. Once again, these findings suggest a lack of significant correlation between political thought and the implementation of renewable energy initiatives.

Figure 4. Renewable energy production from 2000 to 2020 excluding hydropower normalized to the surface area of Washington (WA), California (CA), Texas (TX), and Florida (FL). The x-axis shows the years, and the y-axis shows the normalized value in megawatts per square mile.

Upon normalizing the production values by surface area (Figure 4), the differences between the states became significantly smaller compared to the first test. California remained above in normalized production, except for a short period from 2007 to 2012 where Texas surpassed it. Florida and Washington remain on the lower end of production, showing a similarity in production by state-size rather than political association.

Table 4. Outcome of t-tests for twenty years excluding hydropower across states of interest

State	T-Test Value for 20 Years no Hydropower
CA x WA	0.010429139
TX x FL	0.004286722
CA x TX	0.299160793
CA x FL	0.000834415
TX x WA	0.041078256
WA x FL	0.050048335

The t-test results (Table 4) yielded considerably higher values than the initial analysis. Once again, California and Texas had the highest values in the t-tests, indicating a higher likelihood of being derived from the same population. On the other hand, all the other state pairs yielded values below the threshold of 0.05, suggesting that they were unlikely to originate from the same population. Washington and Florida were on the edge with a value of exactly 0.05, making them borderline cases.

However, the overall analysis indicates that political ideologies appear to have no significant impact on the implementation of renewable technologies. This is evident as the highest probability of belonging to the same population was observed between a "red" state and a "blue" state. These findings suggest that other factors, such as geographical or economic considerations, may have a more substantial influence on renewable energy implementation than political beliefs.

In the analysis of solar energy production, California consistently emerged as the frontrunner with a steadily increasing production throughout the 20-year period. California maintained a significant lead compared to all other states in solar energy production. On the other hand, Washington had the lowest solar production, with Florida (the consistently underperforming state) even surpassing it in solar energy generation. Texas initially had low production and experienced a data gap from 2003 to 2009, but after that period, its production began steadily increasing, aligning with the overall energy production trends observed in Texas. Both Washington and Florida also had data gaps, with Washington not producing solar energy for the first six years and Florida for the first eight years. Overall, California led the energy production in terms of solar energy.

Regarding wind energy production, California started with the highest production and saw a steady increase over the 20-year period, reaching a peak of approximately 12,000 in 2020. In comparison, Texas began with lower production than California but experienced a significant surge in 2008, establishing a substantial lead over the other three states. By 2020, Texas had produced nearly 60,000 Megawatts in wind energy. While Washington had higher wind energy production, it still fell short of California and Texas in overall production. Florida did not record any values for wind energy production.

Discussion

The initial hypothesis was that political ideologies impact the adoption of renewable energy technology. Specifically, it was believed that individuals aligned with the Republican Party, influenced by sections of the party denying climate change, might be less inclined to embrace renewable energy. However, this study reveals little to no correlation between political ideology and the adoption of renewable energy. While California and Washington, considered "blue" states, initially exhibited higher energy production than Texas and Florida, this trend was primarily attributed to factors such as state size and available resources, including the significant use of hydropower.

The prominence of hydropower in Washington's energy production can be traced back to the usage of dams as an energy source since the 1950s. The development of dams in Washington and across the nation was primarily driven by energy efficiency rather than a deliberate effort to promote renewable technology for environmental or sustainable purposes. Excluding hydropower from the analysis further undermines the hypothesis, as it demonstrates Washington's relatively lower production compared to states like Texas and California.

Geographical location and climate are also crucial factors to consider. Washington, characterized by limited sunlight due to environmental factors, would have limited effectiveness in implementing solar panels compared to other renewable technologies. In contrast, California experiences abundant sunlight and possesses extensive open areas, allowing for the widespread installation of solar panels, thereby contributing to its leadership in solar energy production. Texas, benefiting from its placement in the tornado alley, where wind energy is abundant, has prioritized wind energy production and has emerged as the top wind energy producer among all states. Florida, relying more on solar energy than wind energy, has lower overall production, potentially due to a lack of comprehensive government initiatives and limited resources.

California has shown consistent and sustained growth in renewable energy production across various sectors, possibly due to state-level initiatives and access to advanced technologies. Texas, on the other hand, experienced a remarkable surge in production. Initially lagging California and even Washington, Texas witnessed exponential growth in energy production from around 2008 onwards, primarily driven by the wind energy boom in the state[10]. This substantial increase allowed Texas to reach production levels comparable to California, signifying its significant progress.

The surge in Texas's energy production is due to the wind energy boom in 2008. In fact, second to Texas is the state of Iowa, another "red" state. This is partly attributed to the fact that Texas was one of the first states to require a certain amount of power to come from renewable energy sources. In addition, Texas's wind power is cheaper than fossil fuels, which would result in greater adoption. Texas's separate energy grid also aids their production levels since they have shorter distance transmission lines, which is a prevalent issue for many other states.

After removing hydropower from the second analysis, Washington's renewable energy production decreased significantly. The reason for removing hydropower from the analysis was due to the previous development of dams and them not being created with the belief that there was a need to shift to renewable energy sources. However, in 2022 Washington provided 67% of the nation's hydroelectric power. The rest of the generation comes from non-hydroelectric renewable sources (mainly wind), nuclear energy, natural gas, and coal (U.S Energy Information Administration)[11]. In addition, Washington was also second to Texas in the nation's renewable energy production. While the dams may not have been originally developed for the purpose of being a "renewable" form of energy, the renewable generation by Washington beats most other states. Washington may not need to utilize other forms of renewable energy because they excel in the production of hydroelectric power. This is likely the reason why they have not invested in developing the infrastructure for other forms of renewable energy.

Throughout the study, Florida remained an outlier when it came to renewable energy production. It produced significantly less than every other state, including Texas (which shares the same political affiliation) and Washington (which has relatively the same surface area). Florida, often coined the "sunshine state," does not utilize its capacity to use solar energy, despite being the fourth largest energy-consuming state[12]. One of the reasons for this is slight pushback by Florida's utilities. Their resistance makes the incentive to move to solar energy decrease significantly due to added costs for the purposes of maintaining current power lines. However, Florida has released many more incentives to grow the number of solar users, so there may be an increase in solar production in the future.

To better understand this topic, further research could be done on the various incentives given by states and how they help develop renewable energy production. The analysis of lag after a new policy is implemented in a state could be done to understand the general attitudes of the citizens in each state. On the other hand, an analysis could also be done on the relationships between energy sources and the overlap between states which produce the same form of energy—for example, looking into states with the highest wind production and identifying the similarities in their environment, access to technology, and more. In order to get a better grasp of the entire nation, this study's analysis could be done at a larger scale by including all 50 states. From there, there could be an analysis done on states that continuously produce a lower amount of renewable energy and if there is an overlap in factors that could affect production.

While it may have been initially true that political ideologies drive renewable energy production, the past two decades prove that political bias does not affect renewable energy production.

Conclusion

Although it was initially hypothesized that traditionally "red" states would be less likely to adopt renewable energy than "blue" states, this study shows that there is no significant/direct effect of political ideologies on adoption. A statistical analysis was conducted in order to determine the relationship between renewable energy production in four states: Washington, California, Texas and Florida. Two states (Washington and California) were associated with the Democratic party and the other two states (Texas and Florida) were associated with the Republican party. By utilizing the energy data from the US Department of Energy this work was able to compare the gross production in each state and conduct statistical analysis on the data. Their results were compared by utilizing two statistical tests: correlation analysis and t-tests. The aim was to examine the overall energy production levels in each state to determine if Democratic states demonstrated higher production levels and faster growth rates than Republican states. Our results indicated no observable relationship between the political thought and renewable energy production, thus disproving the hypothesis. In fact, the states displaying the most significant growth are Texas and California, a "red" and "blue" state respectively. In conclusion, the development and adoption of renewable technology appear to be spreading nationwide,

irrespective of political ideology. Instead, the overall growth seems to be driven by the availability of technology and resources for renewable energy adoption.

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The Role of Vaccination in Public Health: Navigating Challenges and Maximizing Benefits
By Saranya Shiva Shankar

Abstract

   Vaccines play a crucial role in combating infectious diseases, and their significance has become increasingly apparent during the ongoing global pandemic. This review article delves into the criticality of vaccines amidst the pandemic, exploring their benefits in preventing severe illness, reducing transmission rates, and ultimately saving lives. However, despite their proven effectiveness, vaccine hesitancy has emerged as a significant challenge, hindering vaccination efforts worldwide. By analyzing the contributing factors behind vaccine hesitancy, including misinformation, distrust, and fear, this article aims to shed light on the complexities surrounding this issue. Moreover, it offers a perspective on things researchers could do to build trust in communities enabling the communities to look at vaccines as a potential solution for addressing future pandemics.

Introduction

   After the world was rocked by the 2020 COVID pandemic, a certain issue was brought to light: how pertinent is vaccine hesitancy and what would it mean for the world the next time we face a global crisis like this? As of 2019, The World Health Organization (WHO) named vaccine hesitancy as one of the top ten threats to global health, a threat that was enhanced during the pandemic("Ten Threats to Global Health"). While all vaccines have potential side effects, most are relatively mild and in most cases are much more bearable than the effects of the illness they are meant to prevent. Some recognize that vaccines are safe, and necessary in order to help keep harmful diseases at bay, while others take a more cautious approach due to the belief that vaccines have the potential to cause development issues, various cultural beliefs, and lack of trust in the healthcare field. Despite opposition to the safety of vaccines, they have proven to be extremely beneficial in helping to eradicate diseases, establish herd immunity, and save money for individuals and society as a whole.

Benefits of Vaccination

   Vaccines have been proven to play a major role in helping to eliminate serious diseases. Smallpox was a deadly illness during the 1900's which was most noticeable from the red rashes it left on its victims that was ended through consistent vaccination. The History of Vaccines discusses the process of identifying and eliminating diseases in its article "Disease Eradication". On the topic of smallpox it states "Smallpox eradication was accomplished with a combination of focused surveillance—quickly identifying new smallpox cases—and ring vaccination" ("Disease Eradication"). Scientists and doctors engaged in the ring method, which was where they would only vaccinate those who had the illness, or those who were most likely to contract it. By vaccinating high risk patients scientists were able to slow the spread of the disease. The disease was extremely contagious, so therefore it was imperative that it was dealt with

immediately to ensure that more lives were not taken. This helped to save many lives, and helped prove that it is possible to eradicate diseases. In addition to small pox, Rinderpest was another disease that has been successfully eliminated. Rinderpest was a plague that affected animals, but most often cattle. The sickness caused the death of many livestock, resulting in disastrous effects on the local economy in Africa, where Rinderpest had been common. The decrease in cattle resulted in a major decrease in crops causing famines in Africa, Asia, and Europe. In Ethiopia, many were forced to resort to extreme measures including eating rotting carcasses, and in extreme cases, cannibalism (Morens, et al). In areas that were largely affected by Rinderpest, the livestock were tightly intertwined with the overall economy. Ethiopia is a common example of an affected region where cattle were heavily used in farming. It was later stated in the article that rinderpest was eradicated after years of hard work on 25 May, 2011 by the Global Rinderpest Eradication Programme (GREP) of the UN Food and Agricultural Organization (FAO)(Mornes, et al). The eradication of this disease, which may have not directly affected humans, had a positive impact on many countries that depended on their livestock, saving lives of both humans and animals. The eradication of harmful diseases are imperative to ensure healthy, and stable societies, and with the help of vaccines this can be achieved.

Adding on, vaccines are tremendously beneficial in helping to establish herd immunity. Herd immunity is when a large percent of a group is immune to a certain disease which in turn decreases the risk of contracting the disease for those who are not immune ("Mandatory Vaccination"). A major point brought up in the discussion of how to help enable vaccines to be as effective as possible is that they need to be universal. Certain individuals are unable to receive vaccines, due to medical complications, therefore those who are able to receive vaccines must. Vaccines help to establish herd immunity by allowing the immune system to recognize the disease and fight against it, allowing the body to create immunity at a quicker rate rather than waiting to contract the disease and then fighting it off. Herd immunity not only protects those with compromised immune systems, it also protects the lives of many children who have yet to receive all of their vaccinations. The article "Mandatory Vaccination: Should Vaccination Be Mandatory?" also states children who have not received all necessary vaccines are the largest group being safeguarded from the viruses. Children often have weaker immune systems, therefore they do not receive all vaccines until a certain age. By receiving the vaccine and ensuring that as much of the population is safe from contracting the diseases as possible it helps to protect children and high risk patients. Vaccinating has proven to be the safer course of action to take in order to protect the lives of those who are unable.

Furthermore, vaccines have positive effects on the economy, and have proven to save a great deal of money. Hospital bills can be extremely expensive, and not all families can afford to pay them. Chris Regal, author of "Vaccines Save Lives" writes, "Vaccinations to children born over a 20-year period will save nearly $295 billion in direct costs, which includes avoided hospitalizations and other medical care, and $1.38 trillion in total costs to society, such as lost wages and decreased productivity, according to CDC data". Hospital bills can clearly become extremely burdensome, yet this issue can be avoided through vaccination. By vaccinating and

protecting oneself from diseases, individuals' time spent in the hospital is also reduced therefore lessening the money spent treating illnesses. Vaccines have not only shown the ability to save money for individuals, but for countries as well. The article titled "Vaccinate Your Family" discusses the idea that it costs our country about 27 billion dollars to treat all adult sicknesses that could have been simply avoided through vaccination. It is clear that vaccine hesitancy, not vaccinating oneself and or children, has multiple detrimental effects. Such huge losses result in the system having to fall back on the consumers, in other words increasing the costs of many items including increasing taxes which directly impacts the individual and can be avoided through vaccination.

Barriers to Vaccine Adoption

There are some who argue that vaccines should not be mandatory because they are harmful and can result in development issues. A key article that was inline with this thinking was former physician Andrew Wakefield's study, which he published in *The Lancet,* a prestigious British medical journal. Wakefield studied 12 children who were exhibiting stomach complications and development issues and concluded that their conditions were caused by the MMR vaccine ("Mandatory Vaccination"). The MMR vaccine is a mandatory vaccine that fights against measles, mumps, and rubella. For some, the research done by Wakefield helped to further prove their point that vaccines are indeed harmful for their children and have potentially irreversible effects. Admittedly, Wakefield's article did not have many opposers at the time published and the fear it aroused allowed his ideas to take root quickly. However, this argument fails to take into consideration that Wakefield's study was refuted on multiple occasions, by multiple scientists. The article entitled *"*Mandatory Vaccination: Should Vaccination Be Mandatory*?"*explains that Wakefield's findings was later disproved by multiple scientists on the basis that they were unable to replicate his experiment, which went against a common scientific theory that for something to be true it should be able to be replicated. Multiple scientists proved it to be false, proving that there is no direct link between developmental issues and vaccines. Furthermore, a clinical trial is typically conducted with tens and thousands of people to ensure that the sampling pool is large enough to nullify any and all confounding factors to the experiment. The 12 patients evaluated in Wakfield's study is a statistically insignificant number to prove a scientific theory. Due to the shortcomings in how the experiment was set up and the number of patients observed, one is unable to use Wakefield's trial findings in a conclusive manner.

In addition, there is also a cultural and religious perspective. Some cultures and religions object to the idea of vaccination due to various beliefs, a common one being that the human body is sacred and should not be injected with certain chemicals. For example, the Catholic Church urges its members to seek alternatives to vaccines made using cell lines created through aborted fetuses because they support the idea that human life starts from the moment of conception("Cultural Perspectives on Vaccination."). Therefore, being vaccinated with vaccines that have been derived from aborted fetuses goes against their belief system, which is why they

encourage their members away from these types of vaccines. For Muslim populations the main barrier was the fact that there were non halal ingredients in the vaccines(Kibongani, et al). In Islamic culture halal refers to what is allowed under Islamic law, and based on certain vaccines within vaccines they are not considered halal. Not to mention, many Muslims consider vaccines not allowed during the period of Ramadan, when Muslims are fasting from sunrise till sundown. They stated that possible adverse effects caused by the vaccine "'could lead to breaking the fast'" that is carried out during Ramadan(Kibongani, et al). For certain cultures their belief systems result in vaccine hesitancy, which is something that we as a society must respect and learn to embrace. Through this understanding we open ourselves to the possibility of finding alternatives for these communities so that they too are able to stay healthy and safe during difficult times.

It is also important to acknowledge the suspicion and mistrust surrounding vaccines in certain communities. In order to understand this we have to examine the unfortunate legacy of racism of medicine. An example of that is the Tuskegee Syphilis Study, which was a clinical trial that was conducted to study the natural history of untreated Syphilis("Cultural Perspectives on Vaccination."). The study originally involved 600 black men, 399 who had syphilis and 201 who did not, whose informed consent had not been collected and were not offered treatment despite the fact that it had been widely available during the time of the study("Tuskegee Study"). These are some of the contributing factors that resulted in African American communities' distrust in the healthcare system, as well as in vaccines. In parts of Asia and Africa, there are theories that suggest that vaccines are ploys that are meant to sterilize and infect non-western communities("Cultural Perspectives on Vaccination."). These communities unfortunately do not have strong relationships with healthcare systems, which is resulting in detrimental views of what the system has to offer, including vaccines. It is imperative that the global healthcare system works to build positive relationships with these various communities in order to foster trust and acceptance in these societies. In order to be able to help people around the world the healthcare system needs to work on addressing its past with racism and injustice and take steps towards connecting with communities around the world in order to help build more trust in the treatments the system has to offer, for example vaccines. With more belief in the system, there is a strong possibility that vaccine hesitancy will decrease, and more people will be open to treatments that are necessary for them.

In order to demonstrate to minority cultures that they can trust health care providers, steps need to be taken. During a discussion between Michelle Williams, dean of Harvard T.H. Chan School of Public Health and Paul Hudson, former CEO of Sanofi, they touched upon the ways to help close this "trust gap"("Marginalized Communities"). Some solutions they suggested included diversifying their healthcare workers as well as being better listeners. By that they meant "'recognizing and overcoming unconscious bias, seeing every patient before them as an individual with dignity and worth, and taking the time to understand why each patient has come in seeking care'" rather than making assumptions and overlooking the patients words it is important to listen to them and offer the best care possible based on their needs("Marginalized Communities"). A huge part of healthcare is listening to the patient's needs, and in order to build

trust between the system and these communities, that is exactly what needs to be done.

It is important to remember that people are by all means allowed to control what happens to their bodies, including whether or not they feel comfortable getting vaccinated. There are many reasons why an individual would choose not to get vaccinated, should they have a weaker immune system and are medically unable to be vaccinated, or if their religion prohibits vaccinations, or even if they truly don't want to risk the side effects that could potentially come along with the vaccine. It should be a person's own personal decision. However, in special cases such as the COVID pandemic or any other illness that requires special measures, vaccine hesitancy becomes even more dangerous, and it is important to consider vaccinating oneself, for one's own safety and the safety of those around them.

Conclusion:

Vaccines are vital in helping to suppress hazardous diseases, proven by the elimination of both smallpox and rinderpest through vaccination. Herd immunity has demonstrated effectiveness in helping to wipe out dangerous diseases. Shown by how it raises the immunity of the majority of the community, it lowers the risk of infection for the high risk individuals in the community. Not to mention, vaccines have proven extremely effective in helping to save money for both the individual and society by lowering the hospitalization rates and keeping an increased number of people healthy. While some may argue that vaccines are unsafe and cause development issues, such as autism, this claim has been disproven multiple times by multiple different scientists. However, it is essential that we remember to respect people's personal decisions and the history that their culture may have had with the healthcare system. And as a system it is important that we take proactive steps to repairing and building new relationships with various communities across the globe to ensure as many people as possible have the opportunity to take advantage of vaccines, helping to make our world a safer and healthier place for everybody.

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A Review of Sustainability Concerns and Possible Solutions in Semiconductor Manufacturing By Evan D'Souza

Introduction

The monumental growth and proliferation of the internet, computers, mobile phones, and other intelligent devices have defined the 21st century. With incredible breakthroughs in AI, such as GPT-4, it is clear that growth in technology is accelerating. As innovators worldwide continue to push the bounds of what is possible with current technology, they are shifting attention toward the hardware that makes all modern technology possible - microchips. As a result, investment in the semiconductor industry is skyrocketing. Arguably, the most significant indicator of this shift in the United States is the CHIPS and Science Act passed in August 2022. Provisions include $39 billion in manufacturing incentives, $13.2 billion in R&D incentives, and a 25% tax credit for purchasing equipment [1]. These incentives will ensure that semiconductor manufacturing will significantly increase in the coming years. In the wake of the announcement, companies like Qualcomm have pledged to dramatically increase chip production in the United States [1].

However, an increase in semiconductor manufacturing comes with environmental concerns. Emergent technology is poised to be an invaluable tool in fighting climate change, yet the current state of semiconductor manufacturing is harmful to the environment. Individual fabs use incredible amounts of energy and resources each year, often rivaling the needs of tens of thousands of families [2]. Therefore, reducing emissions and improving sustainability must be prioritized as new semiconductor fabrication plants (fabs) are built. This paper addresses the primary environmental issues present at fabs today, each issue's relative importance, and possible solutions to make the industry as sustainable as possible.

Primary Issues

Two main factors are important when reviewing an industry's environmental impact: greenhouse gas (GHG) emissions and scarce resource consumption. An industry's GHG emissions include both direct and indirect sources of emissions. These emissions are categorized under three "scopes": Scope 1 for direct GHG emissions from the industry, Scope 2 for indirect GHG emissions, and Scope 3 for GHG emissions related to other sectors in the supply chain. Because the industry has the most control over Scope 1 and 2 emissions, and because they make up 80 percent of the industry's total emissions, this article will focus on those two [3]. Since the only source of Scope 2 emissions are electricity-related GHG emissions, all discussions of Scope 2 emissions will concern electricity. Similarly, since Scope 1 emissions are direct GHG emissions, all Scope 1 emissions will be referred to as "direct GHG emissions". The second factor is the industry's significant consumption of scarce resources. For semiconductor manufacturing, water is the most consumed resource of this nature. Therefore, this article will focus on the relative importance of water consumption, direct GHG emissions, and electricity use within the semiconductor industry. In the next section, the industry's water usage will be

discussed, which has a relatively low impact on overall commercial scarce resource consumption.

Water Consumption

Many articles discussing the semiconductor industry's environmental impacts detail how much water fabs consume. Indeed, a single large fab can use around 10 million gallons per day [4]. For example, TSMC's planned fab in Arizona will use 8.9 million gallons of water daily [2]. However, the industry's water usage pales in comparison to total U.S. water usage alone, much less global water usage, for several reasons. First, there are not many semiconductor fabs in general. While there are no specific records on how many semiconductor fabs exist in the United States or globally, unofficial lists estimate the number to be around 500 globally [5]. In the worst-case scenario, assuming all 500 fabs use 10 million gallons of water daily for the year, the *global* total water usage by the semiconductor industry would be 1.825 trillion gallons of water. However, the United States alone uses 322 billion gallons of water daily, or 117.530 trillion gallons per year [6]. In other words, the global semiconductor industry uses only 1.55% of the water used in the United States alone. Other estimates place the industry's water usage in the United States at 264 billion gallons per *year*, significantly less than the total water used in the United States in just one day [4] [6]. As a whole, the semiconductor industry does not use nearly as much water as many other industries [7].

Even more importantly, none of these calculations consider water recycling, an essential aspect of fabs' water usage. While water recycling rates vary drastically from fab to fab, almost all fabs employ some sort of water recycling method, with the industry average around 23% percent [4]. Some fabs have even devoted significant resources to water recycling and reached 98% efficiency, meaning only 2% of new water needs to be externally sourced daily [8]. Overall, as the adoption of water recycling technology continues to improve, the semiconductor industry's water usage will no longer be a significant sustainability issue to consider.

Direct GHG Emissions Breakdown

Direct GHG emissions account for 43.75 percent of Scope 1 and 2 emissions [3], a significant portion of the industry's emissions. Additionally, the overwhelming majority of Scope 1 GHG emissions arise from gasses necessary to process the chips [3]. Process gas is the largest source of direct GHG emissions because up to 80 percent of process gasses used in the chambers are released unreacted into the environment [9]. Chip processing includes the steps necessary to etch, or carve, the physical chip and clean the chemical vapor deposition (CVD) chambers where the chips are made. While many of the gasses used in etching the chip and cleaning the chambers are the same, for the sake of clarity, gasses used for CVD cleans will be referred to specifically, while the gasses used for etching the chip will still be referred to as process gasses.

Around 66 percent of GHG use in fabs arises from CVD cleans [10]. Consequently, fabs prioritize reducing GHG emissions in CVD cleans over general process gasses. Three additional factors also contribute to this prioritization. First, the fluorinated gasses used to etch the chip are

incredibly hard to replace, and no viable substitutes exist. Therefore, almost no improvement is possible regarding general process gasses. Secondly, improving chamber cleans will not hurt productivity in chip production because the processes are independent [11]. Finally, and most importantly, significant opportunities exist to improve CVD chamber cleaning.

Currently, the semiconductor industry has four main strategies for reducing CVD clean-related GHG emissions. These strategies include alternative chemistries, gas abatement, capture and recovery of gasses, and process optimization [12]. Alternative chemistries and gas abatement are particularly noteworthy strategies to investigate for direct GHG emission reduction. Process optimization involves improving sensing technologies to use less gas and improving technology in the chambers, which fabs will naturally do to improve their bottom line. On the other hand, the capture and recovery of gas is costly, inefficient, and impossible to implement effectively in fabs for the foreseeable future [12]. Additionally, with improvements in the other strategies, primarily in alternative chemistries, there will be little remaining gas left to recycle.

Alternative Gasses

Fabs primarily use fluorinated gasses such as CF_4, C_2F_6, C_3F_8, c-C_4F_8, CHF_3, CH_3F, CH_2F_2, SF_6, and NF_3 [9]. The free fluorine atoms provided by the gasses are essential for both etching the silicon wafers and picking up extra material during cleaning [9]. Unfortunately, these gasses are highly potent greenhouse gasses. For example, C_2F_6, a gas primarily used in older CVD cleans, has a global warming potential 9200 times greater than CO_2 and lasts in the atmosphere for 10,000 years [3]. CF_4, a problematic byproduct of CVD cleans, has a global warming potential 6500 times greater than CO_2 and lasts in the atmosphere for 50,000 years [3]. This issue leaves manufacturers in a tough situation, as solutions not involving fluorinated gasses would be costly and ineffective. However, using more efficient process gasses can ameliorate the issue.

All GHGs are problematic when released into the environment, but not all are used as efficiently. Some gasses, such as C_2F_6, are only used with 30% efficiency, leaving 70% of gas unreacted [11]. Low-efficiency gas use is problematic because, while reacted gas doesn't leave the facility, the unreacted gas gets released into the environment and contributes to climate change. On the other hand, modern-day remote plasma cleaners using NF_3, an alternative CVD cleaning gas, have reached 95–99% efficiency [12]. While NF_3 is a much more potent GHG than C_2F_6 [3], it is a much more efficient gas for CVD cleans because it is more reactive. Therefore, by switching all CVD cleans to NF_3, fabs can significantly reduce their GHG emissions from their most prominent source. However, fabs should take care to implement NF_3 cleans effectively because inefficient NF_3 usage in the past has caused its presence in the atmosphere to skyrocket [13]. Switching to NF_3 also requires handling larger quantities of F_2 and replacing equipment used for all the other fluorinated gasses, which is why many older fabs have not already made the switch [11]. Still, the change may decrease costs over time due to higher efficiency and benefit sustainability immensely [11].

Nevertheless, innovations could lead to an alternative chemistry that's even better than NF_3. Fabs have been using fluorinated gasses for their fluorine, so why not use F_2 instead? F_2 is a perfect substitute for fluorinated GHGs because it has zero global warming potential. The issue is that F_2 is highly reactive and toxic, making it extremely dangerous. However, with emerging technologies for producing and storing F_2, companies like Linde have been able to introduce F_2 in CVD cleans [10]. F_2 is an outstanding substitute because it can replace NF_3 on the same equipment, operate three to five times faster, use less gas, and use less energy than NF_3 [10]. While F_2 may still be far from being widely adopted in the industry because the technology is so new and dangerous, it is the next step in reducing process gas consumption.

Gas Abatement

Universal adoption of F_2 technology will take fabs a long time. Thus, in the interim, fabs should also focus on gas abatement technology to improve the usage of NF_3 and other gasses. Gas abatement involves destroying remaining unreacted gasses before leaving the fab, implemented for each chamber or centralized for the entire plant. Regardless, plasma gas abaters can be the final piece in the puzzle to eliminate any final unreacted GHGs leaving the facility. Many commonly-implemented abaters use heat, fuel burns, or catalysis to destroy remaining fluorinated gasses [11]. However, most are ineffective at eliminating CF_4; some even produce additional greenhouse gasses [11]. On the other hand, newer systems implementing point-of-use plasma scrubbers have achieved over 99.9% destruction efficiency, including for CF_4 [14]. Plasma abaters such as the ones offered by Applied Materials [15] and Proteus [16] are also highly energy efficient, which helps cut costs and further reduce the fab's carbon footprint.

Overall, semiconductor fabs have a reasonably straightforward path to solving direct GHG emissions. The first step should be switching all CVD cleans to efficient plasma NF_3 cleans at the minimum. As the technology develops, fabs should transition all CVD cleans from NF_3 to F_2, or fabs should change directly to F_2 from other fluorinated gasses. Finally, fabs should immediately implement point-of-use plasma gas abaters for all of their chambers to destroy any gasses remaining from etching or CVD cleans. These strategies are not universally adopted already because they require additional investment and cutting-edge technology. However, by implementing these three strategies, fabs can negate nearly all of their Scope 1 greenhouse gas emissions.

Electricity Consumption Breakdown

While reducing direct GHG emissions is important, the largest source of emissions by the semiconductor industry is by far Scope 2 emissions arising from electricity usage. Electricity is a big concern for manufacturers — TSMC reports electricity usage accounting for 62% of emissions [17]. From a larger perspective, the semiconductor industry also significantly impacts total energy usage. Only a few fabs currently operate in the United States, yet, they already account for 2% of the energy used in the manufacturing sector [18]. While many other sectors, like the cement and paper sectors, currently use far more energy, this distribution will change

dramatically as companies construct new plants under the incentives from the CHIPS Act [19]. For example, two new fabs under construction in New York by Micron and Global Foundries will use 9,346,000 megawatt-hours a year [20]. For context, New York State uses 141,423,778 megawatt hours of electricity per year, and the United States as a whole uses 3,805,874,253 megawatt hours per year [21]. That means *just two fabs* could equate to 6.6% of New York and 0.25% of the United States' *total* energy usage. As more and larger fabs are built, electricity usage could skyrocket.

Not all existing or new semiconductor fabs are identical, but trends in their energy usage can expose areas prime for improvement. Historically, energy consumption has been relatively consistent regarding allocation within a fab. For example, data breakdowns from 8 different fabs in 1999 [22] and an individual fab from 2008 [23] are very similar, with two areas standing out as the most power-hungry. The first area is silicon wafer processing, which accounts for around 40 percent of a fab's energy use [22] [23]. The second area is air heating, ventilating, and conditioning ~~the air~~ (HVAC) within the fabs. Combining all the elements that make up a fab's HVAC system, their energy usage is around 45% [22], [23]. Combined, the HVAC and process systems comprise about 85-90 percent of a fab's energy consumption, thus offering the most extensive opportunities to save energy.

Improvements in Electricity Consumption

Of these two major contributors to a fab's energy usage, HVAC systems are much easier to optimize significantly than process tools. The energy used by process tools is nearly impossible to optimize further. When the product is so small, energy is primarily consumed based on the chemistry of the process, not the power efficiency of the tools [24]. Because the fluorinated process gasses are so hard to replace, it is almost impossible for fabs to improve energy consumption caused by the chemistry of the process. For now, that means that the minuscule improvements in process energy efficiency will only come from manufacturers buying and implementing newer and slightly more power-efficient tools as a natural course of business. As with any industry, devices become more precise, faster, and power efficient with time, and semiconductor manufacturing will be no different. Still, these changes are insufficient to solve fabs' energy concerns.

On the other hand, the HVAC systems implemented in most fabs can be improved in many ways to become far more power-efficient. Similar~~ly~~ to improving GHG emissions from CVD cleans, improving HVAC efficiency is relatively straightforward, especially for new fabs [24]. This is because improvements do not directly affect production yield and are often implemented in other industries [11]. Improving and upgrading chiller systems is a significant first step. Chillers alone use 25% of a fab's electricity, accounting for the greatest individual portion of HVAC energy requirements [22]. Replacing old and outdated chiller systems is an effective way to save energy and money since chiller upgrades can save significant money over time when energy costs decrease [23]. While replacing chillers may be more expensive initially

than many other upgrades suggested, they help future-proof fabs as cooling requirements increase. Chillers are the most vital cog in energy-efficient fabs.

Next, fabs should focus on implementing the most energy-efficient HVAC design. A typical HVAC system for a semiconductor cleanroom incorporates one or more of the following apparatus: a make-up air unit (MAU), a recycled air unit (RCU), a fan coil unit (FCU), a fan filter unit (FFU), a direct cooling coil (DCC), and an axial fan system. While many configurations of those units are possible, a study by Hu and Tsao [25] found through operational data that an MAU and FFU were the most power-efficient combination. While the study did not mention a DCC, it is also included in the HVAC system. On the other hand, components like the RCU are inefficient and easily replaced. Changing entire HVAC layouts at existing fabs is no small task, but implementing this layout in new fabs will promote efficiency in the long run.

Fabs can further improve this basic layout. In this design, a humidifier is part of the MAU system. However, creating the steam necessary for humidification requires a large amount of energy. Instead, Jo et al. [26] proposed using an adiabatic pressurized water atomizer to humidify the air. A pressurized water atomizer uses a high-pressure pump to spray water and produce incredibly fine droplets. Adiabatic humidifiers inject these atomized water droplets directly into the air, which requires far less energy than turning the water into steam. By implementing this method, fabs can expect to consume 23% less energy compared to a traditional humidifier system [26].

Fabs can also improve energy efficiency in HVAC systems in broader ways. Fabs are prone to being over-engineered and inefficient, which presents itself across the entire facility, especially in air circulation [27]. Processes that run to heat or cool air will frequently overlap, run too long, or run far more powerfully than needed [23]. By installing smart sensors that accurately measure the situation in the cleanrooms, fabs can use only the energy necessary to keep the system in equilibrium [3] [27]. Installing smart sensors can also improve the consumption of resources and energy in the process tools, although certainly not to the same extent as the HVAC system. While the amount of power smart sensors will save varies widely between fabs, installing smart sensors will be a relatively small capital investment of around $200,000 [27]. By using this technology, fabs can decrease energy costs by 30% without making significant changes to the design of cleanrooms [27].

Finally, simple changes like switching all the lights to LEDs and ensuring that parts are correctly maintained are cheap and reliable ways to decrease energy consumption throughout the fab [3].

Improvements in Electricity Sourcing

The best way to reduce GHG emissions from electricity is to create and use electricity from renewable sources. For example, fabs can take inspiration from Tesla's Gigafactory in Nevada, which is located in the desert and uses massive arrays of solar panels to power the plant [28]. Additionally, the factory has many water chilling needs that it meets by overproducing during cold desert nights [28]. Semiconductor manufacturers can use these innovations in almost

an identical capacity in new fabs that are located in the desert. In addition to the solar energy being clean and renewable, it is also a great source of off-grid power. Sourcing off-grid power from cleaner sources is crucial because fossil fuels currently dominate off-grid power. This issue is particularly pervasive in the semiconductor industry, where many fabs own local fossil fuel plants [3]. Another way to improve off-grid power sustainability is to transition off-grid power reserves to green hydrogen. Green hydrogen is an excellent renewable energy storage option because the hydrogen is produced from clean energy processes like water electrolysis. The green hydrogen market is receiving massive support and investment, which will reduce costs and increase availability [29]. The cost of producing clean hydrogen is projected to drop 30% by 2030 due to cheaper renewables and scaled-up production [29]. While green hydrogen is currently not ready for commercial deployment, if this trajectory continues, green hydrogen will make it easier than ever for fabs to transition from fossil fuels to renewables for power reserves.

Regarding on-grid power, the best thing the industry can do is prioritize building fabs in areas with the most renewable energy. Although renewable energy is rapidly developing worldwide, it is not being adopted equally. Energy sourcing is a significant issue for the semiconductor industry primarily because of its over-reliance on Taiwan. Taiwan manufactures 60 percent of all semiconductors and 90 percent of advanced microchips [30], making itself the global semiconductor manufacturing hub. Such concentrated production in any country is dangerous to domestic interests, and Taiwan, in particular, poses significant political and clean energy challenges. On the political side, China poses an immense security risk to Taiwan, and an invasion could see an effective Chinese monopoly over semiconductor production [31]. As for energy, over 85% of Taiwan's energy comes from fossil fuels, compared to 65 percent in the United States [3]. Though Taiwan is making significant strides to increase renewable energy production, such as adding 5.7 GW of wind energy and 14.2 GW of solar energy to the power grid by 2025, this will still amount to only 20% of the country's energy supply being renewable [32]. With individual companies like TSMC taking up to 7.2% of the national power supply on their own, there will be little renewable energy left to go around [33]. This means the semiconductor industry must move away from Taiwan to be more climate-friendly. Recommending which countries the sector should move to is beyond the scope of this paper. This will largely depend on policy decisions, or lack thereof, by individual countries and the companies' responses to these decisions. For fabs within the United States, manufacturers can focus on building them in states that predominantly get their energy from clean sources, such as Washington or Illinois [34]. Still, manufacturers must decide on the best locations for their needs. Ultimately, it is up to chip manufacturers to prioritize renewable energy and sustainability, even when it is not the most cost-effective option.

Policy Changes

The CHIPS Act is an excellent example of how legislation can help spur change in the semiconductor industry. Similar policy measures can be implemented to ensure the semiconductor industry follows through with the changes it needs to make to achieve

sustainability. For example, legislation requiring fabs to recycle at least 50 percent of their water use by 2030 can be passed. States can also limit how much new water fabs can bring in daily, further incentivizing recycling. For direct GHGs, Congress can pass laws that effectively require all new fabs to implement NF_3 for CVD cleans.

An intriguing way to achieve this would be by implementing something similar to a carbon tax. While a general CO_2 equivalent carbon tax would work, historically, carbon taxes have been difficult to pass in the United States [35]. Instead, heavy taxes on the emissions of specific gasses like C_2F_6, C_3F_8, and CF_4 will compel manufacturers to use NF_3 in CVD cleans. Though specific taxes on gasses have not been implemented in the past, outright bans on gasses do have a precedent in the United States. For example, in 1994, through the Clean Air Act, the United States banned the use of hydrochlorofluorocarbons [36]. Because taxes on these gasses will have a much smaller scope than a carbon tax, legislation should not be nearly as controversial or challenging to pass as carbon taxes. To incentivize the development and adoption of F_2 technology, tax incentives and money for R&D can be provided similarly to the CHIPS Act. With respect to energy, minimum standards for energy efficiency and smart sensor usage can be enacted. While forcing fabs to upgrade their chillers or use specific HVAC designs is not feasible, creating general standards to promote energy efficiency across the fab is a step in the right direction.

The government also has a wide array of possible policies available to encourage semiconductor manufacturers to use more sustainable energy. The United States already implements the Investment Tax Credit and Production Tax Credit to incentivize solar and other renewable energy production [37]. The government can offer similar credits for new fabs provided they source a determined amount of their energy from on-site solar energy. In Australia, the government created the Renewable Energy Target to compel energy distributors to source a certain percentage of their energy from renewables [38]. The United States could implement a similar scheme for domestic energy providers, or if the legislation is specific to semiconductor manufacturers, the government could directly require fabs to source a certain percentage of their energy from renewable sources. Finally, the United States could take inspiration from Germany's feed-in tariff system, which purchases renewable energy at above-market prices from suppliers. This system has dramatically increased renewable energy production [39]. By emulating this system, the United States could rapidly expand renewable energy use across the board, including in the semiconductor industry.

Regardless of the policies the government decides to implement, one thing is clear: passing legislation is essential. The world can not rely on semiconductor manufacturers to address sustainability issues purely out of goodwill. Policy changes will be the crucial link between supporting sustainability improvements and actually implementing them.

Conclusions

At first glance, the semiconductor industry is far from sustainable. Fabs certainly have much work to do if they want to implement all the most impactful changes in a reasonable

timeframe. However, many of the changes fabs need to make are quite straightforward. Water consumption is already not a big issue, but it can be solved entirely by implementing more effective recycling technology. Direct GHG emissions can be solved by installing plasma gas abaters, transitioning to NF_3, and transitioning to F_2 for CVD cleans when possible. Most importantly, fabs can solve energy concerns by using the most efficient devices and setup for the HVAC systems, implementing smart energy-saving sensors throughout the fab, and prioritizing clean energy.

The semiconductor industry is irreversibly intertwined in our efforts to combat climate change and pave the way for a more sustainable future. If the industry can make the necessary changes, the future of technology and our globe will look incredibly promising.

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Common Causes of Hair Loss and Their Treatment Options By Diya Doshi

Abstract

　　Research on hair loss is a constantly developing topic, with many studies still being conducted to gain a better, more thorough understanding of different conditions and hair diseases. 35 million men and 21 million women suffer from hair loss worldwide, with a hair loss market worth 52.37 billion USD in just 2022 itself. There are many types of hair loss, though the most common of which are androgenetic alopecia (AGA), telogen effluvium, and alopecia areata (AA). There is no clear path to reducing the effects of hair loss. Rather, many different medications and treatments may be suggested to yield favorable results. Clinicians and patients should take the time to discuss each option and its cost, benefits, and adverse effects. This paper will discuss the efficacy and adverse effects of different treatments for each of these three causes of hair loss.

Introduction

　　Hair loss research and treatment options are a developing field, with studies continuously being conducted to grasp a fuller understanding of the various conditions and hair diseases. Millions of men and women experience hair loss globally, totalling to 35 million men and 21 million women. With such a large population suffering from hair loss, the market has risen to 52.37 billion USD in 2022.

　　There are two classifications of hair loss: non-cicatricial and cicatricial alopecia. Non-cicatricial alopecia is more commonly seen than its counterpart, which is characterized by irreparable hair loss and scarring. Non-cicatricial alopecia may have many causes including stress, drugs, a poor diet, vitamin deficiencies, the immune system, and genetic changes. Of the types of non-cicatricial alopecia, this paper will be focusing on the most common types: androgenetic alopecia (AGA), telogen effluvium, and alopecia areata (AA). To get a proper diagnosis of the patient's condition, the clinician should begin by understanding their history and any medical conditions before conducting a physical exam. Performing a trichoscopy is crucial to help diagnose, though scalp biopsies may be performed in severe or uncertain circumstances.

　　Topical and oral treatments may be used to enhance hair growth and minimize hair loss. Medications like finasteride and minoxidil are especially common, though the patient should consult with a provider before beginning treatment, discussing the pros and cons of both types. Topical minoxidil, for example, requires patients to use it twice a day for a long period of time. The time commitment for such medications presents an obstacle for patients who do not have the time to dedicate to a treatment. Oral finasteride has seen large success rates, though patients reported sexual adverse effects. If such medications are not viable options, patients can turn towards other procedures like laser therapy or PRP. However, such surgical procedures can average out to be around $5000-$10000, so they may not be for everyone.

　　To better understand how hair loss works, one must understand hair on the cellular level. Hair is made of the hair shaft, which makes up the outside portion of the skin, and the follicle,

which is underneath the top of the skin. The follicle, where hair grows, is made of the outer and inner root sheaths. The hair bulb produces hair and surrounds the dermal papilla, which has the key role of determining the size and color of the hair shaft through different growth factors and proteins. The hair cycle is cyclical, coming in phases of growth of the hair shaft followed by phases of rest and regression. There are three phases in the hair cycle: anagen (growth), catagen (transition), and telogen (rest) (Hoover et al.).

Hair loss is a result of when the hair cycle is altered. For example, telogen effluvium can be caused by a disruption in the follicular cycle with a shift from the growth to rest phase, resulting in hair loss due to a change in the hair growth cycle (Alessandrini et al.). Androgenetic alopecia may be caused by a change in androgen (hormone) metabolism and by getting older, which leads to the shortening of the anagen phase, thus reducing the size of the hair follicle (Kaiser et al.). It is said that patients of alopecia areata develop antibodies that impact the structure of their hair follicles while in the anagen phase (Alessandrini et al.).

There are many different treatment options for hair loss, all with varying degrees of efficacy. Not all treatment options in this review are weighed equally as some have been heavily researched while others are new. The goal of this review is to summarize possible treatment options for the three most common causes of hair loss. Patients should consult their physicians before making final decisions on their treatment. Table 1 summarizes the most common treatment options for each type of hair loss discussed in this review, and their respective side effects.

Table 1. Information about the most common treatment options for each type of hair loss mentioned in this review.

Treatment	Administration	Side Effects	Conditions it Treats
Minoxidil	Topical Oral	Scaling, pruritus, initial increase in hair shedding, unpleasant odor Hypertrichosis, hair shedding, scalp pain, dizziness	AGA, TE, AA
Finasteride	Topical Oral	Skin irritation, pruritus Birth defects, depression, sexual dysfunction	AGA
Spironolactone	Oral	Hypotension, hyperkalemia, headache, menstrual disorder, pruritus	AGA
PRP	Intralesional	Infection, scalp sensitivity, scalp scaling	AGA, AA

Laser Light Therapy	Regional	Dry skin, irritation, scalp sensitivity, itching, tenderness	AGA
Microneedling	Regional	Temporary bleeding, erythema, pruritus, headache	AGA, AA
Corticosteroids	Topical	Skin thinning, folliculitis	TE, AA
	Systemic	Chronic inflammatory diseases, immunosuppression, asthma	
Immunotherapy	Topical	Dermatitis, urticaria, eczema, blistering, contact leukoderma	AA
JAK Inhibitors	Systemic	Increased risk of infection	AA
Statins	Systemic	Myopathy, headache	AA
Anthralin	Topical	Pruritus, erythema, scaling, staining of the treated skin, and folliculitis	AA
Sulfasalazine	Oral	Gastrointestinal distress, rash, headache	AA

Cause #1: Androgenetic alopecia (AGA)

Androgenetic alopecia is the most common cause of non-cicatricial alopecia. It is caused by dihydrotestosterone (DHT), a testosterone metabolite, that leads to constant hair thinning (Alessandrini *et al.*). High levels of DHT are found in patients with AGA, meaning more terminal hairs are reverted back into vellus hairs. The root cause of AGA is a change in androgen metabolism that occurs during the aging process, and this leads to the reduction in hair follicle size and shortening of this anagen phase. Because of genetic factors and age-related causes that result in a defective androgen mechanism, vellus hairs, which are fine and short hairs commonly known as "peach fuzz," cannot become longer, thicker, and darker terminal hairs. Rather, hair follicles turn back into vellus hairs (Gokce et al.). AGA decreases the number of terminal hairs and fibrous streamers, replacing them with small vellus hairs in the temporal, vertex, and mid-frontal areas of the scalp (Kaiser et al.; Alessandrini et al.).

Furthermore, while the anagen phase is reduced, the telogen phase is increased, resulting in the shrinkage of the hair follicle. The lag phase, the time between the loss of a telogen hair and the emergence of its replacement anagen hair, increases with each consecutive hair cycle, leading to a decrease in the percentage of hair follicles in anagen phase (only 60-80%), compared to the normal 90% of scalp hair. The shortening of the anagen phase causes the hair to look smaller (Van Neste et al.). The hair follicles are also shortened until they can not penetrate the epidermis, the surface layer of the skin, due to an increased activation of androgen receptors (Kaiser et al.).

In males, AGA affects the fronto-temporal region and vertex region, while in women it primarily affects the frontal region, behind the hairline (Alessandrini et al.). For women, the hairline is typically not impacted. It is the crown and bitemporal scalp areas (Kaiser et al.).

Treatment Options–Topical Minoxidil

Minoxidil is one of only two drugs approved by the FDA for hair loss (Abdullah). It works by acting on ATP-gated smooth muscle potassium (K^+) channels that lead to reduced blood pressure. This increases blood supply and nutrients to the hair follicles, thus increasing hair growth (Kaiser et al.). By increasing blood circulation, minoxidil is able to facilitate quicker hair growth and thicker hair, lengthen the anagen phase, and stimulate kenogen follicles to begin a new hair cycle (Katzer et al.). This treatment helps reduce the excess inflammation that contributes to AGA by reducing the amount of pro-inflammatory cytokines. Topical minoxidil is a good option for when less than 20% of the scalp is affected by AGA (Katzer et al.). When the 5% solution was applied two times daily for men, results showed that it was more efficacious than its 2% counterpart, but the opposite was seen for women. However, a meta-analysis showed that topical minoxidil had far better results than the placebo at all concentrations (*Minoxidil and Its Use in Hair Disorders: A Review - PMC*). Studies demonstrate that after 16 weeks of constant application, less than 40% of patients experienced results. The earliest period that minoxidil may display its effects is at 6 to 8 weeks, while the maximum effect may be seen by 12 to 16 weeks. Topical minoxidil has demonstrated success in treating hair loss, though the long-term commitment may be difficult for some patients because of the need to apply the formula twice daily. For some, the process may be irritating and can cause scaling and pruritus, which is severe itching of the skin, as well as a temporary increase of hair shedding when beginning the treatment. Although minoxidil is considered a safe treatment, patients may also experience hypertrichosis, which is excessive hair growth anywhere on the body, and headaches (Kaiser et al.). The treatment may also result in an undesirable hair texture, and has an unpleasant odor that deters patients from continuing treatment (Ramírez-Marín and Tosti).

Oral Minoxidil

Oral minoxidil has recently been suggested as an alternative therapy for AGA. Due to the commitment required for topical minoxidil, oral minoxidil is seen as a more convenient treatment as it requires one pill daily. Oral minoxidil is processed into its active form in the liver, allowing increased bioavailability, leading to improvements for patients who had no success using topical minoxidil (Kaiser et al.). Although there are no clinical trials on the efficacy of oral minoxidil for AGA, an epidemiological study in Spain revealed that oral minoxidil was prescribed to patients with male pattern hair loss by 50.6% of dermatologists, and to pre- and post-menopausal women by 67.9% and 63% of dermatologists, respectively (Ramírez-Marín and Tosti). The benefits of oral minoxidil include its convenience, as it is easier to take a pill than apply topically, improving patient compliance. Additional benefits include hair that does not turn gray, as well as lack of product residue and cost effectiveness. Oral minoxidil should be used for

patients who have difficulty with compliance or negative side effects with topical minoxidil. In a study conducted on men for 6 months, it was shown that 5 mg daily works faster than other therapies, and low doses were shown to yield the best results (Kaiser et al.). Adverse effects are common in individuals taking 5 mg of oral minoxidil. Hypertrichosis occurred in more than half of patients, though it was dose dependent for younger patients. Hair shedding also occurred in approximately ⅓ of patients , and it was typical for younger men (Kaiser et al.).

Topical Finasteride

Finasteride reduces DHT production in the hair follicles by blocking the conversion of testosterone to DHT by more than 60% in the scalp and serum (Katzer et al.; Kaiser et al.). Topical finasteride may be safer than its oral form as it has fewer systemic effects. (Kaiser et al.). The 0.25% solution used twice daily lowered scalp DHT levels. In a Phase III randomized and controlled clinical trial by Piraccini et al, 323 patients using 0.25% topical finasteride spray daily saw an increase in hair count after 24 weeks. No drastic difference was found in the average hair count between topical and oral finasteride (Kaiser et al.). When 0.25% topical finasteride solution was compared to 1 mg/day of oral finasteride, both yielded similar results in DHT inhibition after a week. However, topical application lowered finasteride in the plasma more than oral use (Katzer et al.). Some adverse effects include skin irritation and pruritus, with no patients experiencing sexual dysfunction. Evidence shows that pharmacokinetics lessens systemic absorption, though more studies are needed to research the best formula and dose (Kaiser et al.).

Oral Finasteride

Oral finasteride is one of only two medications approved by the FDA to treat hair loss. Its anti-androgen properties and role as a 5α-reductase type II inhibitor make it a potential treatment for men with AGA (Kaiser et al.). The scalp converts testosterone to DHT, which is responsible for the shrinkage of the hair follicles, as it plays a large role in the pathogenesis of male pattern hair loss. By inhibiting 5α-reductase, finasteride can decrease DHT levels in the scalp (Van Neste et al.). When used daily, 1 mg of oral finasteride has been shown to reduce AGA (Kaiser et al.). A study found that 1 mg daily boosts the conversion of hair into the anagen phase, resulting in notable improvements in hair growth and quality. When continued for 2 years, there was a significant improvement in the quality of hair, and hair density remained stable (Van Neste et al.). Oral finasteride was best in treating the vertex region of the scalp, but was not as effective in the frontal region. Optimal improvement was seen after 1 year of treatment, with minimal improvement after 4 years. Off-label use of this medication has shown clinical efficacy in women. Some adverse effects present in both men and women include birth defects, depression, sexual dysfunction, gynecomastia (the enlargement of breast tissue in men/boys), and muscle atrophy. There is a dearth of information regarding the long-term safety profile of finasteride. Sexual side effects are the most common side effect, present in 1%-40% of patients (Kaiser et al.). Overall, oral finasteride treatment is well-tolerated in men (Van Neste et al.).

Oral Spironolactone

Oral spironolactone, which is converted into canrenone in the liver, works by blocking the effects of the hormone aldosterone. It can bind and hinder androgen receptors, helping treat acne and abnormal facial hair growth in female patients (Kaiser et al.). This medication is used off-label for AGA in females. It lowers the levels of circulating androgens by abrogating adrenal androgen production and thus the effect of androgens in the hair follicle (Kaiser et al.). James et al found that about 50% of women using this as monotherapy for female pattern hair loss saw an improvement. The medication must be used for more than 12 months at a dosage of 100 to 200 mg in order to see clinical improvement for female AGA. In addition, Famenini et al found that 74% of females using spironolactone long-term experienced clinical improvement (Kaiser et al.). In a subset of 5 different studies, 81% of the 195 females reported improvement in hair growth when receiving a dose between 25-200 mg daily. Another study showed that oral spironolactone was just as effective in restoring hair count or preventing further hair loss when compared to daily usage of cyproterone acetate (Wang et al.). Adverse effects that are common include hypotension, which is low blood pressure, hyperkalemia, which is when there are high levels of potassium in the blood, and sometimes urticaria, which is an intense skin rash (Kaiser et al.). Other effects include headache, menstrual disorder, rash, nausea, and scalp pruritus (Wang et al.).

Platelet Rich Plasma Treatment (PRP)

Platelet Rich Plasma (PRP) is the isolated plasma and platelets from the blood (Kaiser et al.). It is obtained by the centrifugation of patient blood (Katzer et al.). PRP contains chemokines, growth factors, cell signaling molecules, and cytokines, all of which are important in controlling and regulating cellular processes. The alpha granules made and kept in the platelets are the most important molecules found in PRP to treat AGA since these granules have many different types of growth factors that promote angiogenesis, a process in which new blood vessels are formed, and are crucial in beginning the process of stem cell differentiation. PRP releases large amounts of platelet-derived growth factors (PDGF) which are important in minimizing follicular apoptosis and in boosting follicular cell growth (Kaiser et al.). Overall, PRP increases both hair density and thickness(Katzer et al.). Gkini et al led an experiment with 20 patients in which significant results were shown at 6 months and 1 year. Growth peaked at 3 months and continued for 1 year. Furthermore, a meta-analysis by Gupta et al found that all the studies he evaluated using PRP saw a significant increase in hair growth and density. He recommended that PRP treatment should be continued for 3 months in 1 month intervals, then followed by maintenance sessions (Kaiser et al.). Although PRP is a minimally invasive treatment, there is a risk of infection, scalp sensitivity, and mild scalp scaling. PRP may not be suitable for everyone. For example, it is not for patients with a history of malignancy, platelet disorders, anemia, bleeding disorders, and pregnant women (Kaiser et al.).

Low-Level Laser Therapy (LLLT):

Laser light therapy is a new and effective treatment option for AGA. Due to the cost effectiveness and non-invasive nature of laser light therapy, it is a popular treatment option for patients with AGA (Kaiser et al.). It exposes tissues to luminous energy (Katzer et al.). LLLT helps reverse hair loss by promoting telogen hair follicles to reenter the anagen phase, increasing the length of the anagen phase, and preventing anagen hairs from turning into catagen hairs too early (Kaiser et al.). It stimulates cellular activity in tissues, and its range of wavelengths promote tissue repair and regeneration (Pillai and Mysore). LLLT is the only FDA approved device to treat AGA (Katzer et al.). The Laser HairMax comb was approved by the FDA in 2007 for men and in 2011 for women. A laser cap, providing full scalp coverage and even distribution, was also approved by the FDA (Pillai and Mysore). Out of the 32 patients using LLLT for three sessions weekly, 28 patients displayed signs of moderate to significant improvement in 3 to 24 months. A review by Afifi et al discovered that 9 out of 11 studies demonstrated significant improvement in hair count and density. Furthermore, LLLT increased hair growth in both short and long term follow ups for men and women (Kaiser et al.). Another study researched 28 males and 7 females with AGA who used the HairMax LaserComb every other day for 5-10 minutes. Significant improvement was seen in all patients after 6 months. The strength of the hair also increased (Katzer et al.). Overall, the treatment sessions for LLLT usually lasts for 15-20 minutes and occurs 3 times a week for 6 months (Pillai and Mysore). In a study using the HairMax Laser Comb, side effects were uncommon, though some experienced dry skin, irritation, scalp sensitivity, and itching (Katzer et al.). LLLT generally has minimal adverse effects, though some include temporary hair loss, pruritus, tenderness, and acne (Kaiser et al.). It is a safe and effective treatment used to treat AGA as more than half of the studies displayed an improvement in hair regrowth, hair density, and tensile strength (Pillai and Mysore).

Microneedling

The microneedling device works by instilling controlled and repetitive tissue micro-injuries that make transdermal microchannels in the stratum corneum, the outer layer of the skin. It promotes growth factors, activates bulge stem cells, and increases gene expression for genes correlated with hair growth (Kaiser et al.). Rollers and electric pens are the most common devices used to perform this procedure, though the needles used may vary in length and number (Katzer et al.). In a study conducted with 29 females and 14 males over 6 months, participants were told to use topical minoxidil for 24 hours after microneedling. All patients saw reduced hair loss. It is recommended to patients who want to see quick improvements to use microneedling (Kaiser et al.). Another study consisted of two groups, the first group was given the microneedling treatment weekly with 5% minoxidil lotion twice a day, and the second group was only given the 5% minoxidil lotion twice a day. The mean change in hair count after 12 weeks of treatment was greater for the microneedling group compared to the minoxidil group. Furthermore, 82% of patients in the microneedling group saw more than 50% improvement compared to only 4.5% in the minoxidil group. The microneedling group saw noticeable hair

growth earlier at 6 weeks, while in the minoxidil group it was seen at 10 weeks (Dhurat et al.). Microneedling is a good option for those wanting quick results. However, it can be painful during the treatment itself. Adverse effects include temporary pinpoint bleeding, erythema, larger lateral cervical lymph nodes, pruritis, seborrheic dermatitis, and headaches. There may also be a risk of infection, though there is an overall low risk of adverse effects (Kaiser et al.).

Cause #2: Telogen effluvium (TE)

Telogen effluvium is characterized by non-scarring and diffuse shedding of the hair (*Telogen Effluvium: A Review of the Literature - PMC*). Patients experience hair loss every 3 months after a triggering event, and it lasts for 6 months. Hair loss is less than 50% of the scalp hair, and is more common in adult females (Alessandrini *et al.*). Patients can easily extract clumps of telogen hair from the vertex and margins of the scalp, and diffuse loss is seen over the whole scalp (Malkud).

TE may be due to 5 different mechanisms. The first is the disruption of the follicular cycle with an early shift from the anagen to telogen phase, increasing hair shedding in the next 2 to 3 months. The second is a delayed anagen release, which results in increased hair loss during the telogen phase. The third is short anagen syndrome, which is due to the shortening of the anagen phase, leading to continuous TE. The fourth is an immediate telogen release, which leads to large amounts of club hair, hair that has reached the end of the growth stage, loss. The last is a delayed telogen release that results in a stalled transition to the anagen phase (*Telogen Effluvium: A Review of the Literature - PMC*).

Acute TE is due to harmful events, such as diseases, drugs, and weight loss, that allow the entry of many follicles into the telogen phase (Alessandrini *et al.*). Acute and chronic stress are known as primary causes of TE (Gokce *et al.*). Acute TE lasts for less than 6 months, and hair loss occurs for 2 to 3 months after the trigger (*Telogen Effluvium: A Review of the Literature - PMC*). Few drugs have been scientifically proven to decrease hair loss. Chronic TE is when hair loss occurs for more than 6 months. It mostly impacts middle-aged women and is characterized by an increased percentage of hair follicles in the catagen or telogen phase (Alessandrini *et al.*). TE is seen as reversible, though it does impact the psychosocial state of the patient. It is hard to diagnose and treat as there are many factors that can lead to this disease (Gokce *et al.*).

Treatment Options

Minoxidil & Finasteride, & Inhibition

Topical or oral minoxidil may help prolong the anagen phase (Alessandrini *et al.*). In addition, minoxidil and finasteride cannot effectively block the catagen (transition) phase or induce the anagen (growth) phase. Catagen-inducing drugs (retinoids, antithyroid drugs, beta-blockers, etc) should not be used, and catagen-inducing endocrine disorders should be assessed and treated (*Telogen Effluvium: A Review of the Literature - PMC*). Substitution therapy

for catagen-promoting deficiencies, like iron and zinc, can also be started. Additionally, there are also therapeutic options in treating TE. These include the inhibition of catagen to prolong anagen, the induction of anagen in telogen hair follicles, and the inhibition of exogen (shedding) to minimize hair shaft shedding (Grover and Khurana).

Healthy Diet & Correcting Deficiencies

When underlying conditions are at the root of the hair loss, it is important to directly fix them as well. This includes conditions like endocrine disorders, nutritional deficiencies, and other causes such as psoriasis and seborrheic dermatitis, a condition that results in scaly patches and red skin primarily on the scalp. Treatment for these may include a proper diet and healthy body weight (Alessandrini et al.; *Telogen Effluvium: A Review of the Literature - PMC*).

Patient Education

Patients should be well-informed regarding their condition. Disease and triggers correlate with each other, so the timing of the hair loss should be discussed. Losing hair can cause great psychological stress for the patient, so patient education is crucial (*Telogen Effluvium: A Review of the Literature - PMC*). Patients should also be notified that hair loss may take 3 to 6 months to stop, and regrowth may take 3 to 6 months after the trigger is found and corrected. Significant improvement in hair growth may be seen in 12 to 18 months (Malkud).

Topical & Systemic Corticosteroids

Topical corticosteroids, also known as steroids, are a type of anti-inflammatory medication used by dermatologists for treatment. If a side effect of the application of this medication is decreasing trichodynia, it means the therapy is working. Corticosteroids can also be given routinely to patients with chronic TE (*Telogen Effluvium: A Review of the Literature - PMC*).

CNPDA

A new cosmetic treatment has been developed by Davis et al (Grover and Khurana). This treatment is a combination of caffeine, niacinamide, panthenol, dimethicone, and an acrylate polymer (*Telogen Effluvium: A Review of the Literature - PMC*). It works by increasing the diameter of existing terminal scalp hair fibers, which may result in an increase of 10% in the cross-sectional area (Grover and Khurana).

Cause #3: Alopecia areata (AA)

Alopecia areata is a T-cell mediated autoimmune condition, meaning one's own immune system attacks their hair follicles in the anagen phase, resulting in the collapse of the anagen hair bulb (Gokce et al.). It is characterized by non-scarring hair loss in round patches around the scalp, and initially presents itself as one or more patches of alopecia, most likely on the scalp and beard (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New*

Treatment Options - PMC; Alessandrini et al.). Acute AA patients may display exclamation hairs, which are damaged hairs that are thicker at its end and thinner on the end closer to the scalp. The first step in hair recovery is the emergence of thin white hair, then healthy pigmented hair (*Alopecia Areata: A Comprehensive Review of Pathogenesis and Management | SpringerLink*).

AA may occur at any age, though the median is 33 years old. It equally affects both men and women, and is equally prevalent across races (Malhotra and Madke). Studies suggest that 34-50% of patients can recover in a year, while 14-25% of patients' conditions will worsen, making it difficult to completely recover (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC*). AA is caused by environmental factors such as infections, stress, and diet, immunologic factors such as thyroid disease and type 1 diabetes, as well as genetic factors (Alessandrini et al.).

When AA progresses to complete baldness, it is called alopecia totalis (AT). Another type of AA is called ophiasis, which is when hair loss occurs in the shape of a wave along the circumference of the head (*Alopecia Areata: A Comprehensive Review of Pathogenesis and Management | SpringerLink*). AA is unpredictable and there may be relapses in patients (Alessandrini et al.). 30-50% of patients with patchy AA will experience spontaneous remission, the phase in which signs of a disease or condition disappear, in the first 6-12 months of disease onset, and 66% of patients show complete hair regrowth in 5 years. Overall, the chance of going into relapse is about 85%, and about 100% for patients observed over 20 years (*Alopecia Areata: A Comprehensive Review of Pathogenesis and Management | SpringerLink*). Treatment depends on the extension, activity of disease, and age of the individual (Alessandrini et al.). Treatment should also focus on regrowth and maintaining the regrowth (Malhotra and Madke).

Treatment Options

Topical, Intralesional, & Systemic Corticosteroids

Topical corticosteroids are most commonly used to treat AA due to its safety and painless application (Malhotra and Madke). They work by containing inflammation and quickening the recovery of damaged hair follicles (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC*). Treatment should be used for at least 3 months to see hair growth occur (Malhotra and Madke). In one study, 57% of patients displayed complete hair regrowth during treatment (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC*).

Intralesional corticosteroids are a first-line treatment for AA conditions involving less than 50% of the scalp. Common treatments are hydrocortisone acetate at 25 mg/ml and triamcinolone at 5-10 mg/ml. Intralesional triamcinolone acetonide at 5-10 mg/ml is locally injected every 4 to 6 weeks in multiple 0.1 ml injections 1 cm apart, in or beneath the dermis. Injections should not be administered at the same site repeatedly, and should not be used in high concentrations as it may lead to skin atrophy. Severe cases of AA may not react well to this

treatment (Malhotra and Madke). Overall, this therapy has better results than topical corticosteroids, with one study showing 63% of patients displaying complete hair regrowth. A side effect is increased risk of skin atrophy at the treatment site (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC*).

Systemic corticosteroids are used for refractory cases, cases that do not respond to treatment, and for acute and widespread AA (Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC; *Alopecia Areata: A Comprehensive Review of Pathogenesis and Management | SpringerLink*). It is recommended to take 0.5-1 mg/kg a day for adults, for 1 to 6 months to see results, and should not be used for longer to minimize side effects (Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC). To prevent side effects, it is recommended to use pulsed administration (*Alopecia Areata: A Comprehensive Review of Pathogenesis and Management | SpringerLink*). Oral minipulse therapy displayed signs of hair regrowth by 71.43% in a study in which a dose of 5 mg a day was administered for 2 consecutive days for 4 months (Malhotra and Madke). Furthermore, relapse rates are high, between 33-75% (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC*).

Immunotherapy

Diphenylcyclopropenone (DCPC) is an immunotherapeutic agent used to treat AA. DPCP is an experimental drug that creates an immune reaction, thus inhibiting perifollicular immune response to restore hair growth. Immunotherapy works by creating antigenic competition, thus preventing CD4+ T-cells from hurting the hair follicles. Side effects include urticaria, dermatitis, blistering, and depigmentation (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC*). Today, DPCP is the primary choice for topical immunotherapy treatment for AA. In a study of 68 patients with severe AA who were treated with topical DPCP for at least 5 months, researchers Pericin and Trüeb found that 30.9% went into complete remission, and 39.7% went into partial remission. Long periods of therapy are needed and may increase the response for patients. Furthermore, DPCP has a high relapse rate, so maintenance therapy is recommended. Overall, DPCP is well received by most patients (*Alopecia Areata: A Comprehensive Review of Pathogenesis and Management | SpringerLink*).

JAK Inhibitors

Multiple Janus Kinase (JAK) inhibitors, all oral medications, have been successful in treating AA, including tofacitinib, ruxolitinib, baricitinib, CTP-543, PF-06651600, and PF-06700841 (Malhotra and Madke). They work by preventing the production of IFN-γ, a proinflammatory immune molecule which is needed for the immune response of AA (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC*). A study led by Khan et al demonstrated that 72.4% of patients responded partially or

completely to JAK oral inhibitors. It took an average of 2.2 months for initial hair growth, with complete hair growth taking around 6.7 months. Some side effects include nausea, headaches, infection, anemia, and high cholesterol. There may also be relapse after stopping treatment (Malhotra and Madke).

PRP

PRP changes the hair growth cycle through induction and maintenance of the anagen phase. It is injected locally into the alopecia areas. PRP injections may not be as beneficial to those with chronic and severe AA as treatment is needed everywhere on the scalp and is thus painful. PRP treatment for acute AA is typically well received (Malhotra and Madke). In randomized studies, PRP improved hair growth compared to triamcinolone scalp injections, which is another steroid used to treat AA, and to placebo; there were no adverse effects. However, in another study of patients with severe AA, PRP had inconsistent effects. Another trial found that PRP and topical minoxidil increased hair regrowth compared to placebo. PRP also displayed an earlier response than the minoxidil (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC*).

Statins

Statins are drugs that decrease bad cholesterol (LDL) and overall inflammation as reflected by the lowered levels in C-reactive protein (Malhotra and Madke). Its anti-inflammatory and immunomodulatory effects may help them improve hair regrowth. One trial found that out of the 19 patients with 40-70% hair loss who completed the treatment, 14 patients actually responded. However, in another study of patients with greater than or equal to 70% of hair loss who were treated with simvastatin, none showed signs of hair regrowth (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC*).

Microneedling

Microneedling is a new procedure that works by puncturing the skin with small needles. To treat AA, topical corticosteroids are injected using the microneedling technique. Ito et al successfully used a microneedling device to administer intralesional corticosteroid in patients with AA, and Deepak et al also successfully treated 3 patients with resistant AA with scalp roller therapy, a type of microneedling device (*Alopecia Areata: Review of Epidemiology, Clinical Features, Pathogenesis, and New Treatment Options - PMC*).

Anthralin (dithranol)

Anthralin inhibits DNA replication, slowing cell division and stopping cells from rapidly multiplying. This helps in autoimmune reactions such as those underlying AA. Anthralin effectively treats AA when combined with DPCP blocking due to its immunosuppressant and anti-inflammatory properties. It should be used in concentrations of 0.5-1% for 20 to 30 minutes

after shampooing the scalp, every other day and daily as time progresses. Some adverse effects include pruritus, erythema, scaling, staining of the treated skin, and folliculitis. A study conducted by Wong et al showed that 25% of patients completely responded to treatment, while an additional 39.5% had a good response (Malhotra and Madke).

Topical Minoxidil

This is usually used in less severe cases. Minoxidil increases the activity of ATP synthase, which in turn increases the amount of ATP produced. The ATP can be broken down into adenosine, which makes more growth factors such as VEGF, lengthening the anagen phase and reverting vellus hairs to terminal hairs. This means that minoxidil is important in aiding hair growth. No more than 25 drops of 5% solution should be used twice a day. Results can be seen in 3 months, but continuous application is needed to see noticeable results (Malhotra and Madke).

Sulfasalazine

Sulfasalazine is an inflammatory drug used in various autoimmune conditions. Its immunomodulatory and immunosuppressive actions have made it a good therapy option in treating AA. It results in the inhibition of T-cell growth and natural killer cell activity, and it also inhibits the creation of antibodies. Treatment begins at a low dose, around 500 mg two times a day, and is slowly increased to 1 g three times a day (Malhotra and Madke).

Supplements and Hair Oils

Maintaining a balanced and regular diet is important in dealing with hair loss. Quick weight loss, low-calorie diets, unbalanced diets, obesity, and too many vitamin and mineral supplements can result in hair loss. Micronutrients are the key parts of the hair cycle, and thus are important in alopecia. Micronutrients aid in cell renewal, a process seen in dividing hair follicles. Proteins and minerals are also needed to maintain healthy hair. Plant rich diets like the mediterranean diet (rich in antioxidants, anti-inflammatory, estrogenic components) have chemicals that boost hair growth by reducing the generation of reactive oxygen species in the dermal papilla cells, allowing growth hormones to be released (Gokce et al.).

Vitamin B: Vitamin B can be taken in through a good diet, and examples of this vitamin include pantothenic acid, riboflavin, thiamine, niacin, B6, B12, and folate. Hair loss is linked to patients deficient in riboflavin (B2), biotin (B7), B12, and folate. B12 and folic acid may have a role in the growth of hair follicles, though research on vitamin B12 on hair loss is insufficient. There is not enough evidence to show that biotin supplements aid in hair loss (Gokce et al.). It is said that the consumption of biotin in the diet is good for healthy hair, though not many studies show the impact of biotin in patients who are already healthy (Abdullah).

Iron: Iron is important in quickly growing cells, like those in the hair follicle matrix. Some studies show that a few genes in the hair follicle are regulated by iron. The amount of serum ferritin, also called iron-binding protein, is a correlate of iron stores in the body and is

used in hair loss research as an indicator. Women with hair loss most likely have an iron deficiency. Furthermore, more research is needed to further expand on iron supplement guidelines and cures for patients with hair loss due to an iron deficiency (Gokce et al.).

Vitamin C: Vitamin C could be important for those who experience hair loss due to iron deficiencies, as Vitamin C helps in the absorption and use of iron. Citrus juices and other oral supplements are recommended for patients with an iron deficiency. There is, however, no evidence of a correlation between vitamin C and hair loss (Gokce et al.).

Vitamin D: Vitamin D regulates keratinocyte development and differentiation by attaching to the vitamin D receptor (VDR). The VDR is present in higher amounts during the anagen phase, and is present in lower amounts when there is less anagen initiation. This is used to demonstrate how VDR is expressed in hair follicle keratinocytes, which are skin cells involved in the process of hair growth and development, demonstrating how Vitamin D is related to hair development. However, this does not show that it is enough to maintain the typical hair cycle. People with VDR mutations and vitamin D resistance have severe alopecia on the body and scalp (Gokce et al.).

Zinc: A zinc deficiency can lead to telogen effluvium, thin white and brittle hair, and other dermatological issues. A contributing factor to alopecia areata called superoxide dismutase is a type of zinc-dependent enzyme. Furthermore, zinc is linked to the Hedgehog signaling pathway, which correlates with the development of the hair follicle's shape and structure. In a study of 312 people with hair loss and 32 controls, those with telogen effluvium and alopecia areata had low zinc, indicating a correlation between zinc and hair loss (Gokce et al.).

Green Tea: Green tea has many antioxidant compounds like polyphenols and flavonoids. Its anti-inflammatory effects and ability to reduce stress have the potential to improve hair growth. Green tea also has a compound called epigallo-catechin gallate (EGCG), which blocks 5α-reductase, thus boosting hair growth (Abdullah).

Coconut Oil: Coconut oil has emollients, creating a coating over the hair shaft and sealing the cuticle to retain moisture in the hair. It is also a lubricant, so it detangles hair, smoothens and flattens the cuticle surface, and improves the health and look of hair strands. It is also effective in preventing protein loss as it can penetrate inside the hair shaft (Abdullah).

Castor Oil: Castor oil is very moisturizing due to the presence of ricinoleic acid and its derivatives. Ricin and ricinoleic acid protect the scalp and the hair shaft from fungal and microbial infection. The fatty acids in castor oil also have excellent penetrability, so they are able to nourish the hair follicle (Abdullah).

Argan Oil: Argan oil is good at regulating sebum secretion due to its high oleic acid content, and it is also moisturizing as it has good water retention. Topical application has been shown to increase elasticity when comparing results from after 2 months to the start of the study (Abdullah).

Fenugreek Oil: Disogenin, which is found in fenugreek, is shown to have oestrogenic activity, and it can block dihydrotestosterone. A study found that mixing 1 ml of fenugreek extract with 3 ml of water (1:4) decreased Malassezia furfur, a naturally-occurring yeast that may

cause inflammation and damage to the hair follicles. Lastly, fenugreek oil has lecithin, a natural emollient that strengthens and moisturizes the hair (Abdullah).

Sesame Oil: Sesame oil has lignans, which are polyphenolic compounds, that provide anti-inflammatory effects. It can also increase penetration, preventing dryness by moisturizing the hair follicle. In addition, sesame oil increases scalp circulation. This leads to increased hair growth and less graying (Abdullah).

Rosemary Oil: Rosemary's spasmolytic activity is shown to increase microcapillary perfusion, which may allow it to increase blood supply to the hair follicle. Furthermore, rosemary oil has antioxidant activity, which is crucial in patients with alopecia (who have low levels of antioxidants). In a study of 100 men with AGA, there was no significant difference in the change of hair count for the rosemary and minoxidil groups at the 3 month checkpoint. At the 6 month point, however, there was a significant increase for both groups. There was no significant difference in hair count between both groups at either point of the study. A patient treatment satisfaction questionnaire showed that rosemary oil treatment was favored over the 2% topical minoxidil (Panahi et al.).

Pumpkin Seed Oil: Pumpkin seed oil (PSO) has phytosterols that inhibit 5α-reductase and has anti-androgenic effects in rats (Cho et al.). It is also made of anti-inflammatory substances that have antioxidant and 5α-reductase inhibition properties (Katzer et al.). After 24 weeks, self-rated improvement scores were significantly higher for those treated with PSO than in the control group. 44.1% of the PSO group slightly or moderately improved compared to only 7.7% in the control group. Overall, the study shows that PSO has a positive anabolic effect on hair growth (Cho et al.).

Peppermint Oil: After week 2 of a study on mice, peppermint oil bolstered hair growth quicker than saline and jojoba oil. At week 3, peppermint oil promoted more hair growth than saline, jojoba oil, and even minoxidil. At week 4, peppermint oil showed to yield hair growth of 92%, while minoxidil only yielded 55%. Topical application of peppermint oil and minoxidil produced thick and long hair growth while also elongating the hair follicles (Oh et al.).

Conclusion

Hair loss remains a crucial field of research that is currently under development as new studies continue to be published. Novel treatments are still being discovered and tested, such as CNPDA for telogen effluvium. Although this review covers the most common types of hair loss, there are many others including anagen effluvium, loose anagen hair syndrome, stress induced alopecia, and endocrine imbalances. Physicians and patients should consult with one another regarding the most cost effective and efficacious treatment for them, considering factors such as patient history and financial status. Combinations of treatments may also be used, such as laser light therapy and topical minoxidil for androgenetic alopecia, which could improve patient compliance when used together. Note that this review does not cover all treatment options for each type of hair loss, simply the most common and well-researched ones. The treatment options mentioned in this review have differing degrees of evidence and data to factually support the

efficacy of the treatment option. An important point to take into consideration is that some treatments mentioned are relatively new, while others, like minoxidil and finasteride, have already been approved by the FDA.

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Scapegoating in *The Crucible* by Arthur Miller and the 9/11 Attacks By Hayoon Kim

While fear is a natural emotion, it is a dangerous one, and when experienced by a group of people or society, can produce social turmoil and division. This happened in *The Crucible* by Arthur Miller and the 9/11 attack. In *The Crucible*, people feared the devil and tried to get rid of it by executing innocent victims who were convicted as witches. In the 9/11 attack, the Muslim terrorist group, al-Qaeda, destroyed the Twin Towers in New York, causing numerous deaths, further increasing American xenophobia towards Muslims. The violence shown towards characters in *The Crucible* and the hatred demonstrated towards Muslims after the 9/11 attack reveal how America tends to find scapegoats when the country is overwhelmed by fear.

In *The Crucible*, brutality shown towards victims suspected of witchcraft reflects how fear led people to turn on their neighbors in the 17th century. Before John Proctor, the protagonist, and other convicted people were hanged, judge Danforth shouts, "Hang them high over the town. Who weeps for these, weeps for corruption!" (Miller, 144.) Danforth's order to hang them "high over the town" echoes the feelings shared by the town people who feared the devil's existence and wanted to see the end of wickedness. Also, mentioning how "weeping" for the victims is supporting "corruption" shows that the people were even afraid of showing sympathy because it might show that they, too, were aligned with the devil. Additionally, when John Proctor and his wife Elizabeth discuss the accused Giles Corey, Elizabeth says, "great stones they lay upon his chest until he plead aye or nay. They say he give them but two words. 'More weight,' he says. And died." (Miller 135.) Forcing Corey to choose only between saying "aye or nay" illustrates how desperate the people were to find answers amidst chaos, to prove their theories about the devil. Their fear produced irrationality and they were unwilling to consider any possibility that they were mistaken in their beliefs. Corey slowly being crushed to death with "great stone" further highlights how violent and brutal their fears made them. Based in a small, neighborly town, these quotes from *The Crucible* prove that fear can push people to become surprisingly inhumane, practicing merciless violence even on even their closest neighbors.

Though occurring in the 21st century, the hatred and violence expressed towards Muslims after the 9/11 attack shows how reasonless fears still lead people to turn on their neighbors. According to an NBC article, "the data shows anti-Muslim hate crime incidents spiked after September 11th, 2001, jumping from 28 incidents in 2000 to 481 in 2001." (Lisignoli). The significant increase in anti-Muslim hate crime" highlights how 9/11 caused many Americans to view Muslims as a monolith, unable to differentiate between non-violent Muslims and Muslim terrorists. Instead of viewing Muslim-Americans as fellow victims of such an immense tragedy, many Americans were controlled by their fear and categorized innocent Muslims with the terrorists, which has had lasting effects on Muslim-Americans. According to an article from the Harvard Gazette, "the othering of Muslims since 9/11 has had a long-term impact on the lives of Muslim Americans and their sense of belonging and inclusion in the fabric of American society." (Mineo).

Evidently, over the last 200 years, America's tendency to scapegoat those who are "othered" in society has not changed. This trend is detrimental to America's society because it ultimately creates more innocent victims, such as Proctor, Corey, and non-violent Muslims. The scapegoating of innocent people is not only a violation of justice, but also causes further atrocities, such as the executions in The Crucible and the Muslim hate crimes. Ultimately, these social conflicts could cause the society to descend into mayhem, and America will irrecoverably lose its ideal vision of its rights to "Life, Liberty, and the pursuit of Happiness."

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Is Animal Testing An Ethical Practice? By Varsha Niranjan

Introduction

Animal testing has been a medical practice for almost 2,000 years, after being developed in 500 B.C. Animal testing is the procedure of using non-human animals in the process to determine toxicity in different chemicals and medicines. Recently, it has sparked protests in several different animal rights groups such as PETA and HSI. This is due to the modern animal rights movement that began in the late 1900s after the publication of *Animal Liberation* by Peter Singer. The book explains how all animals can suffer the same way humans do, mentally and physically. According to the U.S National Institutes of Health, "Every year in the United States, animal experimentation gobbles up billions of dollars" (Berlatsky). Even though the US is 2nd in animal testing, it is still ranked 49th in life expectancy. Therefore, animal testing is not only an ethically violating procedure, but it also doesn't promise effective results.

On the other hand, animal research has been a crucial part of the medicine and research industry. By eliminating animal testing, "scientific advances would be hopelessly stymied" (Smith). If humans decided to suddenly stop the experimentations, basic data on how organisms function while alive would come to an end. Data that couldn't be taken from human beings ethically. Animal testing has opened so many doors in the medical industry that saved millions of lives. For example, HIV treatment was first tested on dogs before advancing to human consumption. Unexpectedly, "the dogs experienced severe liver damage, but the adverse outcomes saved humans from experiencing the same fate" (Smith). As a result, the medicine was altered, to create a safer drug that led to a successful HIV treatment that saved many lives. If animal testing continues to be this productive, human can eventually have the cure to diseases like cancer or diabetes. As it is gaining more attention and controversy, is animal testing truly an ethical process?

Animal Testing

One side of the argument is to eliminate animal testing and focus on more modern methods. With each day that animal testing progresses, it proves to be more unethical with 100 million animals dying each year due to testing. They can range from small rodents, to large primates. Similar to humans, animals are creatures that can experience both mental and physical pain. Yet, they are put through painful experiments and denied painkillers, due to their interference with the results. By eliminating the procedures, humans will not only save animal lives, but also open new doors to more modern alternative methods.

Even before their experiments, animals go through distress just by being present in the laboratory environment. According to Dr. Jarrod Bailey, "factors that contribute to the stress of animals include the lack of control over the procedures they are subjected to" (Bailey). He goes on to explain that animals are all born with a set of natural instincts, even if they are bred in captivity. In addition to being kept in a caged and unnatural environment, it causes them great amounts of stress. The consequences of this affect both the scientific results and animal mental

health. As a result, the stress can interfere with their vital signs, which can deem the data unreliable. Therefore, using more modern alternative methods to determine toxicity like, "the use of human cells and tissues, and computer based methods" (Bailey). This way, the animals' distress won't interrupt the data, which leads to more promising results.

This point of view focuses on both the morality of the experiments, as well as the scientific results it would produce. If animal testing came to an end, humans wouldn't have to spend large amounts of money simply to breed animals and keep them in the laboratories. According to The International Humane Society, evaluation of just one chemical could take millions of dollars, along countless animal lives. These procedures go back thousands of years, to animal sacrifice. This proves that the practice is not only outdated, but doesn't contribute to raising the morals of people. As the human race is continuing to transition into a more progressive era with the arrival of electronics and AI, it's also time to remove former methods that prove to be unethical and unnecessary. Advances in the medical industry that remove old habits, such as animal testing, facilitate new drugs and methods that could provide new perspectives of human health that were not visible before.

Second Side: Animal Testing Is Beneficial And Should Be Used To Its Full Potential
On the other hand, animal testing should be continued to be practiced in the medicine industry. It has been responsible for many scientific breakthroughs throughout history. From helping create the first vaccine, to curing HIV. Eliminating animal testing will remove the ability to test chemical toxicity and development. Without that ability, people would have to take substantial risks when it comes to medicine. Instead of taking it away, humans should use the procedures to their full potential.

According to the Nature Neuroscience group, because of harsh animal rights activists, high end universities are debating to go forward with their research programs and facilities. Oxford University, one of the top schools in research, has been under attack by animal rights activists, who are targeting suppliers and financial investors (Nature Neuroscience). By shutting down these research centers, it will set scientists back instead of progressing forward to new medicine. So instead of eliminating animal testing altogether, people should start "collaborations and sharing of materials to further reduce the number of animal experiments used for the implementation of new techniques" (Dieterich). These collaborations not only encourage teamwork throughout laboratories across the globe, but ensure people's well being. According to scientists in China who study SARS, an illness targeting the respiratory system, animal testing has been a crucial step to developing successful treatments. When asked about the testing, director of the National Institute of Communicable Disease in China, Xu Jianguo replied, "it's a strict and scientific way of guaranteeing the safety of consumers".

Throughout History, animal testing has always been proven to be effective. Even though it causes certain side effects to the animals, it is a risk that humans need to take to ensure their safety. The biological similarities between animals and humans can be used at an advantage. The data collected from the tests and experiments can not only save human lives, but can also be

directed toward animal healthcare. Though people argue that humans can also be treated as organisms to experiment on, the actions would violate many human rights codes. For example, the famous Nuremberg Code is specific to testing on animals before human trials are even in the picture. Proposing new alternative methods could set the current research and data back decades. There would have to be repeated tests and assessments before the whole process can be up and running. This situation is not ideal when it comes to the current state of the world right now. In 2020, ovid-19 hit the population so suddenly that when facilities and labs opened back up, scientists started working and testing different vaccines as soon as possible. If animal experimentation was shut down until the new methods were ready, it would take years and countless human lives before researchers could determine if the vaccine is safe. As of right now, animal testing has proved to be an effective and reliable source of information and improvement.

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The Rise of Nationalism in Southeast Asia By Li Zang Wang

While many leaders relied on religion to rule their citizens through the early 19th century, the years following that saw a radical shift to reliance on nationalism – devotion and loyalty by citizens to their nation, above individual or other interests -- as a governing force. This can be seen in many countries, including across southeast Asia.

The roots of this change internationally began in the later 18th and early 19th century. The French Revolution proved the strength of common people to overthrow unjust rulers, even though the monarchy previously enjoyed supreme power similar to the Church. The Enlightenment encouraged the colonized population to strive for independence, as the ideologies of individualism, equality and liberty were widely spread across the globe.

Southeast Asia also witnessed changes and continuities in forming national identities starting in the early 20th century. China, Vietnam and Japan all demonstrated persistent pursuit of their own national identity. China wanted to establish a "Chinese people" to fight against foreign invasion and to strengthen the whole country. Similarly, Vietnam strived for a national identity as it managed to gain independence from Western colonization. The Japanese adopted a more belligerent approach in their nationalism, using it to create a highly united force to invade China, as well as taking aggressive action in the two world wars.

Chinese national identity was strengthened in 1914 with its promotion by Sun Yat-sen's new government after the fall of the Qing Dynasty. The fundamental ideology underlying this shift was Sun Yat-Sen's Three Principles of the People, which emphasized national independence, unified Chinese identity and civil rights. As the president of the Republic of China, Sun Yat-sen's doctrine enlightened Chinese people and imposed the critical idea of a uniform national identity onto the ordinary Chinese citizen.

In addition to the political leaders' efforts, scholars played a big part in promoting Chinese nationalism as well. Beginning in1915, the New Culture Movement advocated for democracy, science, individual freedom and women's liberation, which freed Chinese people from previous patriarchal values.

Further, the failure of western powers to pay attention to China's demands in the Paris Peace Conference after World War 1 eventually triggered the widespread May Fourth Movement among students, workers and other Chinese people. Rallying around the banner of "Chinese people for Chinese interest" a mature and strong national identity was formed in the May Fourth Movement.

China's national identity, fostered by political, cultural and international factors, continued growing and consolidating itself in the following decades.

Similarly, the Vietnamese also experienced a growing change in their identities when Ho Chi Min declared the independence of Vietnam. During World War II, the French colonizers slowly began to lose absolute control over their colonized territories, as the Japanese troops began to enter Vietnam and took control of it. Then, just a few hours after the Japanese surrendered to the Allies at the end of the war, Ho Chi Minh declared Vietnam's independence

from French colonization on September 2, 1945 -- a bold move inspired by their pursuit of independence and nationalism. After reading the declaration, however, the French rejected the proposal. This led to the Vietnam War in November 1955.

The Vietnam War perfectly reflects the change of the Vietnamese national identity, as the Communist government led by Ho Chi Minh was committed to the idea of a united and independent Vietnam. The North Vietnamese saw themselves as the true patriots of Vietnam, fighting against foreign invaders and colonial powers. They viewed the United States as an aggressor and saw their struggle as a continuation of their long history of resistance against foreign domination.

On the other hand, the Vietnam War also represents a continuity of national identity, because the Vietnamese have a long history of fighting foreign invaders and resisting outside influences. Throughout their history, the Vietnamese people have been invaded and colonized by various foreign powers, including China, France, and Japan. Despite these invasions, the Vietnamese have maintained a strong sense of national identity and have fought to preserve their culture and way of life. This sense of nationalism was evident during the Vietnam War, as the Vietnamese people fought to defend their country against the United States and its allies.

While there are similarities between the shift of national identity between China and Vietnam, the Japanese utilized a more aggressive form of nationalism through their series of invasions on the Republic of China. The Japanese first started to invade Manchuria from 1931-1932, where they had successfully established the Japanese puppet state of Manchukuo. The appointed emperor, Pu Yi, had no rights or say in anything; although he was technically the emperor, the Japanese still had absolute power over the area.

This, however, could not fulfill the ambitions of the Japanese, as they started the Sino-Japanese War in 1937 to take absolute control and colonize China. At the time, China was experiencing social chaos, as it had just established a new government, and Japan saw this as an opportunity to establish itself as a major power in the region and to challenge China's dominance. This desire for power and dominance was rooted in Japan's national identity, which was shaped by its history and culture. Japan had long seen itself as a unique and superior nation, with a rich and ancient culture that was distinct from that of its neighbors. This sense of national pride and identity was a driving force behind Japan's aggressive expansionism during the late 19th and early 20th centuries.

In short, Southeast Asia experienced both significant changes and continuities in national identities in the 20th century due to the rise of nationalism – but this nationalism played out very differently in China, Vietnam and Japan.

Cross-Modal Action Recognition: A Survey Paper By Abhinav Bulusu

Abstract

Understanding and interpreting actions across different modalities has become a critical challenge in the multimedia era, where information is generated from various sources such as speech, vision, and text. Cross-modal action recognition, a burgeoning area of research at the intersection of computer vision, natural language processing, and audio processing, aims to bridge the gap between these diverse sensory streams and enable machines to comprehend actions holistically.

Traditional action recognition systems often operate independently within a specific modality, resulting in a limited understanding of complex real-world scenarios where actions are communicated simultaneously through multiple modalities. However, human perception is inherently multimodal, with humans relying on cues from various senses to interpret and comprehend actions seamlessly. It is essential to break free from the constraints of single-modal analysis and embrace the challenges and opportunities presented by fusing different data streams to build intelligent systems that emulate human-like understanding.

Introduction

Cross-modal understanding and retrieval algorithms aim to link objects and actions across different mediums like video, audio, and text. Recognition of human actions in videos involves processing continuous sequences of frames, while "real-time images" refer to individual images captured in the present moment without any temporal context. The video data provides a series of frames, enabling the analysis of object appearances and motion over time, while real-time images only offer isolated snapshots of the scene. Additional text data and other information can supplement this analysis and contribute to a more thorough understanding.

Traditionally, information is acquired through a singular modality or one source. For example, football coaches use videotapes of players practicing and recordings of past games to create strategies. However, if paired with another source of information, results and data can be more specific. For instance, player-tracking data collected through wearable sensors or tracking systems can provide detailed movement information about the quarterback, such as speed, acceleration, and direction changes. By integrating this data with already known data, coaches can better understand the players' strengths and weaknesses

The main challenge in cross-model recognition is understanding and getting helpful information from different sources. Each data type (like text, images, and audio) needs its unique way of processing. For example, to understand text, we analyze the words and sentences to know their meaning. For images, we have to extract detailed features from pixels to understand what's in the picture. And for audio, we need to process the sound waves to recognize patterns. Dealing

with these specific challenges is essential for making cross-model recognition systems work well. Understanding and connecting different things like speech, vision, and text is very difficult (Nagrani et al., 2020). There are many challenges in putting together information from these different things, like dealing with different ways data is presented, addressing differences in meaning between them, and handling variations in how the data is spread out. To tackle these problems, researchers have come up with different ways to bridge the gap between these things. They use methods that mix information from multiple sources to learn more about how they are related. They also use techniques like transfer learning and distillation to share knowledge between them more efficiently. Approaches where they use labeled data from one thing to help learn about another also improve overall performance. These efforts help make better sense of all the different types of information.

In this paper, we discuss the research and techniques devised to address the challenges posed by cross-modal action recognition. We explore various cross-modal fusion methods that combine information from multiple modalities, facilitating joint learning and improving the overall understanding of cross-modal relationships. Additionally, the paper also investigates datasets and limitations that are associated with this task and its further applications.

**2. Cross-Modal Retrieval Techniques For Action Recognition**

Data availability has increased over the past few years, and practical techniques to integrate and implement information from various sources have become more widely necessary. Many techniques have been instrumental in this field, enabling feature extraction and capturing complex relationships across different modalities.

2.1 Deep Learning Methods

2.1.1 Convolutional Neural Networks (CNN)

Convolutional Neural Networks (CNNs) are a class of deep learning models that excel at capturing spatial information from images or video frames due to their unique architecture as shown in Figure 1. CNNs are particularly effective in automatically learning and extracting distinctive features from various data types, including audio and visual data (Xu et al., 2021). One practical application of CNNs is in speech enhancement, where they improve the quality and intelligibility of speech signals by reducing or removing unwanted background noise. However CNNs have a few drawbacks, including the need for larger labeled datasets, the inability to handle input changes, and difficulties capturing long-term dependencies (Jiaxin et al., 2021). It means earlier steps can significantly impact or understand events later in the sequence. For example, imagine a video sequence where someone assembles a piece of furniture. The earlier steps, such as attaching the base and adding screws, establish the context for subsequent actions. Suppose a CNN fails to capture long-term dependencies effectively. In that case, it may struggle to recognize the final action correctly because it does not see consider the relationship between the previous steps. As a result, the model's performance in real-world scenarios can lead to poor generalization and inaccurate predictions. These drawbacks are especially relevant to

cross-model action recognition: insufficient data can make a poor generalization to the real world, and capturing long-term dependencies effectively can be a struggle.
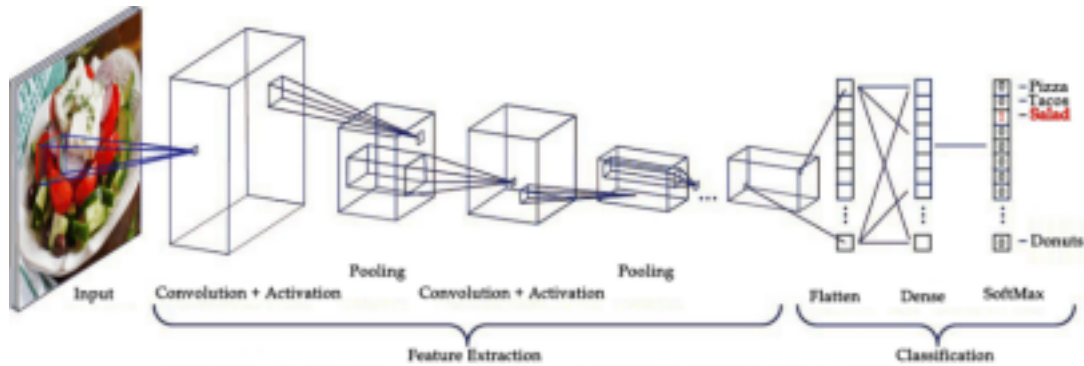
(Figure 1. A simple CNN architecture A CNN is a multi-layered neural network with a unique architecture designed to extract increasingly complex features of the data at each layer, in order to correctly determine the output. CNN's are well suited for perceptual tasks.)

2.1.2 Recurrent Neural Networks (RNN)

On the other hand, Recurrent Neural Networks provide solutions to some of the limitations of CNNs, as mentioned above. While CNNs may be good at capturing spatial data from visual data, RNNs excel at modeling sequential data and capturing temporal dependencies due to their capacity to process data step-by-step. Their recurrent nature allows them to learn information from previous steps, making them great for tasks that require temporal understanding. This nature helps them remember past information in a "hidden state," like a memory. It also helps them understand the context and understand how the relation between different parts of it will change over time.. RNNs are also great for working with sentences or data that happens over time, like languages and time-series data (Yao et al., 2019). On the other hand, Convolutional Neural Networks (CNNs) are specially designed for dealing with pictures and 2D. They are good at recognizing visual patterns making them commonly used for object detection.

2.2 Multi-Modal Fusion Techniques

Fusion techniques and deep learning techniques are distinct but not mutually exclusive. While deep learning is a broader category encompassing various methods for training and utilizing deep neural networks, fusion techniques, on the other hand, are specifically focused on integrating information from multiple modalities to improve the performance of cross-modal action recognition. Now that we've explored deep learning methods let's delve into multi-modal fusion techniques for cross-modal action recognition.
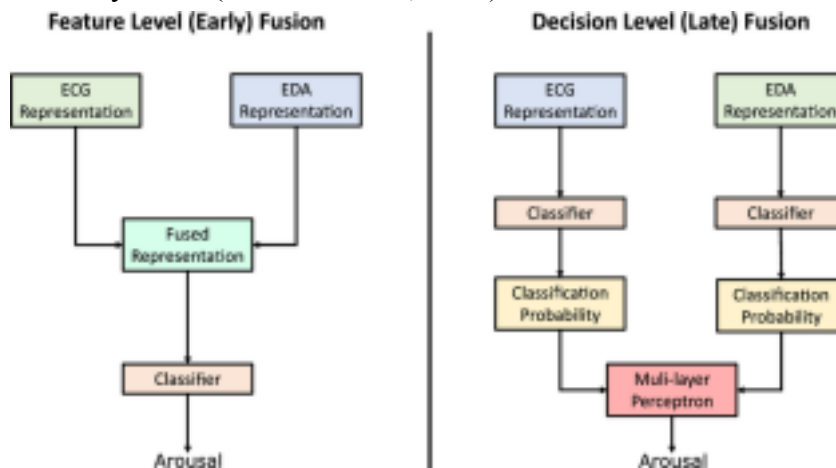
2.2.1 Early Fusion

Early fusion is a commonly used technique in cross-modal action recognition. Fusion refers to combining information from different modalities, such as visual, auditory, and other

sensory data, to improve the accuracy and performance of the recognition task. In early fusion, information is combined at the input level before further analysis and processing happens. This approach directly integrates raw or preprocessed data from various modalities. The main advantage of early fusion is that it enables the modeling of multiple modalities from the beginning, allowing multiple layers to integrate multimodal information (Lingenfelser et al., 2011). By combining information early in the pipeline, early fusion can capture rich cross-modal correlations and dependencies, leading to enhanced action recognition performance as shown in Figure 2. However, early fusion also has limitations. It assumes all modalities are equally important and may not effectively handle specific variations or ones that weigh higher importance. Furthermore, early fusion involves the tricky task of harmonizing different data types, and this can be quite a puzzle in the real world. Picture this: someone going about their business, walking, running, even jumping, all the while being monitored by both a camera and a motion sensor. The camera, snapping away at a set rate, like 30 frames per second, while the motion sensor diligently records accelerometer data at its own pace, say around 100 samples per second. By applying early fusion, we can align the camera and motion sensor data so that each video frame corresponds precisely to the accelerometer data collected simultaneously. This alignment ensures that the visual and motion data are synchronized and can be combined effectively.

2.2.2 Late Fusion

      Like early fusion, late fusion is another commonly used technique in cross-modal action recognition. However, unlike early fusion, late fusion involves keeping the modalities separate until later stages of processing or analysis. Each modality is individually processed with this approach, and the resulting outputs are fused or combined later. Late fusion offers several advantages in cross-modal action recognition. It allows for the flexibility of modeling each modality independently, effectively utilizing modality-specific characteristics, as shown in Figure 2. However, late fusion may be limited in capturing dependencies or interactions between modalities. It assumes that each modality's information is independent and complementary, which may or may not always hold (Boulahia et al., 2021).

(Figure 2. Frameworks for Early Fusion and Late Fusion)

2.2.3 Intermediate Fusion

Intermediate fusion is a technique used in cross-modal action recognition. It combines information from different sources, like pictures and sounds, but it does so in a more advanced way than early fusion. With intermediate fusion, we first take essential details from each source separately instead of directly mixing the raw data. These crucial details from each source to make a more complete and helpful representation of the action. It's similar to taking the best parts of each source and putting them together to understand better what's happening. A benefit of intermediate fusion is that it can be more flexible and detailed when combining information from different sources (Boulahia et al., 2021). It does this by looking at each source separately and deciding how important it is for the task. This gives more weight to the sources that matter most, enabling the model to be able to handle significant differences better than early fusion. This makes the model more intelligent and adaptable to different situations. But there are also some problems with intermediate fusion. Even though it can handle some of the issues of early fusion, it still assumes that the information from different sources fits perfectly. Ensuring that the data from all the sources lines up correctly and happens simultaneously can be tricky, especially in real-world situations where things might not match up perfectly. For example, coordinating the data in real-time can be tricky when monitoring patients with different medical devices, such as heart rate and blood pressure monitors. Variations in measurement intervals or network delays can lead to data misalignment, potentially impacting the accuracy of patient monitoring and diagnosis.

2.3 Alignment Algorithms

In this section we explore the challenges of aligning data from different modalities in cross-modal action recognition systems.

2.3.1 Dynamic Type Wrapping

Dynamic Type Wrapping is a technique that measures metrics like Gaussian Distance or Pearson Correlation Coefficient between two sequences to find an optimal alignment between them. Gaussian Distance measures the difference between two Gaussian distributions, while Pearson Correlation Coefficient quantifies the linear relationship between two variables. In cross-modal action recognition, DTW can be likened to analyzing a football match where we want to compare players' actions recorded from different modalities, such as video frames and audio commentary. In our football analogy, DTW can be employed to align the sequences of actions captured by players from different sources (Khaertdinov & Asteriadis, 2022.) For instance, DTW can match the time-stamped video frames with the corresponding audio commentary, allowing us to simultaneously analyze the player's actions and the commentator's descriptions.

DTW proves to be beneficial when dealing with sequences of different lengths or variations. Like in a football match, where players' actions and commentator's descriptions may have varying durations or timings, DTW can handle non-linear correspondences and small temporal shifts within sequences. It can flexibly align the actions and descriptions, even if they occur at slightly different time instances. However, DTW does have its limitations. In our football analogy, DTW may not consider the meaning of individual actions, like whether a player's movement is a pass, a dribble, or a shot on goal. Similarly, in cross-modal action recognition, DTW might not inherently comprehend the meaning of each action in the sequences so pre-processing and extraction is necessary before using this technique.
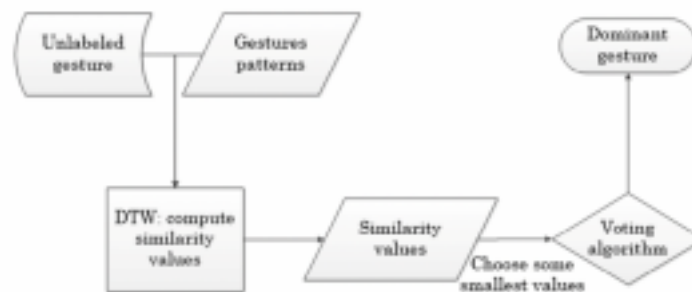
(Figure 3. DTW classification model)

2.3.2 Hidden Markov Models

Hidden Markov Models (HMMs) help us understand data that happens in modalities one step at a time. They can find patterns and transitions in different modalities. One advantage of Hidden Markov Models in cross-modal analysis is that they can understand how things change over time in each data part. Imagine you have data from different sources, like text, images, and audio, and each source presents a sequence of observations. HMMs act like detectives in this scenario, trying to make sense of the unfolding events step by step. As detectives piece together evidence to understand a sequence of events in a crime investigation, HMMs piece together the sequential observations from different modalities to understand how the data evolves. They are skilled at finding patterns and transitions in videos or how sounds change in audio.

However, Hidden Markov Models have some problems when used in cross-modal analysis (Fu et al., 2005). For example, in a video analysis scenario, HMMs may struggle to capture the temporal dependencies between the actions of different players on a football field, as they treat each player's actions as isolated events. As a result, essential interconnections between events may be overlooked, potentially leading to less accurate analysis. This makes it challenging to use them when the different parts of the data are connected in some way. Additionally, HMMs require sufficient labeled training data to estimate the model parameters accurately.

One common approach to assess the efficacy of Hidden Markov Models (HMMs) is to use techniques like cross-validation. By splitting the available labeled data into training and validation sets and measuring the model's performance, one can estimate how well the model generalizes to new, unseen labeled data. However, it is important to note that cross-validation

does not address the challenge of training an HMM so alternative methods, like unsupervised learning approaches, may be employed to discover patterns and structures in the data without the need for explicit labels.

3. Datasets Used in Cross-Modal Action Recognition

Cross-modal action recognition teaches computers to understand human actions by combining what they see (like images or videos) with what they read (like captions or descriptions). To help researchers develop better systems for this task, they use datasets to train and test their models. This section will overview some of these datasets and explain how they help improve cross-modal action recognition technology.

3.1 MMAct Dataset

MMAct (Multi-Modal Actions) is an open source dataset that teaches computers how to understand human actions by combining what they see in videos and images with what they read in the provided descriptions. The dataset was created by Quan Kong and a group of researchers in Seoul, Korea. It has many different actions like running, cooking, dancing, and real-life situations, like people doing them at home or in public places. This variety makes it very useful for training and testing these computer models to recognize various actions in different settings. The dataset includes detailed information about when actions happen in the videos and what they are about (Kong et al., 2019). For example, it tells the computer that someone starts running at 1 minute and 30 seconds into the video. This helps researchers create better models using visual and written clues to understand actions. While the dataset provides temporal information about action occurrences in videos, it may not capture fine-grained temporal details for complex actions. This limitation could potentially affect the performance of models in recognizing actions with rapid and subtle transitions. All in all, MMAct is an essential tool in cross-modal action recognition, helping researchers compare and improve their computer systems' abilities to recognize and understand human actions more accurately and in various real-life situations.

3.2 UT Kinetic Dataset

The UTKinect dataset, curated by researchers at the University of Texas at Austin, is valuable in human action and poses recognition. It collects data, including depth maps, RGB images, and skeleton joint positions, which are captured simultaneously using a Kinect sensor. This multi-modal data allows researchers to study how humans perform different actions and how their bodies move in various real-world scenarios (Xia et al., 2012). By training computer models with this dataset, researchers can teach computers to recognize and understand human actions, such as walking, jumping, or waving, from visual data and to estimate the positions of crucial body joints. The applications of this dataset are diverse, ranging from developing surveillance systems that can identify specific actions to creating animated characters that move realistically. The UTKinect dataset primarily emphasizes indoor scenarios, which may limit its applicability to outdoor or uncontrolled environments. This restriction could pose challenges

when deploying models trained on this dataset in real-world scenarios with varying lighting conditions and backgrounds. The UTKinect dataset remains a valuable tool for advancing our knowledge of human activities and enabling the development of cutting-edge technologies.

3.3 Falling Detection Dataset

The UT Austin Multimodal Fall Detection Dataset is a valuable resource for studying and improving falling detection technology. It consists of various data types, such as RGB-D videos (which capture visual and depth information), accelerometer data, and depth map images. The dataset includes examples of falls and regular activities performed by different people in various indoor and outdoor settings, making it more realistic and applicable to real-world situations (Adhikari et al., 2017). By providing ground-truth annotations for fall occurrences, the dataset allows researchers to evaluate and compare different algorithms accurately. The dataset's reliance on RGB-D videos and accelerometer data might not fully capture the complexities and variations of real-life falls, especially in scenarios where the fall occurs in cluttered environments or involves intricate movements. This limitation might affect the model's accuracy in detecting falls in challenging and dynamic situations. This dataset has been instrumental in advancing falling detection technology and has contributed to developing more accurate and reliable systems for ensuring safety and healthcare applications.

4. Applications in Assistive Technology

Assistive technology (AT) helps people with disabilities by providing tools and systems that make their daily lives more accessible and independent. Cross-modal action recognition helps improve assistive technology (AT) for people who use computers differently. By using this task, AT can become easier to use and more accessible for everyone. Cross-modal action recognition involves understanding and interpreting actions using senses like seeing, hearing, and movement. By using information from different sources, these systems can understand what users are doing and what they want, which helps them interact with computers more effectively. This section provides a few examples of assistive technology applications that can solve specific problems through cross-modal action recognition research

4.1 Using a Computer–Gesture-Based Control Systems

Cross-modal action recognition plays a pivotal role in assisting people with disabilities who face challenges in using traditional control devices, such as keyboards or mice, due to limited mobility. By leveraging multiple modalities, gesture-based control systems enhance the understanding and usability of technology for individuals with disabilities. For instance, a gesture-based control system may capture hand movements through video cameras and detect body posture or motion patterns through sensors. By integrating visual and motion data, the AT system gains a deeper understanding of the user's gestures, resulting in more accurate and intuitive control of computers, smartphones, or other devices.

Eye-Tracking Software

Cross-modal action recognition significantly enhances eye-tracking software, particularly for individuals who face challenges with using computer interfaces. The system gains a more comprehensive understanding of the user's needs by integrating data from eye movements and other modalities. This is done with multiple modalities, allowing the eye-tracking software to capture a broader range of cues, providing a richer context for interpreting the user's desires and actions. The system can better discern the user's intentions by fusing data from eye movements with information from hand gestures or facial expressions, making the interaction more accurate and efficient.

4.2 Communicating with Others and Navigating Independently

Augmentative and Alternative Communication (AAC) Combining AAC technology with cross-modal action recognition offers multiple benefits to individuals facing communication challenges. AAC utilizes communication boards or speech devices, while cross-modal action recognition introduces additional communication avenues, such as using eye movements or gestures to convey the user's perspective. By incorporating multiple modalities, this approach enhances communication possibilities through eye movement-based control and gesture utilization on the AAC interface. This fusion empowers those with communication limitations to interact more autonomously and sociably, augmenting their capacity to engage meaningfully with the world.

Cognitive Augmented Reality Assistant (CARA)

Cognitive Augmented Reality Assistant (CARA) is a headset that assists the visually impaired in sensing their surroundings It uses special glasses or a phone to give sound and touch feedback about its surroundings. With cross-modal action recognition, CARA can understand gestures and movements, making it easier for blind users to interact. Additionally, by connecting with other modalities like Google Maps, CARA can tell them where to go and give them more helpful information, making it easier for blind people to move around and be more independent. For example, if a blind person walks through the National Mall and points towards the Washington Monument to know what is around him, the headset could help him navigate it easily. CARA would also recognize the importance of existing methods visually-impaired individuals use to locate themselves. Devices like mobility canes and guide dogs are vital in helping individuals with visual impairments navigate their surroundings. CARA does not replace these valuable methods; instead, it complements them by providing real-time feedback through sound and touch and combining it with gesture recognition and navigation assistance. Leveraging these existing methods and augmenting them with CARA could enhance and simplify the experience of understanding and navigating one's environment.

4.3 Daily Living Tasks and Independence–Smart Home Integration

Smart Home Integration with cross-modal action recognition is a transformative

technology for individuals requiring assistance with daily tasks, particularly those with mobility or accessibility challenges. Connecting smart devices in their home and utilizing cross-modal action recognition simplifies the control of lights, appliances, and other features, empowering users to manage their living environment independently and efficiently. Users can easily interact with their devices through gesture and voice control, seamlessly switching between different modes based on their preferences and abilities. Customizable automation allows for personalized routines, such as automatically adjusting lights and temperature upon entering a room. Remote access features enable control from smartphones or devices, enhancing convenience and flexibility for users with limited mobility or spatial constraints.

Assistive Robotics

Assistive Robotics with cross-modal action recognition is a transformative technology that empowers individuals with disabilities or limitations to live more independently and enhances their daily lives. By combining advanced gesture and voice recognition capabilities, these robots create a more intuitive and responsive user interaction. The robots can understand simple hand gestures and voice commands, enabling individuals with limited mobility or communication difficulties to control them effectively. Moreover, the robots adapt to individual needs, offering personalized assistance and learning from user interactions. This adaptability enhances communication, as the robots understand non-verbal cues and respond accordingly. The benefits of Assistive Robotics with cross-modal action recognition include greater independence in performing daily tasks, a safe and supportive interaction environment, and an improved overall quality of life for individuals with disabilities. This technology is a big step forward in improving the quality of life for people with disabilities. It takes a more personalized and inclusive approach to assist those with disabilities, not only making their lives easier but also fostering a sense of companionship and empowerment.

5. Limitations

Cross-modal action recognition, while a promising area of research, comes with its limitations and challenges. In this section, we will address some of the key factors that impact the performance and applicability of cross-modal action recognition models. These challenges include modality mismatch, data heterogeneity, and scalability issues.

Modality Mismatch:

Combining information from these two types is tricky because they don't match perfectly in time and space. To solve this, researchers need to accurately bring the visual and textual information together, as mentioned above. They use fusion techniques and attention mechanisms to align and combine the data correctly. This helps the computer understand actions better by using both visual and written clues.

Data Heterogeneity

The models used in cross-modal action recognition rely on datasets containing diverse

information, encompassing variations in lighting, camera angles, background noise, and the complexity of actions. Handling this diversity is crucial to developing robust models that perform effectively in various situations. To tackle these challenges, researchers employ several techniques, such as data augmentation (creating more data variations), domain adaptation (adjusting the model to different data sources), and feature normalization (ensuring data consistency). These approaches enhance the models' capabilities to recognize actions in different environments (Baltrušaitis et al., 2018).

Scalability Issues

As cross-modal datasets grow in complexity, scalability emerges as a significant concern. The sheer volume of data from different sources poses challenges in handling and combining this diverse information. Managing and processing large datasets demands substantial computer power and time, making training complex cross-modal models costly and time-consuming. To ensure the practicality of these systems in real-life situations where time and resources are limited, researchers are actively exploring ways to enhance scalability. Innovative techniques like parallel processing, distributed computing, and model optimization are employed to streamline the training and inference processes, making these models more efficient and feasible for handling intricate cross-modal datasets. By addressing scalability challenges, researchers strive to unlock the full potential of cross-modal action recognition systems and enable their seamless integration into various practical applications.

6. Conclusion

Cross-modal action recognition holds significant implications for various applications, from enhancing human-computer interaction and video surveillance systems to enabling more sophisticated robotics. By nurturing cross-modal understanding, we lay the foundation for systems that can adapt to diverse scenarios and effectively interpret actions, enriching both technological innovation and user experiences.

While challenges remain, the strides made in this field are a testament to the dedication of researchers to bridge the gap between different modes of perception. As we look ahead, the continued pursuit of cross-modal action recognition promises to usher in a new era of AI capabilities, where machines emulate human-like understanding and seamlessly navigate the intricate web of actions that shape our world.

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Do the Results of Elections Express the Will of the People? By Yeqingqing Shu

Abstract

        Elections are essential to democracy, enabling citizens to choose representatives and ensure accountability. The 2020 US presidential election's reflection of the people's will is examined, considering factors like the Electoral College, polarization, misinformation, and representation challenges. While the election was legally valid, there were representation gaps. Reforms and dialogue are needed to address these issues and strengthen democracy. The election's legitimacy is supported by majority preference. Biden's win with 52% of the popular vote and 306 electoral votes displayed broad support. Voter turnout and diversity further validate the process. Critics claim media bias, misinformation, and money influenced voters, but these arguments lack credible evidence and ignore voter agency. Democracy encourages varied opinions, transparency, and accountability.

        Diverse representation in government is key for legitimacy. The 117th Congress is historically diverse, reflecting America's variety in race, gender, religion, and ideology. While critics point to underrepresentation and polarization, these challenges can be addressed through inclusivity and dialogue.

        The election's legitimacy is affirmed by its conduct and accountability. High turnout, transparency, and international observation validate the process. Elected officials fulfilling campaign promises and engaging with diverse perspectives enhance democracy's vitality. The 2020 US election expressed the people's will through majority preference, diverse representation, and democratic legitimacy. Reforms should address gaps, misinformation, and polarization. Enhancing the election process, civic education, and inclusivity will fortify democracy.

Keywords: election, democracy, government, accountability, people's will, voter turnout, diversity, legitimacy

        Elections are widely regarded as a fundamental mechanism of democracy, as they allow citizens to choose their representatives and hold them accountable for their performance in office. However, the extent to which the results of elections express the will of the people is a contested question that depends on various factors, such as the electoral system, the political culture, the media , and the participation of voters. In this   essay, I will examine whether the result of the 2020 U .S. presidential election , which saw Democrat Joe Biden defeat incumbent Republican Donald Trump by a margin of 306 to 232 electoral votes and 51.3% to 46.8% of the popular vote, reflected the will of the American people. I will consider the following aspects of the election: the role of the Electoral College and the state-level variations in voting rules and procedures; the polarization of the electorate along ideological, racial, and geographic lines; the influence of misinformation , disinformation , and social media on the public opinion and

the perception of the election's legitimacy; and the challenges and opportunities for enhancing the representation of the diverse and pluralistic American society. I will argue that while the election result was a valid and legal expression of the will of the majority   of voters, it also revealed some significant gaps and distortions in the representation of   the will of the people as a whole. Therefore, there is a need for reforms and dialogue to address these issues and strengthen the democratic process.

The first argument in favor of the legitimacy of the election results is that they reflect the majority preference of the voters. According to the data , the winning candidate received 52% of the popular vote and 306 of the 538 electoral votes, securing a decisive victory over the incumbent. The margin of victory was larger than in the previous election , and the turnout was the highest in a century, indicating a high level develop their critical thinking and engagement in various forms of activism and advocacy to express their views and interests, thus influencing the public agenda . Therefore, democracy is not a passive or naive system of government, but an active and resilient one that requires and enables the voters to exercise their rights and responsibilities.

The second arguments on why the result of the election express the will of the people is that it ensures the representation of diverse interests and perspectives in the government. The election outcome reflects the diversity of the American society and the plurality of the political views that exist within it . According to the Pew Research Center , the 117th Congress is the most racially and ethnically diverse in U .S. history, with 124 lawmakers of color, or 23% of the total. The Congress also has a record number of women , with 144, or 27% of the total. Moreover, the Congress includes members from different religious backgrounds, such as Muslims, Hindus, Buddhists, and Jews, as well as the first openly atheist senator . The Congress also represents the geographic diversity of the country, with lawmakers from every state and territory, from urban , suburban to rural areas. The election also showed the diversity of the political preferences and ideologies of the American voters, who cast their ballots for candidates from different parties, coalitions, and movements, such as Democrats, Republicans, Libertarians, Greens, Progressives, Conservatives, Moderates, and Independents. The election also revealed the diversity of the issues and values that matter to the voters, such as health care, economy, environment , immigration , social justice, national security, and democracy.

The representation of diverse interests and perspectives in the government is important because it enhances the legitimacy, accountability, and responsiveness of the elected officials. As Representative Ilhan Omar, one of the first Muslim women in Congress, said , "When people see themselves reflected in their government , they feel more connected to it and more empowered to participate in it."

However, some might argue that the representation of diverse interests and perspectives in the government does not necessarily express the will of the people, but rather creates more conflicts. They might point out that certain groups, such as Native Americans, Asian Americans, LGBTQ+ people, and young people, are still underrepresented or marginalized in the government. They might also claim that the government is too polarized or

fragmented to function effectively and cooperatively, and that the elected officials are too influenced by special interests, money, or partisan loyalty, and not by the public interest. These arguments, ignore the benefits and challenges of living in a diverse and democratic society. The underrepresentation marginalization of certain groups is not a reason to deny the representation of other groups, but rather a reason to work harder and smarter to achieve more inclusion and equity in the government. The polarization or fragmentation of the government is not a reason to suppress the representation of different views, but rather a reason to seek more dialogue and compromise in the government. The influence of special interests, money, or partisan loyalty is not a reason to distrust the representation of the people, but rather a reason to demand more transparency and accountability in the government. Rather than viewing the representation of diverse interests and perspectives in the government as a flaw, it should be seen as a strength and success of the election and of

the American democracy.

The third argument for why the result of the election express the will of the people is that it enhances the legitimacy and democracy of the political system . Legitimacy refers to the extent to which the people accept and support the authority and decisions of the government , while democracy refers to the extent to which the people have a meaningful and effective voice and participation in the political process. To apply the standard above, the election is egitimate and democratic.

First , the election was conducted in a free, fair, and transparent manner, with a high turnout of voters and a diverse range of candidates and parties. According to the official results, the election had a participation rate of 78%, which is the highest in the history of the country. Moreover, the election was monitored and verified by independent and credible observers, such as the United Nations, who confirmed that the election met the international standards and best practices for democratic elections. The observers praised the professionalism and impartiality of the electoral commission , the security of the voting and counting process, and the orderly conduct of the voters and

the candidates.

Second , the government has demonstrated its responsiveness and accountability to the people and their needs and preferences. The elected president and the parliament have fulfilled their campaign promises and implemented various policies and reforms that have improved the social and economic conditions and the human rights situation of the country. For example, the government has increased the minimum wage, expanded the health care and education coverage. The government has also engaged in a constructive and inclusive dialogue with the opposition , the civil society, and the media , and has respected the constitutional and institutional checks and balances, such as the judiciary, the audit office, and the ombudsman .

Of course, some might argue that the election and the government do not reflect the will of the people, because they are tainted by corruption , fraud or violence. However, these arguments are flawed , because they are based on exaggerated outdated allegations, or because they distort the facts. For instance, the claims of fraud in the election are unsupported by any

credible proof, and have been rejected by the courts and the observers. The allegations of human rights violations or constitutional breaches by the government are misleading, because they either refer to isolated or exceptional cases, or because they misinterpret or misapply the legal and democratic principles. To conclude, this paper argues that the election results reflect the will of the people. This is because they echo the majority preference of the voters, ensure the representation of diverse interests and perspectives in government , and enhance the legitimacy and democracy of the political system .However, this does not mean that the election process is flawless or the elected officials can ignore the voices of the minority groups or the dissenting opinions. Therefore, some implications and recommendations for the future are to improve the election process, how to foster civic engagement , and to address the challenges or opportunities that the election result poses to improve the election process.

To improve the election process, the electoral system should be reformed to ensure that it is fair, transparent , and inclusive. For example, the electoral college, which can distort the popular vote and create disproportionate outcomes should be replaced by a national popular vote or a proportional representation system . Moreover, the voting rights and access should be protected and expanded , especially for marginalized and disenfranchised communities, such as racial minorities and low-income groups. The campaign finance and media regulations should be revised to limit the influence of money and corporate interests, and to promote the diversity and quality of information and discourse. To foster civic engagement , the political culture and education should be enhanced to encourage the participation of the citizens. For example, the civic education curriculum should be updated into the formal and informal learning settings to equip the public with the knowledge, skills, values of democracy and citizenship. Moreover, the civic platforms should be created and supported , to facilitate the collaboration among different stakeholders, such as civil society organizations and media outlets. Additionally, the civic incentives should be offered and celebrated to motivate and reward the contributions of the civic actors and initiatives. Lastly, the elected officials and the political parties should be responsive to the people. For example, they should implement the policies and programs that reflect the priorities of the voters, and that address the pressing issues of the society, such as the pandemic, the economy, the environment , and the social justice. Moreover, they should consult with the people and the civil society, seeking to build consensus and compromise across the ideological and   partisan lines to foster the trust and cooperation among the diverse yet divided segments of the population . Additionally, they should respect the constitutional and democratic principles to protect and promote human rights alongside the rule of law, to ensure the stability and integrity of the political system .

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The Moral Obligations of Parenthood: Why Parents Owe Duties to Their Children By Ziyang Zhang

Abstract

It explores the moral obligations and responsibilities of parents towards their children. It discusses the duty of parents to pass on their bloodline, ensuring children have a pleasant life to build a better world, and parental care as pre-emptive payment to children. The concept of intergenerational reciprocity is emphasized, recognizing parents' responsibility to care for their children, preserve cultural traditions, and pass on support received from previous generations. Ultimately, fulfilling these obligations contributes to the well-being of both the children and society as a whole. The article argues that parenting is not only about perpetuating a bloodline but also about creating a better world for all children and a better society.

Introduction

Throughout the world, an increasingly common complaint is the alleged sense of entitlement possessed by the young, in distinction to supposedly more obedient and less demanding previous generations. This is clearly reflected in phenomena as distinct as "little emperors" in Chinese families and anti-boomerism in the West.[1] Now more than ever, humanity must ponder whether parents are morally obligated to provide for their children. Historically, philosophers have had relatively little to say about the claim that parents have moral obligations, as parents, to provide their children with material wealth and support. The lack of attention towards such an important topic is surprising considering that the parent-child relationship plays a critical role in the healthy development of a child's brain, self-confidence, capacity to thrive, and even their ability to form relationships as they go through life, along with their ability to achieve success.[2] Nonetheless, parents do owe duties to their children or at least should be viewed as owing them due both to moral and practical reasons. Parents and children are both bound by past, present and future webs of obligation that require them to do their best to look after each other's material needs, provide emotional support and make their lives as pleasant as possible.

To fully understand such a complex topic, defining keywords is crucial to avoid misunderstanding. Here, I define "owe" as meaning having a moral obligation to repay in return for something one has received. A parent is someone who gives birth or raises a child, while "you" refers to children and the younger generation. Ultimately, while parents typically do not receive material benefits from children (until possibly later in life), I argue below that parents do have obligations imposed on them in respect of children, from other sources, including their own parents.

Duty to Pass on Bloodline

In many cultures around the world, there is a strong emphasis on respecting and honoring one's ancestors, such as Buddhism, Taoism and Confucianism. The idea that parents have being, happiness, and personal growth, regardless of whether or not they choose to have biological children. Moreover, the idea that bloodlines must be preserved can be exclusionary and harmful to individuals who are unable or choose not to have children. One way to do this is by taking care of one's children and ensuring that they grow up to be responsible and respectful members of society. Parents who prioritize the well-being and development of their children are not only fulfilling their own parental obligations but also honoring the legacy of their ancestors. By providing a stable and nurturing environment for their children, parents are not only ensuring a better future for their offspring but also carrying on the traditions and values of their forebears. We are inclined today to think as individuals and assume individualism is thus often normative. However, if we accept that it is just as natural or proper to think collectively in terms of families and lineages, then it is clear that we owe a duty to ensure the survival of the next generation just as much as one of our limbs should sacrifice itself for its body. In this way, taking care of children can be seen as a way of honoring and respecting one's ancestors, by passing down their traditions to future generations. On an aesthetic level, such an approach is also desirable because the more people adopt such a standpoint, the more they can contribute to preserving the world's diversity.

Ensuring Children Have a Pleasant Life to Build a Better World

Each generation also has a moral duty to create a better world for their children because they are the primary caregivers and role models for their offspring. Children learn through observation and imitation, so parents' actions and attitudes shape their children's perspectives and values.3 By creating a better world, parents can instill positive values such as empathy, kindness, and respect for others in their children. Parents can also ensure their children have access to a safe and healthy environment with opportunities for education, personal growth, and career development. It is only by bearing children and fulfilling the duties of the parent that one fully experiences an important part of the human condition. Indeed, it is likely that in the long run, having the experience of successfully raising children actually makes parents happier.4 Likewise for the child, a pleasant childhood is important. It can create a foundation of positivity, resilience, and emotional stability that can carry a person through the challenges of adulthood. Children who grow up with a sense of security, love, and stability are more likely to have strong self- esteem, healthy relationships, and a positive outlook on life. Conversely, children who experience neglect, abuse, or other adverse experiences may struggle with mental health issues, addiction, and other difficulties later in life5 . By ensuring that their children have a pleasant childhood, parents are not only providing immediate benefits but also setting the stage for their children's long-term success and happiness and thereby fulfilling moral duties to the rest of society by providing individuals able to be of more use to everyone. Additionally, by taking action to address global challenges such as climate change, poverty, and inequality,

parents can help secure a better future for all children. In short, by creating a better world for their children, parents invest in their children's well-being and happiness while contributing to a more just and sustainable world. Ultimately, it is the parents' responsibility to provide their children with the best possible start in life, and ensuring that their children live a pleasant life is an essential part of that.

Parental Care as Pre-emptive Payment to Children

In many modern societies, it is common for children to financially support their parents both directly and indirectly as they age. Parental care can also be viewed as a pre-emptive payment to children for their financial assistance in the future. By providing for their children's basic needs and supporting their education and personal development, parents are laying the foundation for their children to become financially independent and successful adults. As children grow up, they become more independent and may require less direct support from their parents, but the investment in their upbringing and education can pay off in the form of greater earning potential and financial stability in adulthood. By investing in their children's development, parents are essentially pre-paying for the future financial assistance their children may provide, whether it be in the form of financial support, caregiving, or other forms of assistance as they age. As people live longer and healthcare costs rise, many elderly parents may find it difficult to support themselves financially.6 In such situations, adult children may step in to provide financial assistance to their parents. This may take the form of regular financial contributions, paying for   healthcare expenses, or providing a place to live. In some cases, adult children may even move back in with their parents to help care for them and provide financial support. For instance, 54% of Americans in their 40s have a living parent age 65 or older and are either raising a child younger than 18 or have an adult child they helped financially in the past year.7 While this can be a difficult and challenging responsibility, many adult children see it as a way to repay their parents for the support and sacrifices they made in raising them. Parents should thus support their children as a way of acknowledging the sacrifices that their children may have to make in the future in providing financial assistance. This may be particularly true if the parents did not adequately prepare for their own financial future or if they made choices that negatively impacted their ability to provide for themselves in old age. Providing one's children with the best possible upbringing can (and should) be seen as paying for the care, support and sacrifices that their children may make (as well as being practical as doing so should encourage children to take better care of parents in the future).

Duty of Intergenerational Reciprocity

Parents have a duty of intergenerational reciprocity for several reasons. First, parents have a biological and emotional connection to their children, creating an obligation to care for them and provide for them to the best of their ability. This responsibility extends beyond the child's infancy and childhood, as parents must also consider the long-term well-being of their children as they grow into adulthood and become parents themselves. Intergenerational

reciprocity also recognizes that parents have benefited from the care and support of their parents and grandparents.[8] This means that parents are morally obligated to pass on this support to their children and future generations. In this way, intergenerational reciprocity ensures that each generation is supported by the previous one, creating a cycle of care and support that is essential for the well-being of society as a whole. Furthermore, parents are responsible for ensuring that their children are equipped with the skills and knowledge necessary to succeed in life. This may include providing education and training, teaching them life skills, and instilling values such as empathy, compassion, and responsibility. By ensuring that their children are prepared for the challenges of the future, parents are contributing to the well-being of society as a whole. Intergenerational reciprocity recognizes the importance of preserving cultural traditions and values. Parents have a responsibility to pass on their cultural heritage to their children, ensuring that these traditions are not lost over time. This helps to maintain cultural diversity and promote understanding and respect between different communities. Additionally, parents have a duty of intergenerational reciprocity because they have a unique and profound responsibility to care for and provide for their children. This responsibility extends beyond simply meeting their children's immediate needs and includes preparing them for the future, passing on cultural traditions and values, and ensuring that they are equipped with the knowledge and skills necessary to succeed in life. Parents have a duty of intergenerational reciprocity because of their biological and emotional connection to their children, their obligation to pass on the support they have received from previous generations, their responsibility to ensure their children are prepared for the future, and their duty to preserve cultural traditions.

Conclusion

The relationship between parents and children is complex and multifaceted, involving a range of moral obligations and responsibilities. Parents have a duty to provide for their children's material and emotional needs, to create a safe and nurturing environment for them, and to prepare them for adulthood. This is important not only for the well-being and happiness of the children but also for the betterment of society as a whole. The concept of intergenerational reciprocity recognizes that parents have a responsibility to care for their children, just as their parents cared for them, and to pass on their cultural heritage and values to future generations. By fulfilling these obligations, parents can ensure that their children have a strong foundation for a successful and fulfilling life, while also contributing to the well-being of society as a whole. It is important to recognize that parenting is not just about perpetuating a bloodline (although this is important) but also about creating a better world for all children, regardless of their background or circumstances, and thereby a better society. Ultimately, parents have a profound responsibility and obligation to their children, and fulfilling this duty is an essential part of what it means to be human.

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Timeless Reflection of Dance and Society in the US, Europe, and Korea By Yeleung Leini Hwang

Abstract

This paper explores the emergence and evolution of dance in the US, Europe, and Korea, focusing on their societal backgrounds, values, and transformations in different time eras. In the early stages, European dance was dominated by men, closely tied to societal events, and celebrated figures from history and mythology. On the other hand, Korean dance was led by women and rooted in Shamanism, expressing positive ideas and reflecting the struggles of lower-class people. Moving into the modern era, European contemporary dance, represented by the Gaga dance company, embraces individualism, politics, and cultural diversity. It emphasizes feminism and confronts white privilege while creating a unique Gaga technique. In Korea, contemporary dance has evolved rapidly, blending Western and local influences, and addressing global values. Notable Korean dancers, like Bora Kim, break boundaries by using water on stage and embracing virtual dance forms. Comparing Europe and Korea, both regions have experienced dynamic changes in dance. While Europe's contemporary dance has deep roots in historical traditions, Korean contemporary dance has quickly evolved, seeking to retain its identity while adapting to global influences. Both regions use dance as a means of expression and communication to reflect societal values, challenges, and transformations.

Keywords: Dance, individual freedom, transformation, society

Introduction

This study employs a comparative approach to analyze the development of dance in Europe and Korea from the early stages to the modern era. The research combines historical analysis and literature review to understand the societal backgrounds that influenced dance in each region. Since dance has stayed close to human life, dance was an ideal tool to be used as a main component while delving into this history of our lives. Primary sources, such as historical treatises and dance performances, are utilized to gain insights into the cultural values and societal perspectives reflected in dance. Additionally, scholarly articles and academic papers on dance history and contemporary dance practices in Europe and Korea are reviewed to comprehend the unique characteristics and importance of dance in both regions.

Crucial findings based on In Europe, dance emerged as a social activity, often celebrating events and representing historical or mythological figures(Ravelhofer, B, 2009). In contrast, Korea saw women-led ritual performances in Shamanism, which expressed positive ideas and emphasized societal identity(Jeno-Kyoung Wook, 2005).

In the Middle era, the late 19th and 20th centuries in Europe and the US were marked by conflicts, economic changes, and the rise of nationalism. Women like Isadora Duncan broke stereotypes and embraced modernism in dance(Kelly, G, A, 1950). While in Korea, Choi Seung Hee modernized traditional dance while preserving Korean culture and identity(David, R,

2015). For the current time era, the European dance company, Gaga, reflects political values, cultural errors, and diverse perspectives, with a focus on feminism and individualism(Quinlan, M, R, 2016). Korean contemporary dance embraces international values, freedom, and creation while maintaining its own cultural identity(Howrk, K, 2013)

Overall, the study highlights the uniqueness and importance of dance in Europe, the US, and Korea, demonstrating how dance reflects and shapes societal values and perspectives throughout history and into the modern era. The comparison provides insights into the cultural, political, and artistic influences that have shaped dance practices in each region, fostering a better understanding of the dynamic relationship between dance and society.

Early Dances–The Emergence of Dance in Europe

Europe has a long dance history compared to any other country in the world. In the early stage of dance, it was more like a social activity than dance itself. People commonly focused on events that dance should celebrate, conduct, mourn, and represent. In theatrical dance, performers actively used diverse costumes and disguises, which mostly represented famous historical and mythological figures or fabulous animals(Ravelhofer, B, 2009). 17th-century Europe was a robust patriotic society. Therefore, men dominated dance, owned dance schools, and choreographed for performers. In this time era, dance was an occupation and gradually made a foundation of economic activity and programs. In the mid-16th century, the concept of dance master appeared(Ravelhofer, B, 2009).

2.1 **Renowned dancers and dance styles based on the societal values**

Since dance was not the sole thing to determine greatness, people who worked in areas that could amplify the effect of dance tended to be more praised. Saint Hubert managed costumes, stage machines, structure, and rehearsal. He dominantly increased the popularity and extended its usage to operas and comedy ballet, which also expanded the music styles of dance in the 17th century(B Ravelhofer, 2006).

In 1642, the treatise of Juan de Esquivel Navarro mentions the dance and its relation with the aristocracy. "The prince, the lord, the well-born, the elegant, and the learned" got interested in dance and delved into dance which led to the development(Ravelhofer, 2009). Aiming for graceful perfection, this makes more sense when dance is a supplement that adds on to the person or society.

Some key performances were the "Pleasure Reconciled to Virtue(1618)" and "The Masque of the Inner Temple and Gray's Inn(1613)"(Ravelhofer, 2006). As time passed, the Stuarts got interested in dance(B Ravelhofer, 2006). They incorporated the plays with dance, which worked as a diplomatic activity between France and Italy(Ravelhofer, 2009; B Ravelhofer, 2006) During the Renaissance and Baroque periods, dance started to reflect societal values. During the Renaissance, there was a return to the ideals and philosophies of Ancient Greco-Roman society(Anderson, K, 2022); they focused mostly on gender and power-related theories(B Ravelhofer, 2006). During this time, women were controlled by their parents from

the day she was born until the day they married, and their marriage just shifted from parents to husband(Ravelhofer, B, 2009). In other words, women were considered to legally belong to their husbands, prevented from performing creativity.

Away from gender roles, the Renaissance was when society was being reformed. A bunch of changes occurred in both the political and economic aspects of Italy and foreshadowed larger transformations for all of Europe(Ravelhofer, B 2009) The rise of strong central governments and an increasingly urban economy, based on commerce rather than agriculture, implied the dynamic changes of dance(Ravelhofer, B, 2013).

2.1 **How the Korean Society and Belief System Stimulated the Emergence of Dance**

Likewise, dance was used as a tool both for society itself and for people breaking boundaries in Korea. However, the religion was different. The Joseon dynasty(1392-1897) was a very important timeline to stabilize public sentiment and secure the sustainability of the new dynasty in the situation immediately after the founding of Joseon. As the new political behavior of the aristocracy expanded under the monarchy, the impact of the Confucian scholars enlarged, and the civil servants got the power to stand against the king, the society was full of ups and downs(OH.K, 2016).

Sexual segregation was prevalent in an extremely patriotic society. However, unlike in Europe where men dominated dance, women-led ritual performances initiated the movement opposed to Confucianism(Jeong Kyung-wook, 2005). Called Shamanism, women did not reflect noble ideas, instead, they supported the identity of human beings(OH.K, 2016). They included positive ideas of luck, peace, and wealth, and expressed themselves with dancing and singing. This movement is even more notable because the lower class people, who suffered from poverty and violence, were the majority(OH.K, 2016).

Reflecting a daily life, Shamanism did not have a strict scripture or generalization to follow. However, the basic idea was virtues like love, mercy, wisdom, justice, freedom, and mortality(Jeong Kyung-wook, 2005). This event, particularly the dance style called 'GUT', exploded the misfortune and called for happiness, wealth, and longevity for family members(Jeong Kyung-wook, 2005). By wearing different clothes in various colors and forms, women performed rituals that follow the ecstasy of the vigorous rhythm of the drum(OH.K, 2016; Jeong Kyung-wook, 2005).

2.3.2 Another Type of Dance That related to the society of the Joseon Dynasty

Another popular dance that acted as an early European dance was the mask dance, which was usually danced at public festivals and national holidays. Including certain dramatic qualities, the dance was based on poems, theatrical qualities, and folk drama that were widely enjoyed and transmitted among private groups(Jeong Kyung-wook, 2005). The performers satirized the problems of society, kings, and monks, which aimed to humiliate Buddhism that enlarged the gap between gender and social status(Jeong Kyung-wook, 2005). Dancers used costumes of rural villages and prayed for bountiful harvests, masks representing gods and men,

a vestige of the transition from an exorcism for settling the conflict with nature to art for expression of social conflict. It represents fierce criticism of hypocrisy such as class discrimination and male violence(OH, K, 2016).

Compared to 'GUT," men were the main dancers of the mask dance(OH, K, 2016). Covering their faces with a big mask, dancers hoped for peace and a rich harvest, expelling evil spirits. Rice was the most important thing to the Koreans(OH, K, 2016; Jeong Kyung-wook, 2005). Farmers had to pay a lot of attention to the very complicated process required by laborers. Since this harvest started from early spring to late fall or early winter, farmers had to rely on the harvest to survive the whole year(Jeong Kyung-wook, 2005).

4 Comparisons Between European and Korean Dance

The starkly different point between European and Korean dance at the early stage of dance is the main protagonist of dance. Eventhough the two regions both formed man-dominated societies, dance did not follow this pattern in Korea. However, the Europeans maintained a patriotic society. Consequently, this led to differences in dance styles, perspectives, and ideals.

While focusing on everyday life themes, Europe used dance as a tool for one country. This includes diplomatic, religious, and enjoyable dance. Moreover, the dance could earn popularity as the aristocracy and the rich people paid attention to it. In contrast, Korea carried on the style as the dance initiated. Women, as main dancers, expressed themselves using dance as a tool. Mostly celebrating their life and asking for their rights, women in Korea danced for their rights.

Middle–The Societal Background and Various Ideas of Europe and the US Until the 20th Century

The late 19th century and 20th century were a time of conflicts and confusion. WWI(1914-1918) produced economic changes, the transformation of the economic system from agriculture to factories, the growth of corporations, and changes in the business system(Kelly, G.A, 1950). Consequently, the Cold War and globalization created chaos even more. America strived to strengthen its own national identity(Kelly, G.A, 1950). Individuals determined the spread of the naturalization of US ideology and emphasized the importance of freedom and individual identity(Kelly, G.A, 1950). The country suddenly accumulated wealth through industrialization and urbanization at great speed. However, this could not always be positive as the nation had to face another challenge: the sudden flux of immigrants, the transition of culture, and the change in politics(Kelly, G.A, 1950).

Changes in Political and Social System

While democracy spread in the US, they had to take care of the regulation of communism as well. Progressivism was the emerging idealism in the early 20th century(Kelly, G.A, 1950). It was a response to the changes in the society and politics of the Gilded Age when

the great burst of industrial activity and corporate growth formed(Kelly, G.A, 1950). Since the rich grow richer and the poor become poorer, the Progressives passed legislation to regulate big business and corruption, free the government from special interests, and protect the rights of consumers, workers, immigrants, and the poor(Kelly, G.A, 1950).

Moreover, Progressivism led conservative activities that wanted to regain the old American ideals of morality. Darwinism, which was one of the prevalent beliefs, argued that people should be divided based on race, sex, and very subtle things(Kelly, G.A, 1950). One evident class division was sex. The Victorian ideals confined women and their roles in the household and society. This led to the new term feminism. Mainly hoping for women's emancipation, the modernists supported the feminists who had a mutual understanding: the modernist quest for wholeness(Kelly, G.A, 1950). Even though this idea was not embraced and even the modernists were concerned if new ideals could contract some aspects of society, it was widespread(Kelly, G.A, 1950).

How the Dancers Reflected the Society and Transformed Dance

Dance expanded one's identity. Not only as a festival dance of supportive things to the main events, dance became the main event. Moreover, the society that was rapidly changing affected dance to change dynamically(Manning, S., & Daly, A., 1997).
Isadora Duncan used the body as America's social, cultural, and political life. Living in the era of dynamics, she had to strive and struggle for human will. For her, dance was the place where women, nation, culture, identity, moral values, and race could be ignored. Using the body as a verbal deception, she expressed the dynamics occurring in society. She moreover expanded the range of dance. From moving bodies based on concepts of society, she danced about mathematics, science-the rising topic due to the Cold War(Francis, E., 1994). This abstract dance style was called 'modern dance.' The impact of the external and internal world affecting dance enlarged((Francis, E., 1994).

As a woman dancer living in the Victorian time era, her biggest ideal was to break the stereotype of women(Rudnick, L., & Daly, A. 1996). Identifying herself as one person instead of one woman, she broke her given sex, defining herself as one identity. She ripped off all the 'corsets and let herself go(Bradley, P. 2009).' Pursuing freedom, Duncan changed a woman's rights in the artistic process. Duncan as an artist and a woman as a modernist, her career reveals both the connections and the tensions between feminism and modernism in the early twentieth century(Rudnick, L., & Daly, A. 1996).

Isadora Duncan's choreography and details about her representative characteristic
Her solo 'La Marseillaise' was performed during WWI in France and the United States(Bradley, P. 2009). Mainly demonstrating the struggles of the maternal figure, she performed a few weeks before the US entered the war, exaggerating the chaotic society of modern war and invoking nationalism(Bradley, P. 2009). This was very influential as Conservative nationalists responded and came up with solutions.

Her costume represented her ideals. Costumes that had constituted a huge part of dance

were transformed into short and light leotards. In order to stay away from the norm, she decided to dance barefoot, showing her natural beauty. From the early dances that magnified the surroundings, Duncan avoided the commonplace of the stage and made a breakthrough(Francis, E. 1994).

Societal Background of Late Joseon Dynasty and Its Impact on New Dance

As traditional dancing had been standardized very early, the Koreans had difficulty creating new types of dance. However as people entered the 20th century, they realized that traditional dance could not follow the transformation of society, ideals, and perspectives of the society(Lee, S. K, 2011). Besides the maintenance of strict social regulation, people strived to overcome the restriction through dance.

During the late Joseon Kingdom, Korea was ruled by Japanese colony ruling parties. This caused the extreme regulation of artistic and social relations(Lee, S. K, 2011). People wanted to modernize the premodern society that could point out problems of the society. However, the power of the Japanese government to destroy the spirit of Korea was more dominant(Lee, S. K, 2011). Including the identity, history, perspective, policies, and laws, the Japanese governors smashed the identity of the Koreans and assimilated the Koreans into the Japanese empire. Soon, the Japanese occupation and annexation demoralized the Koreans over the loss of the emperor, the native ruling class, the army, and sovereignty, by using violence and brainwashing between 1910 and 1945(David, R, 2015). In contrast, the spirit of resistance of the Korean people increased. Rather than directly engaging in political activities, people found diverse ways to stand against Japan. Dance was one of these resistance movements(David, R, 2015).

Important Values and Social Circumstances that Emerged and Their Impact of Nationalism began and earned popularity in the late nineteenth century. The aim was to keep Korea culturally and ethnically distinct from China and Japan after repeated invasion attempts by both neighboring countries(Lee, S. K, 2011). The movement even gained more attention when the Japanese invaded and annexed Korea in 1910 and continued throughout the 35-year Japanese rule(Lee, S. K, 2011. Korean Nationalist movements continued after the liberation from Japan following WWII and the Korean War, the division of the country, and the change of the focus of the movements from protecting Korea from any external invasion to attempting to reunify the nation(Lee, S. K, 2011; David, R, 2015).

At the end of the 20th century, South Korea's economic boom started as the government began to focus on globalization. The whole nation focused on globalization while maintaining its own identity(Kim, J, 2018). Maintaining "our country" the Koreans sought a distinctive and unique Korean culture. However, this brought societal issues. The Koreans faced tension that includes a modern identity that is becoming increasingly homogenized and a clear Korean identity(Kim, J, 2018). This dual identity was shown in dance. The policies that developed in the late 20th century and early 21st century have impacted current efforts to be both unique and modern.

Korean Dancers Who Reflected the Societal Ideals Through Dance

Inspired to combine Western interpretive dance with Korean traditional dance, 'Choi Seung Hee' created a dance that was different from early dance while retaining a similar value. She initially had to deal with problems of lack of Korean identity as she danced during the Japanese occupation(Kim, J, 2018). To spread her thoughts and choreograph based on the ideas of the Koreans, she spent time decreasing the gaps and missing details in the dance(Choe, S, 1996)

Working as a society activist, she focused on producing work of an artistic revolt against the conservative tradition in Korean dance(Choe, S, 1996). She created 'New Dance' by modernizing Korean dance into a more expressive and universal method of communication. Even though many people criticized her work as it seemed to destroy and modernize traditional dance, she maintained the Korean culture(Kim, A. 2018). Just to gain wider support for dance, she used 'selective modernism' by incorporating modern values into early dance.

Her costumes intensified her breakthroughs. Choi Seung Hee's dance costumes were neutral and emphasized the image of the dance movement itself(Kim, J, 2018). Her biggest transformation of the dance costumes was the weight of costumes. Changing from heavy, long dress dance costumes to light, short costumes, she could show what dance is.

Comparison between Europe and Korea

Western countries and Korea each experienced significant changes during the 20th century. In Europe, there were conflicts and confusion including WWI, affected by Darwinism, Progressivism, and Gilded Age. In the US, there was a transformation from an agrarian to an industrial economy, and the Cold War was accompanied by the rise of corporations and mass production. In contrast, Korea experienced Japanese colonial rule during the early 20th century, leading to extreme regulation of artistic and social relations internally, which made the Koreans suffer from suppression, loss of identity, and a struggle for independence.

The diversity of each region affected dance accordingly. This period of turmoil influenced Korean dance; dancers aimed to modernize Korean dance and spread their thoughts while preserving Korean identity. Combined with efforts to maintain a distinctive Korean culture amid modernization, the dance transformed. The US saw the expansion of dance as a main event rather than just a supporting act. Trying to break away from Victorian ideals and advocating for freedom and personal expression, dance truly modernized society. The combination and collaboration increased due to embracing modernism and incorporating Western elements.

4. Modern–Contemporary Europe and Dance Companies who express societal opinions

Contemporary dance transformed rapidly and dynamically in the modern era. The aspects of dance drawn on procedural, and implicit became the dance that intentionally communicated and expressed feelings, personal experiences, and creativity. The ideals of individual dancers became more prominent. As dancers earned more freedom, they actively demonstrated societal values(Burt, R. 2019). In Europe, the Gaga dance reflects this ideal of

society. Gaga considers political values, current cultural errors, and diverse perspectives. One of the ideas they care about is feminism(Quinlan, M. R, 2016). Rather than looking for an answer as in previous dance genres, Gaga dancers show their understanding from their perspectives. By acknowledging their positions and understanding their responsibilities, dancers influence society regarding their positions(Quinlan, M, 2017). Considering feminism as a complex, multiple, and contradictory idea, Gaga dancers represent the conflicts of external and internal forces(Quinlan, M, 2017).

How Gaga Dancers Express the Idea of Modernism through Dance

The Gaga Dance Company stands as the foundation of modern dance in Europe. After the establishment of the State of Israel and the support from the United States, concert dance was initiated in Israel(Quinlan, M. R, 2016). Affected by American modern dance, folk dance, and concert dance, the German culture that was not influential due to the Holocaust became widely influential(Quinlan, M. R, 2016; Quinlan, M. 2017). Another factor was the wave of immigration to Israel as the cultural exchange actively happened. Baroness Batsheva de Rothschild started the company based on this involvement in dance. As a leader of the Israel concert dance, he brought European and American dance techniques such as Graham Technique, pilates, and ballet. Based on these ideas, he spread the universality of the human experience that can transcend 'aesthetics, politics, and cultural specificity'(Brooks, L. M., & Meglin, J. A, 2015). He, moreover, incorporated concert dance techniques that impacted Western Europe and added his aesthetic and personal histories in terms of art form.

Correlation between Dance, Politics, and Religion

Gaga Dance Company focuses on politics. Rather than thinking of dance as a singular movement that tries to enact one specific message, they perform dances to deliver the meaning and identity of certain effects and consequences of politics(Quinlan, M. R, 2016). Currently, dancers view the cultural politics of globalization and the role of nations and their cultural exports in the global marketplace(Meglin, J. A, 2015). Initially, the dancers tried different experiments in dance styles by blending Middle Eastern and Western European influences. Incorporating Israel's religious practices and biblical stories of Western Europe, the Gaga dancers showed the cultural mixture and historical view of union(Meglin, J. A, 2015). While dance was a minor event in early European society, dance in the modern era became a more main and important event(Meglin, J. A, 2015). Strengthening the ties and influencing people about the importance of historical, religious, and political values.

Gaga Dance company is related to Jewish communities across the country. Actively participating in educational and cultural exchanges for Israeli artists and academics, Jewish is an important part of the Gaga dance company(Quinlan, M. R, 2016). Mainly supporting and pointing out the current status of Jews in Israel, the company reveals the truth through movements(Quinlan, M. R, 2016).

This style of proactive and aggressive dance sometimes involves boycotting debate and how people should engage with Israeli art, especially reading about the surroundings, politics, and the efficacy of their position as a tool for social and political change. Despite some dangers and negative feedback, Gaga company innovates the dance and keeps removing useless limitations(Brooks, L. M., & Meglin, J. A, 2015). Using dance as language, they work as cultural and political influencers.

Unique Characteristics of Gaga Dance Company

Gaga's dance company made their own technique, called the Gaga technique. Primarily focused on the technique that allows dancers to excel in multiple styles, choreographers create new dance techniques to satisfy their goals to let dancers require a new kind of body that would be competent at many styles(Badar, A,2016). Adding on to this, a myriad of styles and meta techniques help dancers work with distinctive styles and combat the blandness that can occur in many dance singular styles.

Gaga dancers confront the idea of white privilege of the early American modernists. Since this is still frequent in dance practices, Gaga appeals to individualism and the rights of modernists(Brooks, L. M., & Meglin, J. A, 2015). They allow dancers to pursue distinct goals and the history of their world. This equality is an important step to consider as they experience St. Denis's brand of cultural colonialism(Brooks, L. M., & Meglin, J. A, 2015; Badar, A, 2016). Her whiteness and her cultural and societal status allowed her to be privileged and explore her spirit and tradition in an easier way(Badar, A, 2016). Considering each dancer as a unique individual, the Gaga Dance Company raises racial messages in the culture.

Korean Dance in Modern Society and Transformation of Dance Styles

Entering the 21st century, Korean society paved the way for modern contemporary dance. Korea opened the door and tried new approaches to culture. The modern dance society realized the necessity of a creative direction through dance. Asking themselves, the Koreans were affected by external sources(Lee, S. K., 2016). The expressionism of Germany, for example, allied Korea observes the theoretical backgrounds of dance and how it reflects the society and transforms accordingly(SungJae, J.2015). Expressionism was the resistant trend of the artistic movement in Germany(SungJae.J, 2015). The dancing resisted the formal techniques and the fixed thoughts; they insisted on the liberation from the forms. In other words, dance accepts every form of art form even if they are without dance. (Lee, S. K., 2016)

Behind the development of Korean contemporary dance, there are changes in public support such as increased discovery and development programs and distribution support. Unlike the late 20th century, when large-scale works were mainly centered, small-scale activities of independent dancers as artists are prevalent(Ishani, G, 2022). They do not need to be conscious of their affiliated organizations or associations, so they can create works themselves that reflect their values or what they want to value. Smartly responding got the attention of contemporary audiences, and what is requested in the application, and what can attract interest in Korea and

overseas became more crucial(Ishani, G, 2022).

The tendency of these worlds is increasingly focused on rarity and public affinity to secure competitiveness. To survive, dancers must be different and understood or relatable by the public. Among the physicality and intelligence cultivated through early education is making Korean contemporary dance better(Ishani, G, 2022). Regarding diversity, dancers pursue conceptual and experimental performances, and they simultaneously pursue artist-pure movements(Ishani, G, 2022).

How Korea Extends the Value of Dance

Currently, Koreans value international relationships via dance. The direction of dance is focused on international values(Howard, K. 2013). They add on freedom and creation based on the contemporary spirit, the two forces that sustain the value of dance. Even though the timeline in Korea accepted contemporary dance is much later than European or American countries, Korea is trying to demolish the barriers of the world and many choreographers have experiences working as instructors abroad(Howard, K. 2013).

In the past, Korea's contemporary dance had no choice but to pay attention to Western dance as an important country. However, Korea's modern dance produced Korean own contemporary dance that had not been seen on the world stage at a relatively rapid pace and achieved drawing acclaim from the dance world(Howard, K. 2013). Working as a universal nonverbal means, dance is perceived as the work of giving creativity, collaboration, and appreciation(Howard, K. 2013).

Specific Dancers Who Correspond to the Societal Changes

Different settings of dance emerged. "Somu" by Art Project Bora breaks the boundary of dance that dancers should dance on a stage. The stage is filled with water. Emphasizing the image and touch of water, it affirms women's bodies and explores gender roles(In a new time, 2023). The presence of men paces them within the feminine interior. The water approached with fear and dreariness due to bluish lighting and sparsely located dancers delivering a vivid sense of feeling(In a new time, 2023). The screen on the back is used as a graphical representation of the waves caused by the water, and a round wave spreads throughout the theater space(Dancepostkorea, 2023). The spreading feminine image and grotesque sound on the stage reflects the image of women in society who try to break the norms(Dancepost, 2023).

The dance itself breaks the boundary. Bora Kim developed the application to meet the audience in the virtual world during the Covid-19 pandemic(In a new time, 2023). In addition, she constructed nonface to face dance videos as a dance film. By adapting to new changes in society, many dancers are trying to show what dance means to society and how dance can view society(Dancepost, 2023).

Comparison between Europe and Korean dance

In Europe, contemporary dance has transformed rapidly, embracing intentional

communication of feelings, personal experiences, emotions, and creativity. Starting from political values to diverse perspectives, dancers created a blend of cultural influences and historical viewpoints. Similarly, in Korea, contemporary dance has undergone significant changes in the 21st century. The country has explored new creative directions and embraced external influences. Both in Europe and Korea, contemporary dance has become a platform to address societal values and challenges. They resemble the point that they both broke traditional boundaries in response to the status quo. Despite these commonalities, there are still distinctive characteristics that set each region's contemporary dance apart. Europe still has a rich heritage that continues to influence modern dance forms. Likewise, the US has its unique dance traditions, with influential choreographers and dance companies. Meanwhile, Korea has developed a contemporary dance scene that incorporates both Western influences and its cultural expressions, embracing diversity and experimentation.

Conclusion & Limitations

The emergence and evolution of dance in Europe and Korea have been shaped by their respective societal values, political climates, and cultural backgrounds. Even though dance cannot be specifically told the exact time of emergence and provide very precise things of dance, this paper overall suggests the timely development according to society. Moreover, the article primarily focuses on dance developments in the US, Europe, and Korea, which leaves out other crucial dance cultures and regions around the world. Including a broader global perspective could provide a more comprehensive understanding of dance's evolution and impact on societies. Both European and Korean contemporary dance scenes share a common thread of embracing change, breaking boundaries, and using dance as a powerful tool for expression and communication. However, they also have their distinctive characteristics shaped by their unique historical, cultural, and political contexts.

Overall, the emergence and transformation of dance in Europe and Korea reflect the societies' values, struggles, and aspirations. As dance continues to evolve in the modern world, it remains a powerful medium for expressing individuality, advocating for change, and embracing diversity. It is an art form that transcends borders and communicates the shared human experience across different cultures and nations. Whether in Europe or Korea, dance remains a vital and ever-evolving expression of the human spirit.

As dance developed together as society changed for a long time, I believe dance would go further to play a more important role in society. Being more inclusive and diverse, dance would make a huge step when people widely accept the diversity in culture, identities, and experiences. Embracing the richness of human diversity would be the only way to break away from traditional norms. Moreover, dancers should keep a strong role in social and political commentary. Dance, serving as a medium for expressing social and political commentary, should address ongoing conflicts in the world. Lastly, as a tool, dance should connect cultures to create unique and multicultural performances. Intersecting with other art forms, dancers would likely blur the boundary of different art forms. However, the most important value of

dance is encouraging individuality and authenticity. If dance keeps developing in response to the changing dynamics of society, the future of dance is likely to be innovative and im

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Is Latin Truly a "Dead" Language By Shiv Sibal

Whenever you hear about Latin, you probably envision a language once extremely popular, but now with hardly any speakers. You likely have heard the term dead language associated with Latin. That is simply not the case. Although there are very few fluent speakers of the language, Latin is alive and well in the culture of billions of people. It impacts the languages we speak, the companies we buy products from, the universities that educate us, the law that governs many nations, and the names of many animals and diseases in the scientific world. Latin originally was spoken by the people of the lower Tiber region, which is located in Italy. The people that spoke it were called the Latins and they lived in a city called Latium, in Central Italy. It started as just a language spoken by a small group of people but eventually was the dominating language of the region, leading to its use by the Romans. The earliest confirmed time in which Latin was spoken goes back to the 6th Century B.C.E, which is around 2600 years ago from now. Like many other languages, Latin took on different forms and had variants from region to region. Classical Latin was a literary and formal variant, having been used by famous people like Julius Caesar and Cicero. Caesar was a famous Roman ruler and Cicero was also very powerful politically, although he opposed Caesar. Vulgar Latin was the spoken and informal variant, typically used in everyday conversation and which had slight changes from place to place. People primarily think that the history of Latin is confined to just the Romans when in reality its cultural impact went far beyond the now-distant civilization.

Although Latin is relevant in areas outside that of the Romans, it became a notable language because of the Roman Republic and the Roman Empire. Because of its proximity to Rome, It was adopted as the language of the Roman Republic and subsequently the Roman Empire and continued to rise in prominence as the Romans gained power and influence throughout the globe. Because of Rome's vast Empire, the language spread not only throughout Europe but to many places in Africa and Asia. Latin was used inside Rome through administration and law. Official documents of any kind were always written in Latin and it was expected of anyone who worked inside the bureaucracy for them to be fluent in Latin. Without proficiency in the language, they would be unable to read important documents and it would be impossible for them to do their job. Additionally, literature was mainly written in Latin. Famous writers such as Virgil, Cicero, Ovid, Horace, and Tacitus wrote many of their works in the Latin language. These names are probably very familiar if you have ever explored classics and the famous literature within them. Additionally, Latin was taught to Roman children. It was considered a core subject, similar to how we consider English a core subject in the United States of America. Proficiency in Latin was valued highly as it helped build a foundation so that students could understand other advanced topics, such as philosophy. The Roman education system was much less advanced than our current one today as there were hardly any public schools. Only the wealthy could afford a tutor or send their children to an expensive private school. The rest of the population was just trying to make ends meet on their farms. Because of this, a large portion of the population was illiterate, meaning that they would not see the

importance of Latin in their lifetime. Latin was commonly used during speeches. Public speaking was a highly prized skill because the ability to convince people that you are right allows people in positions of authority to change policies, similar to how we have a presidential debate. The Roman military extensively used Latin in all of their operations. Commands were often issued in Latin by military generals to the soldiers. Latin was also often used in everyday communication. The elite used a more refined type of Latin called Classical Latin, while others used Vulgar Latin, which ended up evolving into the Romance Languages we know and commonly use today. When the Roman Empire collapsed and the Byzantine Empire took its place, Latin's dominance in the region started to falter. It was still used in the Byzantine Empire but Greek became the language of choice for many in the Empire. Latin reached its peak during the height of the Roman Empire and started to become less influential as time went on. During the Renaissance, which started in the 14th century and went into the 17th century, there was a renewed interest in classical literature and Latin as a whole. Humanists(people who embrace human-centered values) wanted to revive the knowledge and culture of ancient Rome and Greece. As a result of this, a lot of people in the upper class were well-versed in Latin through writing and speaking. Famous figures of the Renaissance like Thomas More and Erasmus wrote many of their works in Latin. If you have taken an AP social studies class, you probably would have come across at least one of those two names. Erasmus' most famous work was "Praise of Folly." This piece of literature was satirical. It was criticizing certain parts of society at the time, such as the Catholic Church. He hoped to avoid persecution by making fun of the Church in a subtle manner. Since the Catholic Church was the most powerful part of society at the time, people weren't allowed to openly criticize it without facing any severe consequences. His criticism of the Church was not unreasonable. The Church practiced nepotism in an extreme manner. Only very powerful people were ever given positions. They also had a system of indulgences, where the church would forgive you of your sins if you paid a sum of money. Thomas More was also very influential. His most famous piece was "Utopia." The word utopia means an ideal society. Thomas More contrasted a perfect society with the society of his day to highlight the many problems that plagued it. Both Erasmus and Thomas More were promoters of humanism. Their works and ideas had a substantial influence on future generations, shaping the course of European intellectual history. Despite Latin's status as a language of ancient times, it retains much of its value to modern society.

Although Latin's influence on the world may not be readily apparent, it is most easily seen through the Romance languages. Now what are the Romance languages? The Romance languages are languages that came from Latin. Spanish, Portuguese, French, Italian, and Romanian are all examples of Romance languages, though there are many more. Billions of people speak these Romance languages that all are derived from Latin.

Among all of the Romance languages, Spanish stands out as by far the most popular. There are 486 million people in the world who speak Spanish as their native language. This means that it has the second most number of native speakers, only beaten by Mandarin which has over 900 million speakers. This makes sense because China is the second most populous

country in the entire world with well over a billion inhabitants. The United States of America alone has a large Spanish-speaking population, with 41.7 million people speaking Spanish as their first language and an additional 15 million speaking it as their second language. The U.S. has the second largest population of Spanish speakers, only bested by Mexico. This makes sense because around 92% of Mexico monolingually speaks Spanish while an additional 5% percent speak Spanish in another language. Nonetheless, Spanish is primarily spoken in the Americas. 60% of Latin America speaks Spanish. Not many people speak Spanish in Europe as a whole despite its origins being in Spain. Spain has the third largest number of Spanish speakers with 46.6 million, having recently been taken over by the United States of America. Spanish is also widely spoken by former colonies of Spain. An example of this is in the Philippines. 3 million Filipinos speak Spanish or a language derived from it, called Chavacano. A few countries in Africa also have large Spanish-speaking populations. 68% of Equatorial Guinea speaks Spanish.

Portuguese is also a very popular Romance language. It has the second most native speakers out of all the Romance languages, only edged out by Spanish, as I mentioned above. Similar to Spain, Portugal was a colonial powerhouse. They were able to obtain numerous colonies, allowing them to acquire great wealth through trade. Despite all their former holdings having been granted freedom over the years, they maintained a cultural bond with their mother country. Many of these countries, like Brazil, still speak Portuguese, which is one of the main reasons it maintains importance in the world because around 200 million people in Brazil speak it. Brazilian Portuguese and European Portuguese have some minute differences but maintain almost the same structure and words.

French has a lot of major similarities to both Portuguese and Spanish. France had numerous colonies across a lot of the continents in the world. They used to hold significant parts of North America and had a major influence on African culture. France used to be the official language of over 25 countries. In France and Corsica, 60 million people spoke it as their primary language. In Canada, around 7 million people speak French. This is because Canada used to be under French control until they ceded most of their territories there after the 7 years of war. More than 49 million Africans speak French because France used to be in control of their countries. France is slowly starting to lose the influence it had on its former colonies. Many former African colonies have tried to move away from the sphere of FRance's influence, which is hurting France because they are losing potential allies.

Romance languages may be the most influential group of languages in the entire world. I only had the chance to list three of the most important ones but there are plenty more with similar levels of popularity across the globe. The reason that these particular languages became so widespread is because of their mother countries' former imperial and colonial past. Regardless, without their mother language of Latin, these languages would not have developed in the way many of us know them today. We have Latin to thank for the unique structure and many of the words of these languages.

Even today, we could still see the influence Latin has, especially in numerous medical and scientific discoveries. While English is often seen as the language of discovery today, Latin used to hold that position long before. Latin's historical significance in these fields has left a lasting impact on the terminology used in both fields, including through the naming of diseases and living organisms.

One of the main reasons Latin is seen in the medical field today is once again because of the ancient Romans. The Ancient Romans were very advanced in terms of medicine for their time. Despite the Romans' seemingly primitive knowledge of the medical field, they laid the groundwork for medical exploration. They first started to realize the need for medicine because of the many wars they participated in and the soldiers that got hurt. They needed to find ways to prolong the lives of their soldiers so their army could maintain its strength through its numbers. The abilities of Roman doctors were often tested on the battlefield. They kept kits containing arrow extractors, catheters, scalpels, and forceps with them so they could quickly tend to injured soldiers. They used acid vinegar to clean up wounds and opium and scopolamine to relieve pain. Despite the benefits of these medical innovations, they were often not encouraged in Roman society. The Romans valued strength and often looked down upon these remedies thinking it was only for the weak. That's why the English word infirmary, which means a hospital, comes from the Latin word infirmus, meaning weak. From this, it is safe to infer that the Romans thought frail people needed hospitals but true warriors would fight through their pain for their country. Fortunately, we have outgrown this way of thinking through the years.

If you were to enter medical school, it may help to know some Latin roots. Many diseases are named after Latin words. Knowing Latin may even help you understand what body parts are affected by the condition or what the condition does to a patient's body. There are hundreds of examples of conditions that come from Latin words but I am just going to list some of the more prominent ones. The first one is influenza. It comes from the Latin word influentia which means influence or attack. They used to believe that this disease was brought by the Gods. This was very common back then as they did not have the scientific technology we have today. They had no way of knowing where the disease came from so they used the gods to explain the unexplainable. Now we know that influenza is a type of flu, which commonly affects our respiratory system. It originates in animals but spreads during flu season, which is why doctors commonly advocate for their patients to take the vaccine.

Dementia is derived from the Latin word dementia with a macron on the e, meaning madness or insanity. This definition makes sense seeing dementia as a neurological condition that affects the brain. Back then, people did not know what happens to the human brain over time so they attributed it to mental illness. It took us a very long time to learn about dementia and we still are trying to get a better understanding of its causes as we try to create pharmaceutical cures for the condition. Dementia typically involves memory loss but could also affect thinking skills and social cues.

Hypertension comes from the prefix hyper and the Latin word tension. Hyper means excessive and tension means tension. The synthesis of these two words pretty accurately describes the

condition. Hypertension usually happens because of high blood pressure. The force of the blood pushing against the artery walls is consistently too powerful, which puts stress on the heart because it has to work harder to pump the blood. Long-term hypertension could cause the arteries to start to shrink, leading to the body not getting enough oxygen. This is extremely dangerous and commonly results in death.

In the scientific world, Latin remains prevalent. This is because many animals are named after Latin words. Look no further than everyone's favorite household pet: dogs. The term "canine" comes from the Latin word "canis", meaning dog. Dogs are part of the Canidae family, which also comes from the word canis. Similarly, many people think the English word cat comes from the Latin word cattus meaning cat. We don't know this for sure because it may have come from a Greek word meaning cat. There is a lot of ambiguity surrounding where many words were derived from. If we look at the age of the dinosaurs, we similarly will see creatures whose names were derived from Latin words. The king of the dinosaurs, the Tyrannosaurus Rex, is named from the two words Tyrannosaurus and Rex. Rex means king in Latin and Tyrannosaurus means tyrant lizard. The exact translation would be the Tyrant Lizard King but that doesn't have the same dramatic effect as the name T Rex. On a side note, the term "Rex" was given a negative connotation in Latin because they did not have a good experience with kings. Tarquinius Superbus was the last king and they often called him a tyrant king which isn't very far from the T Rex's designation. Moving on, the Asian Elephant is named after the term Elephas Maximus. Elephas, as we can imagine, means Elephant, and Maximus means the greatest or the biggest. This can be misleading as the Asian Elephant isn't the biggest type of Elephant but is the second biggest, so perhaps they could have used a better term. It is still the biggest animal in Asia, which is the largest continent in the world. The Sri Lankan elephant is one of the biggest types of Asian Elephants, almost reaching twelve thousand pounds. That's a lot especially compared to a human being, but just a bit less than a Tyrannosaurus Rex, which could get to fifteen thousand pounds. The great white shark is another ferocious predator named from Latin roots. It came from the words Carcharodon carcharias. Carcharodon means shark and carcharias means sharp or jagged, which describes the nature of their teeth.

Latin is not only useful when studying science or medicine. It is also very useful when it comes to studying law. We have based our system of government on that of the Roman Republic. If you live in the U.S.A, you probably have heard the term "Republic" come up very often. A republic is by definition a system of government where power rests in the hands of the public and the people that represent the public. That must sound familiar because that directly describes our system of government today. Despite the major similarities between the Roman Republic and our Republic today, Republics have evolved a lot since then. Back in the time of the Romans, only rich white males had a say in the government. It was a lot more exclusive meaning it wasn't a Republic because the vast majority of the population had no say over what happened in Rome. Here everybody above the age of 18 has the opportunity to vote and make a difference in whatever small or big way they can.

A lot of technical law terms come from Latin. For example, If you study law, you probably have heard the term subpoena. This term means under penalty. It is an order that forces someone to either appear in court or produce documents relevant to their case. This is one of the most common legal terms used today because of the many circumstances it could potentially be used. In Ancient Rome, the words sub and poena were written at the bottom of a legal order. If one didn't comply with the order, they would be subjected to penalties. This would still happen today because ignoring a subpoena may result in criminal consequences, such as a fine or jail time. Sometimes they may refer to it as a subpoena duces tecum. The term Pro Bono also comes up a lot in courts. This means for the public good and is typically when a person gets assigned a lawyer for no charge because they can't afford one. In the U.S.A., everyone is entitled to a lawyer in a criminal case to make sure people aren't imprisoned for crimes they didn't commit. The problem with this is public defenders don't get paid very much because they work on a government salary. This means that the worst or least experienced lawyers are public defenders because they make the least amount of money, resulting in poorer people getting worse legal representation than richer people. This is why it is common for poorer people to get much more severe sentences than richer people for the same crimes. Another phrase that you may or may not have heard is nolo contendere, meaning I do not wish to contend. This phrase is a plea commonly used by defendants, today known as pleading no contest. It means that you are not admitting guilt in the case but you are saying that whatever is alleged is true. This prevents a prosecutor from using that plea against you in a later trial. It also opens up further appeals to the court. Seeing as it is one of the four main types of appeals a defendant could plead to, it is extremely important to the legal system, although it can be difficult to understand.

Latin has had a major impact on legal terminology but it also has had a major impact on our legal system as a whole. The trials in ancient Rome were quite similar to the trials we have today. They had a system of separation of powers so that no person would be able to affect a case that much. A Roman trial started with an accusation brought by a private or public official. The accuser must state the charges and the evidence supporting their claims. Next came the preliminary investigation. A magistrate would determine if there was sufficient evidence to move on with the case. Pre-trial procedures remain in place today so that one can't just accuse someone of a crime without any evidence. The Trial would take place at the Roman Forum and either one judge or a panel of judges would be listening to the evidence to determine whether the accused was guilty. The accused would not be judged by a jury of their peers like they would today.

Without Latin, we would not be able to learn much about ancient civilizations, such as that of Rome. Most Roman records were kept in Latin so it has been and continues to be very useful in translating old records and scriptures. For example, when wealthy Romans died, they were given a tomb to be buried in. The grander the tomb, the wealthier they were. The poor often couldn't afford a tomb so they were buried in pits full of other human and animal carcasses. The inscriptions on the tomb tell us who they were. If you were famous enough, you may even have a temple in your honor, as Julius Caesar did.

Latin literature is still prominent today, despite being written hundreds of years ago. Vergil wrote the epic poem "The Aeneid" which is one of the most famous pieces of Latin literature ever. Vergil narrates the spectacular story of Aeneas, who becomes the ancestor of the Romans. His journey begins in Troy, where despite being a hero, he is forced to flee the ruins of the once-great city. He knew that all efforts to resist the Greeks would be in vain and that he must move on. He is met with lots of adversity as he no longer has a place he could call home. As he searches for a new place to settle, he survives storms and supernatural entities. Finally, things start to look up for him when he arrives in Carthage and meets Queen Dido. Despite falling in love, he is ordered by Jupiter to move on, leaving Dido heartbroken. His next journey is his hardest yet as he goes to a place few come back from The Underworld. Guided by the Sibyl of Cumae, he meets his father, Anchises. His father tells him of all the achievements Rome will have in the future. With this information in mind, Aeneas travels to Italy and finally fulfills his destiny. This story is still being told in many classics classes throughout the world today. Many life lessons could be learned through this story which is one of the reasons it remains so popular. If you are interested in learning more about this particular story, feel free to watch some youtube videos that go in more depth than I did here or you can read it. Another famous person who was very influential in terms of literature was Cicero. His full name was Marcus Tullius Cicero. Cicero was a famous Roman statesman, lawyer, philosopher, and orator of Ancient Rome. His public speaking abilities were very good, enabling him to convince others of the merit of his ideas. He was born wealthy, leading to him receiving a very good education. He rose through the politics of Ancient Rome, even rising to the ranks of praetor and consul. He was avidly against corruption in the government, which is best seen through the Catiline Conspiracy. The Catiline Conspiracy was a conspiracy to overthrow the Roman Republic. His fiery speeches against Cataline ensured that Rome maintained its form of government. Despite being temporarily exiled by Caesar, he returned to Rome to write many philosophical works that covered the Republic, the laws, and the duties of people in Rome. He had a very brutal ending as he was caught up in the politics of his time. Caesar was killed towards the end of Cicero's life and because Cicero supported the Republic, he was hunted down and killed by orders of Mark Antony, one of Caesar's generals and the man who would lose the upcoming fight for control over Rome. Cicero's belief in a constitutional government has shaped our current ones today. His oral skills are one of the reasons why public speech is such a highly valued skill in real life. His impact on the world would have been lost had we not had the amazing tool of Latin at our disposal. Another historical figure whose contributions would have been lost without Latin is Julius Caesar. We may be likely to think Caesar was a terrible person because he committed treason against Rome and effectively destroyed the Republic and transferred it to an Empire. Obviously, in today's world, we view a representative form of government as better than a dictatorial type of government, at least in America. It is so deeply woven into the fabric of our society that our forms of entertainment use these same standards. For example, in Star Wars, the Empire is led by the Sith which we view as evil while the Republic is led by the Jedi who are good. But because of Latin, we have access to Caesar's first-hand accounts and many other

people's accounts on the situation surrounding the collapse of the Republic. As previously stated, the Republic wasn't truly representative. Only rich white males had any say in how the Republic was run. This means that they were in charge of the flow of money in Rome. The rich men that were in positions of power were not very generous to the plebians, whom we would know as peasants, who worked the land. They created governmental policies that favored themselves and also gave conquested land to themselves to increase the amount of crops they could grow and in turn money they could make. We know Rome as a very rich and prosperous place but the majority of people struggled to make a living because of these unfair policies. Caesar saw this and wanted to change it. He gave land to the plebians that previously was owned by the rich patrician class, much to their dismay. Caesar also gave grain to people who did not have the money to purchase it by themselves, which we could think of as ancient food stamps. Caesar was constantly battling someone or the other, but despite the constant warfare, he made sure to take care of his soldiers by giving them parts of the spoils of war. Whenever he conquered territory, he would give some of the land to all his soldiers. This was one of the reasons he was so successful in combat. People were motivated to join his army because of the rewards they could potentially receive. Many of these details that we now know about Caesar would have been lost without the historical records written in Latin. Caesar himself wrote "Commentarii de Bello Gallico" which means the commentaries on the Gallic Wars and "Commentarii de Bello Civili" which means commentaries on the civil war, which I referenced above. These writings serve as primary sources on what Caesar's conquests were like through the eyes of the general himself. If you have taken a social studies class, one of your teachers has probably stressed the importance and validity of primary source documents. They are accurate sources of information because they are first-hand accounts of what happened. Secondhand sources aren't as reliable because they are basing their information on a different source. There may be some bias in the source, but as a critical thinker, it is easy to identify how the author's bias influences their ideas. Furthermore, we have access to the records of some of Caesar's speeches in the Senate and to the common people. These speeches help us realize how Caesar gained immense popularity he had during his reign and how he convinced people to agree with his many ideas. Latin's role in this is often overlooked but it definitely shouldn't be. Translating from a direct source is much more reliable than translating from an already-translated source. Much like the idea of primary sources and secondary sources, the meaning gets lost the more you translate something. Think of a game of telephone. The original message is clearest through the first couple of people but it gets increasingly changed the more people it goes through. By the time you get to the end, the last person has an entirely different idea of the contents of the message than the first. If there are any hidden connotations in the original message, it is almost impossible for the last person to ever understand them because all hidden meanings get lost as the message gets continually changed.

Next Chapter

I know that all these mentioned above may not relate much to your life today. Your question of why Latin and why classics as a whole are still relevant today can not be answered

by their importance in ancient times. This chapter is going to focus on companies that you probably know very well and how they were influenced by both Latin and Greek.

My first and best example is Nike, the worldwide sportswear and equipment company. If you look around your home, I can practically guarantee you that you will find something from Nike. It's a multi-billionaire dollar company with thousands of employees, delivering its products all around the world. Their slogan, "Just Do It" is one of the most famous slogans in the world. It is commonly used in ads that inspire young athletes to work hard and accomplish their dreams with the help of Nike sports equipment. Now, you may wonder, what Nike has to do with the world of classics. Well, the name Nike comes from the Greek Goddess of Victory, also known as Victoria in Roman mythology. This is no mere coincidence because the founders of the company wanted the people using their products to win, which is why the origins of the name are so fitting. Nike commonly uses athletes at the top of their respective sports, such as Lebron James, Cristiano Ronaldo, and Serena Williams to advertise their many products. This way, people will be more likely to buy these products because of the massive influence these athletes have over their fan bases. When the Greeks hosted games, the contestants would typically pray to Nike for success. The Romans did the same thing with Victoria. Despite it being around 2,400 years since the Ancient Greeks, the symbolism of the name Nike persisted from this time to the present day.

Neptune is yet another example of a company heavily influenced by classical history. Neptune is a company that provides services based on water and wastewater management. This makes sense because Neptune is a Roman God. He was the God of water, making it very appropriately named. He was not as revered as his Greek version, Poseidon. The Romans feared the oceans because of all the storms that occurred and ships that got lost there, so they didn't spend as much money on the navy and focused their conquests primarily on land rather than water. Their favorite god was Jupiter which brings me to a company with that name. Jupiter is a company that focuses on traveling and tourism. This makes sense because Jupiter was the God of the skies. Traveling nowadays often refers to going in airplanes to places far far away. Jupiter was the most respected Roman God by a very wide margin. His name commanded respect then and still commands respect now so to name a company this is a very big power move. They could have chosen any of the gods but they chose the most important one, signaling that they think their company can be the strongest in their industry. Going away from the names of Gods, even restaurants get their names from the classics. Little Caesars is a very good pizza place that bases its name on Julius Caesar, the great Roman leader. The name Caesar will always attract attention because he is one of the most well-known people in the history of the world. Naming a pizza place after Caesar makes sense because Italy is the birthplace of pizza and Rome is in Italy. It's quite ironic that they called it Little Caesar's when there is nothing little about Caesar's influence on the world.

Amazon is another example of a company that traces its roots to Greek mythology. I think we all know the creator of Amazon, Jeff Bezos. His company's fame elevated him to the pinnacle of success. He was the richest person in the world for an extended period until Elon

Musk took over with Tesla, which by the way isn't a name that came from Roman or Greek mythology. Amazon is such a massive company that despite starting as a shipping company is going into other industries such as streaming. Millions of people rely on Amazon's services to get goods delivered right to their doorstep. Amazon is even moving into the NFL, as they have the television rights to certain NFL games and both parties are continuing to expand their partnership. Now you once again may be asking, what is the correlation between Amazon and Greek or Roman mythology? Well, the Amazons were a group of female warriors who were very powerful. If you are a fan of Rick Riordan, you may have read how he masterfully incorporated the Amazons in an actual Amazon factory. This isn't part of mythology but it just made his stories more interesting to read. The name Amazon is also associated with the Amazon rainforest, which is in South America. It is not exclusively in one country in South America because of its massive size. The name Amazon would be appealing to people who love nature and people who have an interest in mythology, which may be one of the reasons Bezos chose the name, although we don't know for sure.

Apollo Hospitals is also a very famous company. It is based in India, so if you don't live near there, you likely wouldn't have heard of it. It is generally known as the best hospital India has to offer. It is so good that many people specifically travel to India to go to Apollo hospitals. This phenomenon can be referred to as medical tourism. Along with normal hospital services, Apollo Hospitals also participate in medical research. This research is done to learn more about certain types of diseases or conditions, which then allow them to look into potential cures for the future. Apollo Hospitals aren't limited to India, though most are in India. There are some international Apollo hospitals. The reason that this name relates to mythology is quite clear through the name Apollo. Apollo is one of the most powerful Greek and Roman Gods. His Greek and Roman versions are both named Apollo. He is the God of many things like music, the sun, but most importantly, at least in this circumstance, medicine. As the God of medicine, Apollo has access to healing powers that the other gods don't have. He has children that deal in more specialized forms of medicine, but he is the most powerful of them all. Naming a hospital Apollo is a very logical thing to do because you want the god of medicine to look out and guide a hospital into doing the best job it can.

Hercules is yet another in the long list of companies that have been heavily influenced by Greek and Roman mythology. Hercules is a brand that sells hand tools and hardware products. You would likely find this company's products in a store like Home Depot, which sells equipment empowering individuals to complete home improvement projects on their own. If you are very good with your hands, you probably would have heard of this company. Hercules, or Heracles in Greek mythology, is known for his superhuman strength. He could do things with his hands that no other mortal could do, which is why the name is so fitting for a hardware company. He is the son of Zeus, who is the most powerful of all the Gods. He was one of the most famous Greek heroes. As a punishment for killing his entire family, Hercules had to complete the twelve labors, imposed on him by King Eurystheus. These labors were killing the Nemean Lion, destroying the 9 headed hydra, capturing the Golden hind of Artemis, capturing the Erymanthian

Boar, quickly cleaning the Augean Stables, driving away the Stymphalian Birds, capturing the Ceryneian Hind, stealing the Mares of Diomedes, obtaining the Girdle of Hippolyta, obtaining the cattle of the Monster Geryon, obtaining the apples of the Hesperides and capturing Cerberus, who is the dog guarding the underworld. Most heroes would die even trying to complete any one of these ridiculous achievements. He was the first to do a lot of these, which is why he is so revered, even today. He has had such a massive impact on the mythological world that he is still being taught today.

The list of examples continues to go on, even extending into the automobile business. Midas is a very popular automobile company that mainly deals with changing tires and fixing up various parts of the car, including the exhaust, engine, and steering wheel. There are over 2000 Midas stores in the United States of America and Canada. They also have stores in 15 other countries, making them a highly relevant company in the lucrative automobile business, seeing as so many people across the world use cars and as more and more places industrialize, the number of people using cars will only go up. Midas is a very recognizable figure in mythology. King Midas was given a wish by the Greek God Dionyounous. He chose to make everything he touched turn to gold. At first, he was extremely pleased that he could turn cheap goods into priceless treasures. His pleasure turned to displeasure when he hugged his daughter, turning her into a lifeless statue. He begged Diouyounous to reverse this curse which he did, allowing him to go back to a normal life. This tale is often read to children to warn them of the dangers of greed.

I could go on and on listing companies that have been influenced by the classics because there are just so many more. I won't because of how tedious it would be. The fact that so many companies have chosen names with such a rich, classical history shows how influential the classics remain. Despite being seemingly forgotten, they aren't because they surround everything you buy and everything you see.

Learning Latin has many academic benefits. Latin is considered one of the most difficult languages to learn, so having proficiency in it means that one could learn practically any other language with ease. The reason for this is most other languages have a similar structure to Latin, albeit a bit easier. Furthermore, as you probably already know, since a lot of English roots are similar to or the same as Latin roots, knowing Latin will help you understand English words that you may never have heard before. That is why many Latin speakers find sections of the ACT or SAT, which are standardized tests in the United States of America, easier because they test vocabulary.

Learning Latin also helps to improve one's analytical thinking skills. In Latin, you have to think about which verb ending to use, based on the many ways it could be used. You have to constantly match the case and number of many words based on an initial word. This system is much more complicated than most other languages because of the number of different tenses and because of the indicative and subjunctive cases. For each one of these unique situations, one has to remember a whole different set of verb ending conjugations. One also has to be able to identify when each one would be necessary, which takes a lot of analytical skills that most other activities wouldn't give you. For this reason, numerous studies have shown people who take

Latin tend to do better in other subjects than people who do not take Latin. This might be because the rigor of Latin prepares students for harder classes. It also takes a lot of discipline to go through all the different declensions of Latin and to memorize everything one has to, which can help people get through the more boring parts of other classes, like reading textbooks.

In addition to all these benefits, learning Latin, or learning any language in particular helps to develop one's mind and improve one's cognitive function. I'm sure you have been encouraged to take any language because of the numerous benefits, but these same benefits also apply to Latin, despite it seemingly being a dead language.

If you are in high school or college, you probably have heard of some phrases that are a symbol of academic excellence over a lengthy period. One of those phrases for high school students is cum laude. Cum laude is a Latin phrase meaning honor. For most high schools, they give out this distinction to students who had a GPA in the top ten percent of their graduating class. Some schools offer higher distinctions like summa cum laude which means with the greatest honor and magna cum laude which means with great honor. The distinction of summa cum laude is only given to the best student while magna cum laude is given to the students who performed better than the standards for cum laude but slightly worse than summa cum laude. Receiving any of these distinctions is a major accomplishment that helps when getting into colleges or applying for certain jobs.

Staying in the realm of college, many prestigious universities have Latin sayings on their buildings to motivate their students to work the hardest they possibly can and to be the best person they possibly can be. For example, Harvard's motto is Veritas, meaning truth in Latin. This motto is on the university's seals and is found in various buildings. They know that their students will make a massive impact on the world around them but they want to ensure that they do so with integrity and honesty. The phrase Christo et Ecclesiae is also commonly seen in Harvard buildings. It means for Christ and for the Church, which emphasizes Harvard's Christian roots. MIT, which stands for the Massachusetts Institute of Technology, is another prestigious school with a Latin saying. Its saying is Mens et Manus which means Mind and Hand. This motto combines MIT's desire for its students to have theoretical knowledge and to combine that with practical application. Watching or reading about something will give you some knowledge about it but doing it helps you understand it even better. For example, if you are going to try to build a robot, reading books and watching videos of other people building robots will only take you so far. If you build a less complicated robot, you will have practical experience which you could then apply to your final project. Moving on, Princeton has two notable mottos that are in Latin; Dei Sub Numine Viget, which means Under the protection of God, she flourishes. This motto emphasizes the university's commitment to academic excellence, which is made clearer by how low the acceptance rate is. It is also saying that as long as we are guided by a higher power we will be fine. This motto doesn't specify which religion God we are talking about so we can infer it's talking about whichever God you believe in. Another phrase that is common in Princeton is Vetustissima Universitas In Novo Orbo. This means the oldest university in the new world, which is quite a distinction. It is the only university in the entire

world that can have this saying because it only applies to it. Many more universities have Latin inscriptions on many of their buildings. If you are in college right now, I'm sure you can find one there. Many common phrases are universally used by many different universities. For example, the phrase Alma Mater means nourishing mother. This phrase doesn't reference anyone's actual mother but is referencing the institution in which they received their education. Clearly, from these examples, we can see that Latin is very prevalent in our institutions of higher education.

In conclusion, the prevailing belief that Latin is a dead language is incorrect. While it may not be spoken as a native language in everyday communication, its impact on numerous parts of our lives remains profound. From its foundational role in the development of the Romance languages to its critical presence in medical and scientific terminology, Latin's influence is both widespread and timeless. The language managed to overcome the test of time as it remains part of so many people's lives. Thus, Latin's impact exists not solely in our history books but also in the very essence of our culture, education, and understanding of the world around us.

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The Limits of Liberalism: Achieving Genuine Equality in Modern Society By Ajay Sharma

Abstract

  This paper delves into the constraints of Liberalism within contemporary American society, guided by a passionate drive for equality. The belief is that society's limitations stem from inequality and discrimination, inhibiting personal growth and societal progress. The argument contends that differences within groups often outweigh those between them, emphasizing that potential for success in any field is unaffected by gender. The core example, involving a cake shop, illustrates that legal equality does not equate to true equity; an individual's experience is shaped by social attitudes beyond the law. Liberalism's promise of equality is deemed inadequate, especially in addressing gender-related issues. The paper criticizes Liberalism's simplistic approach and highlights its failure to address intricate causes of sexism and racism. Liberalism emphasizes individual rights and justice through institutions but disregards the impact of background conditions. This critique particularly focuses on Rawls's theory of justice. While necessary, legal protections alone are insufficient for achieving comprehensive equality, as demonstrated by persistent societal inequalities. Analyzing racial and gender myths, the paper underscores storytelling's role in maintaining oppression. Addressing and dispelling these myths is critical to push societal attitudes toward progress. Systemic oppressions, rooted in unchallenged beliefs and expectations, necessitate the dismantling of enforcement mechanisms in order for genuine equality to flourish. The paper concludes that overcoming expectations, fostering social equality, and committing to affirmative actions are imperative for societal change. Effort, work, and persistence, akin to the Civil Rights movement, are essential to transcend normalized oppression and achieve a truly equal, fair, and free society.

Why This is Important to Me

  This paper explores Liberalism and its limitations in contemporary American society. The paper is guided by my belief that my own life, as well as those of others, would be vastly better if there were more equal opportunities. We inordinately limit ourselves and our society when inequality and discrimination are practiced. I believe that, truly, greater differences can be found within each group of people, divided by gender or race, than can be found between different groups of people. There are, without a shadow of a doubt, two white women in the world that are more different from each other than either is from some black man. Thus I also believe that the potential to improve our world is equally likely to be found within a person regardless of the person's gender or race. And I think everyone would agree that this is a very rare trait. So if so few people truly have the potential to make the world an undeniably better place, why would we ever choose to limit the opportunity of some of these people to explore and develop their abilities? But I also find a more egalitarian motivation for my ardor on this subject. I have seen firsthand how people can work hard but still not get the recognition they deserve because their identity, something outside of their control, affects the way people see them. This can often result in people giving up on their passions, and this concerns me not because they

might advance the world with their talent, but because I believe, regardless of skill, impact, or quality, people should be able to unabashedly pursue and enjoy the things that make them happy. The impetus for me to start writing this paper was a conversation I had with a friend about the very same topics which I am planning to discuss. In that conversation, I tried to explain my critique of Liberalism using a cake shop. Say two people walk into a cake shop the day after legal segregation was abolished, one black one white. The shop has always been open only to white customers, but today they must finally serve their first-ever black customer. So the two friends go in, order their cakes, and both leave with their orders. Both people were protected by the law to ensure they could get what they wanted, but the entire time they were in the shop, the black customer was getting dirty looks from all of the patrons in the shop and all of the staff. People were scoffing at him and muttering their frustrations under their breath. So when the two friends leave the cake shop, yes they both got their cakes, but does the black customer really *feel* equal? According to the law, he definitely is, but I believe there's much more to true equality than just legal protection. That is why I feel Liberalism falls short on its promises of equality, and in today's world especially on issues of feminism's equality.

Liberalism is Not Enough For Equality

Sexism and racism are thought to be the most clear-cut forms of discrimination that are prominent in our country. (Other forms seem to have exceptions and different interpretations, but these two are just "basic.") Unfortunately, the truth of these issues, as truth often does, resists simplicity. And Liberalism is far too simple to effectively address the complex consequences of these ideologies. Liberalism in this case refers to the idea proposed in political theory, which protects the rights of the individual and places faith in institutions to create a just and proper society. Liberalism refuses to acknowledge the background conditions of individuals or groups (i.e. the unique circumstances of these people and what has led them to be where they are) and attempts to create universal equality through prioritizing what is right in the hopes that it will naturally lead to what is good. This is apparent in John Rawls's famous book, *Justice as Fairness*, where he proclaims that the key principles to achieving equality are equal access to liberty and opportunity and ensuring that any inequalities that arise come into being through a completely fair system and benefit the least advantaged members of society. His exact words for the first and second principles were "Each person has the same and indefeasible [permanent] claim to a fully adequate scheme of equal basic liberties, which scheme is compatible with the same scheme of liberties for all" and "Social and economic inequalities are to satisfy two conditions: first, they are to be attached to offices and positions open to all under conditions of fair equality of opportunity; and second, they are to be to the greatest benefit of the least-advantaged members of society" respectively (Rawls). Rawls's theory of justice says that achieving equality requires creating a system that fairly distributes primary social goods, i.e. rights, liberties, opportunity, and other such things. Rawls holds steadfast that true justice can be achieved only by paying no mind to background conditions, but the reality is that while this

system might be great for maintaining equality, it is simply not enough to take our society from where it is now to one that is truly equal.

For a moment imagine America as a car. Political theory is essentially the study of how to best maintain, operate, and improve this car. Rawls's proposal can be thought of as him asserting that Liberalism is the absolute best engine to make this car run as fast and as smoothly as possible along the freeway of equality. I largely agree with this claim in theory, but I find the suggestion entirely moot. I see the car as broken down, currently stuck in a ditch on the side of the road. And I do not believe that Liberalism is anywhere near strong enough to lift the car out and get it back on the road. For such a task, much more is required than merely righteous institutions and words on paper. The current oppression that Americans face is almost entirely free from legal backing. For example, according to the Pew Research Center, "In 2022, women earned an average of 82% of what men earned," (Aragão) but the Equal Pay Act of 1963 protects against wage discrimination based on sex. Once again think of the cake shop. After all, there was much legislation passed throughout the 20th century that explicitly prohibited discrimination and protected vulnerable groups from it. And yet America has certainly not achieved true universal equality. Socially, economically, and even educationally, America is far from equal. And because America is now at the point where Liberalism has done virtually all it can, since practically every legal protection has been instituted, it is crucial to understand what more past Liberalism is required to truly achieve equality. To succeed in this daunting task, however, it is also essential to combat the social obstacles to equality that exist outside of Liberalism's scope.

Racial and Gender Myths

In his book, *Racism Without Racists,* Bonilla-Silva provides profound insight into how storytelling, something central to human nature and communication, is a powerful basis for enforcing racial oppression. Racial myths were perhaps one of the most crucial tools to socially pressure Black Americans into staying in their "place." Bonilla-Silva mentions both the story of the black rapist during Jim Crow and the more modern story of a white candidate not getting a job because of a black candidate. Because of the former, black Americans were forced to scrupulously monitor their behavior to make sure that no one would be able to accuse them of "lecherously looking at a white woman," and because of the latter, black Americans are sometimes not treated with the respect they deserve because "they only got here because they're black." There is barely any better example of this than the current attitudes of high schoolers about affirmative action. I recently spoke with a high school senior about the chance that race may no longer be considered in college admissions starting as early as next year, and they told me that this would be great for me as I am Indian. I, however, disagreed with the removal of affirmative action, but thankfully, the senior I was speaking with happens to be renowned for their kindness and is both open-minded and strikingly intelligent, so this led us to have quite a rousing, productive discussion. In it, though, they provided an anecdote about another school nearby where numerous African American students got accepted into elite colleges despite seemingly having worse academic achievements than the average students at those colleges.

Sure, their ethnicity almost certainly improved their chances of getting into any particular college, but that is not the same thing as them not deserving to. This extremely deep-rooted story about undeserving black people getting special treatment still had its hold on not just the senior I spoke to, but countless students across America. Everywhere from TikToks to Harvard philosophy classes, there are people who believe that black students at good colleges don't deserve to be there. But, of course, this is largely immeasurable and mostly unbelievable. Obviously, many black Americans are much worse off because of the horrific abuses that black people faced throughout American history. In fact, a black student with worse grades might actually be a more impressive student because of the relatively worse resources available to them, for example, higher standardized testing scores are heavily correlated with higher household income. According to a 2012 study from the University of Minnesota published in *Psychological Science*, "21.2% of variance in SAT scores" is correlated with socioeconomic status (Paul R. Sackett et al.). And obviously the black students who get into these colleges might have just had such outstanding applications that their race was irrelevant to their admission. So how is it that this smart, open-minded, and remarkably kind person came to be caught by the influence of this racial myth? Importantly, this senior was certainly not racist, but just like Bonilla-Silva explained, racism does not actually require any individual racists. But as terribly powerful as racial myths like this can be, they have a fatal flaw that gender myths do not. They are simply jarring. When someone says, "Black people don't deserve to be accepted into universities or hired to jobs as successfully as they are" in today's America, heads will probably turn and that person will most likely be challenged. When I talked to this senior I was slightly taken aback. I tried to change their mind. Interestingly, they were eventually swayed, and it seemed that they only took up this position originally because of their personal stake in the situation: they obviously wanted to be accepted to every college they applied to. But because these racial myths immediately bring into question the character of the person referencing them, they lose a lot of their power. The reason that the myth of the black rapist was so powerful during Jim Crow is that it was never challenged. As a society, most white people and most power structures in Southern America believed in this story and thus it dominated black people in the South. Gender myths, however, face almost no opposition. They are seamlessly melted into American society without question. Children are the best example of this. Parents buy children different toys based on gender, of course, the classic example of Barbies vs. monster trucks comes to mind. Sure this is slightly challenged by activists very far on the left, but more important than toys, children's behavior is also nurtured differently based on gender. Often unconsciously, girls are pushed to value being polite and beautiful and reprimanded and ostracized for being angry and/or "bossy." Boys are pushed to value strength, leadership, and emotional repression, often masked as stoicism. The immeasurable influence of gender myths truly lies in the fact that no one would challenge a parent who tells their son to be strong, toughen up, and not to cry when they're upset, or one who tells their daughter to be polite, relax, and not worry about what everyone else is doing. These things are all not just acceptable, but admirable in our society, but the problem is that behind them hides the deeper cause of gender

discrimination in America. Nobody bats an eye when a man offers to carry something for a woman but wouldn't do the same for another man. No one questions it when the teacher speaks to the female students in a softer tone as if they are somehow more delicate or sensitive. Even when I interviewed a few teachers from my school about the inequalities that might present themselves in our school's environment, gender discrimination was relegated to an afterthought. After I had asked the teachers questions about the state of equality at our school, I asked them what they thought the point of the questions might be and what they thought I was researching. All of them responded with something about fairness and if our own school was fair. Some of them narrowed it down to something to do with whether racial prejudice was present in the school. But not a single one of them mentioned or even considered gender. Even the teachers who were able to point out some sort of difference between how students of different races were treated by staff and other students were completely bereft of any observation that students might have different experiences due to their genders. Another important commonality of the responses to these questions was that every single teacher I asked said that they wholeheartedly believed that the school provided unequivocally equal opportunities for all students. Upon talking to everyone that I could, I found that this sentiment was not shared among the students at my school. And from simply being a high schooler in America, I found that people in school are not in fact treated equally regardless of their gender. Again, the most important difference between gender and racial discrimination in schools, on the whole, is that treating people differently based on their gender is normalized. The reason that movements to end racial discrimination worked on a social level is nothing more than people simply no longer being okay with interpersonal interactions being based on race. At a certain point in time, the majority of Americans decided that they at least wanted the chance to be able to see people as more than their race, or able to talk to and get to know them regardless of the color of their skin. Without this crucial step, without people closing their books of gender myths, no social progress will be made. Just as Bonilla-Silva said that these racial myths are so powerful in enforcing the discriminatory status quo because storytelling is so fundamental to human communication, the repudiation of these stories has just as much potential to push societal attitudes towards progress.

Expectations

Now examine systemic racism (or systemic misogyny or any other systemic oppression). The foundation of every single one of these systemic forms of discrimination is that they work without any individual bad actors. That's what makes them *systemic*. Someone might not encounter a single individual who bears them any hatred or does them any wrong because of their race but still end up feeling the effects of systemic racism. Look at redlining during the Jim Crow era. Redlining was a discriminatory practice in which such things as financial services were not given to people in certain neighborhoods that were designated as bad to invest in, and these neighborhoods were made up of mostly racial and ethnic minorities. Since property and equity are some of the most prominent ways to build generational wealth and being unable to get loans to start business ventures massively hinders people's ability to economically advance,

these practices are some of the biggest contributors to the economic inequality in America today. Countless people might never have dealt with any racism or racial animosity firsthand but still ended up in a much lower quality of life with far fewer opportunities because of the laws deciding whether or not their grandparents' neighborhood was a good place to invest in. This in turn creates social pressure to maintain these conditions. When America has a culture and history of seeing and treating certain groups of people as less than others and those same groups are currently in worse conditions, then stereotypes are inherently formed, prejudices are ingrained, and people are set out into the world with ideas of what they think people *should* be. People have *expectations*. Truly expectations are the bane of equality, and to be free of expectations is what it takes on top of Liberalism's equal access to opportunities to truly achieve equality.

However, these foundational ideas of what people *should* be or where they "belong" are not things that merely hold themselves together. These ideas need to be maintained. As Kate Manne said in her book, *Down Girl*, sexism can be thought of as a set of beliefs, and misogyny can be thought of as an enforcement strategy to maintain these beliefs and keep that status quo. Without misogyny, there wouldn't be any significant expressions of sexism. Without people enforcing discrimination, equality has the *chance* to thrive. So since philosophy is all about logic, let's look at solving this problem logically. If the enforcement of these beliefs is what gives them power, then the only two solutions we need are stopping the enforcement and enforcing the opposite ideology because just like discrimination, equality also needs to be maintained as a form of thought, as something society believes in. This is intrinsically tied to the repudiation of myths that I discussed earlier and how that can lead to social equality, true equality. But denying the myths and stories is only one part of it. It is taking action to affirm these beliefs that solidifies them. It is not just speaking out against discriminatory statements, but questioning the reason that such statements would even be made, putting in the effort, and taking the time to explain to people why discrimination is harmful to others and even themselves and why equality is not just what people deserve, but it's what is better for everyone in society. It is not enough to just create opportunities for success, for example, programs like Women in STEM. The attitudes around these opportunities need to shift for there to really be equal opportunities. In fact, the very existence of programs like this highlights the issue with Liberalism. These special programs have a tone of being just that, special. Outside the norm, something different. Liberalism lacks the ability to account for these social aspects of equality. Liberalism doesn't care if people *feel* equal because you can't legislate how people are allowed to feel, but unfortunately, the fact that someone is legally allowed to buy a cake doesn't always directly translate into them *feeling* equal when they go to the shop. Therefore the only way to create true equality is through social aspects and communitarian efforts. Of course, legal protections are necessary, but they are only the first step. It is much like the aftermath of Brown vs. BOE. The Supreme Court ruled that segregated schools are unconstitutional, but it still took a long time for black students to actually be allowed into white schools in the South, and even longer still for them to be socially *accepted* at those schools. And it would most likely be

universally agreed upon that these students were only really equal once they could walk down the hall without feeling alienated, without constantly being told that they don't belong there, and when once they could finally join clubs, make friends, and have a normal school experience. Similarly, the only way that women will finally be able to be equal in their opportunities, pursuits of career paths, etc. is if it becomes completely socially unremarkable for girls in schools to do things like spending all their time at their computer coding, and for organizations like Girls Who Code to become obsolete. Really, what needs to happen is for people to take active steps in their schools and communities to deny and tear down the *expectations* placed on girls today. And ironically, the challenge of normalizing equality across genders will often require a deliberate effort to do nothing. To accept the different pursuits people endeavor in and notice them without mention.

One way that the hold of expectations on society can be observed is the so-called "white standard." This is an idea I discussed with Dr. Columbus Pruitt at Brown University. It holds that the normative culture in America is one dictated by the actions, behavior, and values of white Americans, and they are the only ones truly free from expectations, thus the only ones with true social freedom. For example, a common stereotype that black Americans have to face is the idea that they have some sort of thuggish nature, so when a Black American does become very successful, the reaction is usually that they managed to achieve this *despite* the fact that they're black. It is seen as some sort of exception. And it is precisely what it's an exception to that this theory describes. But it is not limited to only successes. Even if a Black American ends up in a poor situation they are still haunted by the pressure of what they "should be." They are seen as part of the "proof" of the expectations rather than simply an individual who made a unique series of choices in their unique life circumstances. Another vivid example of this is the expectation that Asian students are supposed to thrive academically simply because of their race and inherent disposition. When an Asian student does perform well academically they might be faced with something along the lines of "you're only smart because you're Asian." I myself was told this on more than one occasion. On the other hand, when an Asian student underperforms in school, they are seen as some sort of inexplicable anomaly and are criticized much more harshly than non-Asian students with the same level of academic achievement. One can not escape it regardless of which way they go. In stories of either success or failure, they are utterly unable to escape the larger pressures of what people think they should be. Expectations are pervasive and powerful. No one can move outside or beyond ideas and their power. And according to an article in *Education Week*, a recent study even showed that teachers have biases that cause them to expect more of Asian students (Najarro). This has significant real-world consequences because there will undoubtedly be countless Asian students that need help in school that might be overlooked by their teachers because they *look* like they *should* be able to handle it.

School Specifically

But all of these ideas apply throughout society and solutions ought to be implemented universally, so why is school particularly important to the faults of Liberalism? Obviously,

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childhood is an extremely formative time, but the years spent in school, especially high school, are integral to the paths in life that people choose to pursue. High School is often when people have to start deciding what they want to do when they grow up and what college they want to attend. But the years themselves are not just important because of the stage of life people are in. The actual experiences that people go through in high school have immeasurable effects on what people end up pursuing in their lives. And social interactions and the attitudes expressed by others in the school are the most important parts of what create these experiences. According to the Pew Research Center, in 2022, on average women earned 82% of what men earned on average. Wage discrimination based on sex is illegal, so a common explanation of the gender pay gap consists of two components: one, a boss might just *feel* like a man is doing a better job than a woman doing the same work because of their individual bias and expectations and two, much more significant, women are simply going into lower-paying fields more often than men, for example, there are far fewer women in stem fields than men. The reason for the difference in professional choices between men and women obviously has a very large foundation in their school experiences. It's not that stem opportunities are less available to women so much as it is that women are simply not encouraged to pursue those careers as strongly as men are. And all of this can be almost entirely traced back to expectations set in childhood and the social pressures commonly found in high school. Certain aspects of high school will just always be present for the majority of students because they are still children. For example, wanting to be liked or "part of the group" are simply things that children will naturally gravitate towards for several reasons. Humans are of course social creatures so mostly all people want a connected group of friends, high school can also be quite a stressful time, so having friends to help you relax is also foundational to the high school experience, and having to deal with the increased social pressure of not being part of the group or labeled as an outsider is something that most high schoolers would rather do without. These aspects of being a high schooler are not without reproach, but they are likely not going anywhere. The real problem is not mainly that kids in high school often feel at least some pressure to do certain things or act a certain way, it is *what* specifically they feel they have to do. Currently, they often feel that they need to strongly associate with classical traits of their gender. For example, boys need to play sports and girls need to care a lot about prom. Of course, it is a much broader cultural issue that coolness and academic performance are inversely related, but as with many other societal pressures, the constraint on girls is much stricter than it is on boys. According to a survey by the Mental Health Foundation, "46% of girls reported that their body image causes them to worry 'often' or 'always' compared to 25% of boys" (How comfortable are children and young people with their bodies?). And in the final interview that I conducted with one of my teachers (after I asked them about the differences between students' experiences based on gender), they told me they've noticed that during times when groups of boys will be talking about sports or other common small talk, groups of girls will actually be talking about their worries over their body images, how boys might be perceiving their looks and actions, and other high school social concerns. Now, it is important to understand that none of these concerns will usually manifest so concretely, but social worries of

this nature are far from uncommon. And while this is certainly stretching the problem to its extremes a bit, it is still integral to why there are so fewer girls pursuing these high-paying career paths while in high school. The solution to this is not allowing girls to have the opportunity to be the president of the computer science club. The real solution is creating an environment in schools where girls can feel comfortable wanting to take that opportunity. Because all the opportunities in the world mean nothing if people don't have the opportunity to *want* to take advantage of them. Removing the factors that could cause someone to hesitate to pursue an opportunity that they would otherwise commit to in a heartbeat, specifically the social attitudes around someone like them pursuing that opportunity and, of course, the societal expectations that might pressure that person away from what they really want, and doing it in schools specifically is absolutely paramount to achieving social equality and *true* equality in our country.

It Takes Effort

There is a notion that many people who examine systemic forms of oppression subscribe to: that there is no such thing as an apolitical action. This is because actions and decisions are inherently embedded within a social, cultural, and political context. They can often reflect and perpetuate existing power structures, norms, and ideologies, or they can challenge and disrupt them. A classic example of this idea is the products people choose to purchase. If someone chooses to buy products that are produced by a company exploiting workers in less developed countries, then the consumer is essentially making a tacit endorsement of that company's actions and thus supporting and perpetuating those business practices. However, this idea is especially important to the social decisions that people make. As I have emphasized throughout this paper, things like societal expectations have the power to exert massive pressure on people and limit their ability to truly exercise their freedom, and the response to these social pressures is what will define how much our country will value and move towards true equality going forward. If we as Americans want women to finally be truly equal in society, then we need to create an environment that fosters social equality through the denial of things like misogynistic myths and societal expectations. And this is difficult because it requires affirmative action to change the world around us. Doing nothing is the same as enforcing the status quo. In terms of women's equality, it is utterly impossible to do anything other than advocate for change or advocate for the current systems of domination to remain in place. If you believe that women are not entirely equal in society right now and you want that to change, then you *must* go out of your way and exert the effort required to take actions that go against the current systems and disrupt the status quo. Otherwise, you are helping and enforcing that oppression by choosing to abide by it. A perfect illustration of this is another thing often talked about in school bystanders watching a bully. Teachers and even Disney Channel have long told kids that if they see one student bullying another student and they don't do anything to stop it, they are part of the problem. Similarly, if you just do nothing to address the inequality between men and women, then you are, unfortunately, part of the problem. If there is one single thing I would want a reader to take

away from what I've written, it is that effort, work, and persistence are the cornerstones of achieving equality. Assuming you do think that the world could be more equal and you want it to be, then you have to actively work against the systems of domination preventing equality. During the Civil Rights movement of the 1900s, Martin Luther King Jr. heavily emphasized this. He said it would not be easy and that people need to endure massive hardships if they really want to make a change. In many ways, achieving equality today requires less endurance than it did then. The laws have already been passed. Liberalism has reached the maximum it can do. All that is left for people to truly achieve equality is to march down the social avenues and demand it through systems like communitarianism. Undoubtedly, this is still a difficult process. It can feel abrasive to interject when one observes oppression taking place through all of its subtlety and especially because it is often so normalized. It can be awkward. It can even lead to the person acting against oppression facing some social stigmatization towards them. They might be told something like "Why do *you* need to point that out?" "Why are *you* making it about gender or race?" "If anything, you're the sexist or racist one." But these are in fact the very mechanisms that enforce oppression and keep it in place. You just need to push through. The feelings of awkwardness or being judged or being told that you're the one creating an issue are all completely worth it if they can help bring your community and your society closer to what you believe it ought to be: equal, fair, and free.

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The Images of Aphrodite Urania and Aphrodite Pandemos as an Act of Resolution and Symbol of Enlightenment in the Mythological Novel by Clive Staples Lewis "Till we have faces" By Arailym Kairolda

Abstract

Clive Staples Lewis' novel "Till we have faces' ' is a philosophical composition of images that explores the myth of Cupid and Psyche as an early and unconscious clash of pagan and Christian. Psyche is a symbol of the enlightenment of the barbarian world, and her sister Orual is an illustration of the enlightenment process. Orual goes through a series of metamorphoses, symbolising both the movement of the whole ancient world and a single individual. From the archaic cruel goddess Ungit, she becomes Aphrodite Urania. Her final image of Urania is compared with the static image of Psyche - Aphrodite Pandemos. The purpose of the study is to compare the function of the images of Aphrodite Urania and Aphrodite Pandemos with the conflict of the novel "Till we have faces' '. To achieve this goal, the writer used the method of systematic literature review. The results of the study showed that the end of the metamorphosis of the protagonist (Orual) into Aphrodite Urania marks the finale of the conflict of the novel: Orual crosses the line between pagan and Christian. Based on the results of the study, it can be concluded that the images of Aphrodite in the novel are an act of resolution of a theological issue.

Introduction

Clive Staples Lewis's novel is a philosophical parable, revealing the problematic of selfish love by contrasting it with selfless Christian love. The conflict of the novel is the metamorphosis of Orual, the protagonist: throughout the novel she undergoes a process of enlightenment, committing sins and redeeming them through love.

This study presents an addition to the definition of conflict in Lewis's novel. The aim of this study is to identify and prove the role of the images of Aphrodite Urania and Aphrodite Pandemos in the process of the metamorphosis of the protagonist. Defining the role of allegories is an important part of defining the main idea of Lewis's novel, because in and through them he demonstrates the destruction and enlightenment of the pagan world.

Myth in the Conflict of the Novel.

Clive Staples Lewis was influenced by theology and mythology, to which he, once a staunch atheist, was drawn by his close friend J. R. R. Tolkien [1]. "Like speech, it {myth} is an invention of objects and ideas," Tolkien said. "We are descended from God, and inevitably the myths we create, though they contain delusions, also reflect fragments of the true light, the eternal truth belonging to God." Tolkien infected his friend with the idea that only through mythmaking, only by becoming 'falsifiers' and making up stories could man experience the state of perfection he knew before the fall into sin." In September 1931 Lewis was already defining the story of Christ as a myth, "with the striking difference that this myth actually took place".

Years later this led him to rethink the myth of Cupid and Psyche, which he had read as a young college student [2]. The images of Psyche and Cupid haunted his work for many years: at a young age Clive Lewis began his retelling of the myth as a ballad and poem, but the years made a metamorphosis and a dozen years before its first publication "Till We Have Faces" became a prose work. And the novel itself, its entire concept is built on the metamorphosis of the work's protagonist, Orual, the sister of Psyche. From the archaic Ungit, a cruel pagan foremother, she becomes a pre-Christian omniscient deity. The novel was published in 1956[3], and in it Lewis explores dark idolatry and pale enlightenment. Saturated with human imagery, he uses mythological imagery to define the conflict of the work. The historical conflict of faith and barbarism.

Metamorphosis of Orual

The novel is divided into two parts, both of which identify the stages of metamorphosis and Orual's self-awareness. The first part of the novel is Orual's complaint against the gods, in which she remains deluded, blind and faceless. She only has names, which she gains and loses throughout the first part of the novel.

Orual's Metamorphosis in the First Part

The hypostases of Orual in the first part are dependent on the other characters of the novel. As a child, Psyche called her Maia[4] (Greek. mother, nurse), which was also her first word. Psyche's mother died in childbirth, so her older sister Maia became her patroness, a symbolic foster mother. Maia's name is associated with the image of Psyche: she is not independent [5], emphasising Orual's blindness. Having lost Psyche during the sacrifice, Orual experiences a moral shock [6] that deprives her of her name.

After that, she, along with her mentor Fox, becomes an adviser to the king. Now she bears the name given to her by her father - Orual. Her life is completely subordinated to her father, she is in his will. She serves her father and bears the name that her father gave her. She also puts on a veil that hides her face from other people, and this act becomes a vivid illustration of her facelessness.

After her father's death, becoming the queen of Glom, she renounces all her former names and calls herself the queen: "Since Arnom said a few hours ago that the king was dying, it seemed that another woman was acting and speaking instead of me. Call her the Queen; but Orual was someone else." However, the Queen speaks of Orual as a glimmer of sanity, and this shows how mistaken Orual is even in his last metamorphosis of the first part of the novel: "And now I was Orual again." (I was wondering if all princes felt that way.) I looked back at what the queen had done and was surprised by it." The Queen, despite the apparent freedom that Orual experiences after the death of her father, depends on Orual herself: on her inner pathetic humanity.

Orual's Metamorphosis in the Second Part

In the second part of the novel, Orual begins her journey towards enlightenment. Apart from the names, she turns a face that signifies her transformation.

She begins to be haunted by visions. In one of them, she appears in a mirror with the face of Ungit: the vision takes place on the ground, in a stuffy and damp pit. Ungit is the Glom Aphrodite, she is material and earthly [7]. It is a faceless and ugly statue, in whose stone features a thousand bloody soulless faces can be discerned, but none spiritualised. It is a soulless symbol of pagan idolatry. While at the temple of Ungit, Orual notices a woman offering a sacrifice to the formless statue, preferring it to the Greek statue of Aphrodite. The woman says that this Ungit is the sole patroness of their people. Ungit is the only one of her and Aphrodite's two recognised deities by the barbarian pagan people. In answer to Orual's question as to who Ungit is and where she comes from, the priest Arnom replies that 'she is the mother of the earth, the progenitor of all things'. Orual notes that "she {Ungit} rose from the earth as if she were an emissary of those unknown forces that do their dark work in the damp, warmth and oppression of the dungeons."

Thus, Ungit, contrasted with the Greek Aphrodite, corresponds to Aphrodite Pandemos, the earthly beginning. Pandemos, as well as Ungit, unlike Urania and Aphrodite, are recognized by the pagan pantheon and are the patronesses of earthly people[8]. Aphrodite Pandemos is the fruit of the union of a man and a woman, Zeus and Diona. In the same way, Ungit is involved in the image of man and woman: for her son, the God of the Grey Mountain, she is both consort and mother. Because if Ungit is the earth and her son is the sky, "That means that the sky by its showers makes the earth fruitful". Urania as well as the Greek Aphrodite Anadiomena belong only to the masculine, because they have no mother; Aphrodite Urania and Anadiomena were born from the blood of the scattered Uranus and sea-foam [9].

So Orual sees herself in the mirror with the face of Ungit. In opposition to Aphrodite she is Ungit, and in opposition to Urania, she is Pandemos. The image of Pandemos emerging from the mirror is not new. In 1651, Diego Velázquez painted Venus with Mirror [10]. The viewer is presented with the nude body of Urania lying on layers of silk. Her face is deliberately presented only in the mirror. In antiquity, the reflection in the mirror was a symbol of a second essence, a double. According to Philolaus[11], the sun itself was a mirror reflecting the light of Zeus' house: a mirror enabling the world to see the face of the Olympian Aphrodite. The face of Ungit, which Orual sees in his reflection, belongs to the archaic Aphrodite. "Ungit is me," says Orual. Orual suffers her final metamorphosis before a divine court[12]. She appears before the gods naked: stripped of her clothes and veil. In this scene she renounces to the end her complaint to the gods, written in the first part of the novel; so she also renounces her delusions and fears, her earthly names. She realises that before the divine face all questions disappear. She asks herself: "Until we have learned to speak, why should they listen to our meaningless babble? Until we have faces, how can they meet us face to face?".

She looks into the face of the God of the Grey Mountain because she herself has now found a face too. In the reflection of the water surface, Orual sees two Psyches: naked and

clothed. These are the two Aphrodites, Urania and Pandemos. In contrast to Pandemos, the clothed and earthly Aphrodite, Orual becomes the divine, naked Urania. And in opposition to Ungit, she becomes Aphrodite, Psyche. This is how she reaches her climax and end. The transformation process is over and Orual dies on her manuscript.

Relating the Static Nature of Psyche to the Transcendence of Orual

Psyche's image was static [13], and this is her main difference in relation to Orual. At the beginning of the novel, she is part of the pagan world of Glom. However, Psyche's behaviour is very different from the barbarism of her compatriots. She demonstrates Christian selflessness and humility during the plague, for which the pagans begin to believe in her cult. She is recognised by the people, she is loved, and she is divine: divine is her beauty, her spirit, her behaviour. Psyche was Aphrodite Pandemos from the beginning. This image, unlike that of Pandemos Orual, was independent and not opposed to anyone. The virginal image of Urania Orual was not coherent from the beginning, and was complemented by the married Pandemos Psyche, so they appeared together at the end of the novel.

Conclusion

Thus, becoming Aphrodite Urania, Orual comprehends the Christian omniscience [14] of Psyche, Aphrodite Pandemos. Orual is at peace with his hypostasis and sister [15], that is, reconciles with his metamorphosis and the stimulus of metamorphosis. Orual's death demonstrates the death of the cruel pagan world, the collapse of the polytheistic temples of the pantheon. The images of the two sisters are inseparable from each other, and this puts an end to the conflict of Clive Staples Lewis' novel "Till We Have Faces."

This study's definition of the relationship between allegory and imagery in "Till We Have Faces" draws a clearer distinction between definitions of pagan and Christianity in Lewis' literary worldview. By exploring the theological context, this study provides a definition of conflict that is relevant not only to the novel Till We Found Faces, but also to other works by Lewis. This enables future attention to the metaphors arising from the images and their meanings; to identify the main idea of the texts.

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Transforming Justice: An Analysis of Québec's Specialized Courts for Sexual and Domestic Violence Cases By Andreas Petropoulos

Abstract

In November of 2021, the province of Québec had introduced Bill-92, An Act to create a court specialized in sexual violence and domestic violence and respecting training of judges in these matters. The legislation proposed the development of a separate, specialized court system that will address gendered violence, specifically being offences of domestic and sexual assault. Due to the ongoing concerns surrounding the handling of sexually violent cases, Québec has taken the initiative in addressing the lack of faith and confidence victims of gendered crime have long held within Canada's judicial system.

This article begins by addressing common misconceptions surrounding sexual assault by establishing the process of which a complainant must undergo in their pursuit of justice. Rape myths have long played a significant role in the high rates of case attrition, underreporting, and interactions with criminal justice actors. To reflect the Victims Bill of Rights (2015), the framework of Bill-92 calls for the implementation of professional development programs which will reflect the realities of sexual violence while including those deemed significant to its involvement. This article then examines a relevant case study, which provides examples as to how the current criminal justice framework often neglects the needs of the complainant, then moves on to analyze effective programming that has been supported through empirical evidence. Finally, this paper will establish methods of best practices in order to support those involved with special courts of judicature by focusing on the needs of those victimized by sexual assault.

Introduction

The urgency to address sexual and domestic violence has been increasingly recognized in recent years, especially with the rise of the #MeToo movement. The #MeToomovement was founded in 2006 by a sexual assault survivor named Tarana Burke (Brittain, 2023) and by 2017; millions of people were using the '#MeToo' hashtag all over the world. The movement played a massive responsibility in spreading awareness regarding sexual assault and its prevalance (Campbell, 2020). A pilot project of Special tribunal is introduced for domestic and sexual violence (Millán, 2022). Expert Committee Recommends Specialized Courts for Quebec's Sexual Assault Victims (2020) further highlighted this issue, revealing that many victims of sexual violence do not report the crime due to a seeming lack of importance placed upon complainant concerns of the criminal justice system. This report was significant as it provided 190 recommendations to better support victims of sexual assault and domestic violence, prompting the Québec provincial government to propose legislation to create a specialized court division. This new tribunal, established through Bill-92, An Act to create a court specialized in sexual violence and domestic violence and respecting training of judges in these matters, in November 2021, is Canada's first court system exclusively dedicated to hearing sexual and

domestic violence cases. This tangible action, combined with the pressure of the #MeToo movement and the increase in domestic violence during the Covid-19 pandemic, demonstrates the growing importance of addressing sexual and domestic violence in our society.

After the passage of Bill-92, the government of Québec has begun to establish new courts that exclusively hear sexual and domestic violence cases (Millán, 2022). These courts will be separate from the criminal division of the judicial system and will be established throughout the province by November 30, 2024. The initial phase has begun with pilot project courts, eventually making them permanent over time. The pilot project courts will be assessed by a ministerial advisory panel to determine their readiness for permanent status, which is to be completed by the November 2024 deadline, as stated in the legislation (Cour du Québec, 2022). The first five pilot project courts were announced in January 2022 and will be located in the districts of Beauharnois, Bedford, Saint-Maurice, Drummond in the Centre-du-Quebec region, and Quebec City (Quebec National Assembly, 2021).

This paper begins by reviewing the existing legal framework sexual assault complainants must endure in order to achieve justice. The information provided will then be used to analyze the current judicial framework and where it falls short of effectively supporting victims of sexual violence. The shortcomings of the justice system are then exemplified through R v Milovanovic (2020), which will be used as a case study to examine the impact of the current judicial system and its effects on complainants. The idea of restorative justice is then introduced as a potential aid in supporting sexual assault victims through sentencing alternatives, with additional frameworks supported through empirical evidence being analyzed for their effectiveness in supporting complainants throughout the judicial process in what may be deemed as best practices.

Understanding the Judicial Process for Victims of Sexual Assault in Québec

The current process for sexual assault victims seeking justice can be complex and challenging for complainants to navigate. The victim's first step is to file a police report, where a police investigation is then immediately initiated, during which thorough information about the incident is acquired. When the investigation is complete, the prosecutor, also known as the crown attorney, must then decide whether or not to proceed with the laying of a charge based on sufficient evidence. Prosecutors must be convinced that their analysis of the evidence is grounded and may opt not to commence proceedings. If the evidence found is deemed insufficient, the case may be closed, or the prosecutor may request an additional investigation. If the crown attorney grants the prosecution, a police officer will obtain an arrest warrant and apprehend the suspect and advise them of their charges, as per section 11(a) of the Criminal Code (1985). If the officer believes the subject will re-offend or fail to appear in court, he or she may choose to retain the defendant or release on judicial interim release subject to certain provisions or a surety.

The suspect must be present in court on the set prosecution date provided on the information for a reading of the charges. The defence may then decide, based on the charges

presented and disclosure of evidence, to request a preliminary inquiry. During a preliminary hearing, the judge will review the evidence to determine if it is sufficient enough to proceed to trial. If the evidence is deemed adequate, the judge may then decide which charges will remain, or may even dismiss any charges that are not competently supported by the available evidence. If the accused pleads guilty at any time throughout the trial, the sentencing process begins immediately; however, if the defendant files a not-guilty plea, a criminal trial will then commence. At this stage, the accused may then choose between a judge-only trial or a trial before a judge and jury.

The trial is the determining step in which the criminal and penal prosecuting attorney will aim to prove that the defendant is guilty beyond a reasonable doubt of the acts for which they are accused. Two parties take part in the trial: the prosecution, represented by the criminal and penal prosecuting attorney, and the defence, represented by the accused's lawyer or by the accused themselves. It is at this stage that witnesses, including the victim and expert witnesses, may testify, and evidence is introduced. In cases where the accused testifies, the prosecutor will cross-examine them. Specific laws have been implemented in Canada when it comes to the cross-examination process of victims, which has been widely referred to as 'Canada's rape shield laws'. The Criminal Code was only recently revised to include section 276(1), which limits the admissibility of evidence collected through cross-examination of complainants concerning their past sexual history. Legislative and judicial developments in Canada explicitly reject these myths about victims of sexual offences that historically shaped assessments of their credibility.

If the verdict is guilty, the judge imposes a sentence, while a not-guilty verdict leads to the immediate release of the accused. If either party feels that the jury or judge has made an error, the case can be appealed. The onus is then on the individual responsible for filing the appeal who must prove that the judge or jury has made an error that affected the result.

Challenges faced in the Current Judicial Process

The provincial government of Québec's objective in implementing the act is to establish a specialized court for sexual violence, which in turn may aid in restoring confidence in the criminal justice system for survivors of sexual assault. This is primarily achieved by implementing measures that enable victims to feel safe and secure throughout the criminal justice process. However, the underlying question which must be addressed is why is there a need for such measures in the first place?

Underreporting and High Case Attrition Rates

A common challenge faced in the criminal justice methods for sexual offences is the generally held belief that these approaches disregard victims' rights and interests. These beliefs are ultimately backed by underreporting and high attrition rates (Campbell, 2020). As a result, victims experience a high chance of re-victimization. Re-victimization refers to the negative experiences that a survivor of sexual assault may encounter when they become involved in the

judicial process. A typical example of re-victimization may be caused by a lack of understanding and sensitivity towards the survivor's needs and therefore may exacerbate the trauma of the initial assault.

Sexual assault victims have been reported using negative descriptive terms to refer to themselves after their assault. Feelings of shame resulting from sexual harm can affect not only an individual's self-perception but their response to the crime. This not only deeply affects their mental state and dignity but also makes them prone to re-aggravated trauma (Josse, 2010). Individuals who have experienced sexual harm frequently undergo a protracted process that requires ongoing engagement with different criminal justice practitioners, such as attorneys and law enforcement. These interactions with the legal system have proven to exacerbate victims' distress, as they are often met with suspicion, invalidation, or dismissal by individuals who demonstrate little regard for their situation (Lorenz, 2019). Reporting may also be impacted by the apprehension of experiencing re-victimization. For instance, women who have undergone sexual assault are more inclined to report their experience to official support services when their case adheres to the characteristics of a 'real rape', a term coined by Susan Estrich in 1986, or if the survivor fits the narrative that victimologist Nils Christie (1986) described as the 'ideal victim' (Eelmaa, 2021). Examples of this may include when the perpetrator was unknown to the victim, the belief that their allegations will be accepted, the likelihood of trial resulting in a conviction, when they have physical injuries that substantiate their claims of non-consensual intercourse, or when a weapon was used (Reno, 2000). A study that analyzed data from the National Violence Against Women Survey (2000) investigated the factors that contribute to survivors' reluctance to report incidents of sexual harm to law enforcement. The decision to refrain from reporting was primarily attributed to concerns that the police would be unable to take action, apprehension that their account of events would not be accepted, fear of retaliation, and feelings of disgrace and humiliation (Reno, 2000).

Dealing with law enforcement and lawyers can be a stressful experience for anyone who has just experienced a traumatic event, especially when the individual is part of a marginalized group. Empirical evidence suggests that members of social groups who face systemic barriers to legal and political institutions are also more likely to experience sexual violence and be uncomfortable with police interactions (Ibrahim, 2020). Transgender and gender diverse, Two-Spirit Indigenous, disabled, and racialized persons experience higher rates of sexual violence. Research has found that among Black women, reporting decisions are influenced by various factors, such as economic status, apprehension of experiencing racism, the degree of adherence to a Black cultural obligation to safeguard Black men from criminal justice proceedings, and previous negative experiences with social service agencies (Washington, 2001). Additionally, after experiencing sexual harm, women of colour typically avoid seeking aid from institutions and organizations run predominantly by White individuals, including the criminal legal system.

Not only is underreporting sexual assault a global issue but so are high rates of case attrition. Out of the 40'000 sexual assault cases presented in Canada from 2009 to 2014, only about half of those accused ended up incarcerated (Statistics Canada, 2017). Both underreporting and case attrition are largely connected to rape myths. Rape myths are false beliefs or stereotypes about sexual assault that contribute to victim blaming and excuse a perpetrator's behavior. Examples of rape myths can include: the belief that the complainant was culpable in their own victimization - this myth suggests that a victim's behavior or clothing was provocative and therefore enticed the assailant to commit the offence. It can also include the false notion that rape only happens to women who are physically overpowered. This belief suggests that sexual assault is only perpetrated by strangers and is always accompanied by physical force. In reality, many sexual assaults are committed by acquaintances or intimate partners, and physical force may not always be present. Adherence to rape myths result in the silencing of survivors of sexual harm, ultimately leading to high rates of case attrition.

Police and Prosecutorial Interactions

The police play a significant role in determining the trajectory of cases within the criminal legal system; include determining whether a crime has occurred, the allocation of resources towards identifying suspects, whether to make an arrest, and whether to refer the case to the prosecutor's office. Given this, it is important to understand the factors that influence police discretion in regard to decision-making in cases of sexual harm. Many survivors choose not to report due to fears of re-traumatization, disbelief, and low perceived efficacy. Unfortunately, these concerns are often validated by negative experiences with law enforcement. A study found that in 2019, only 41% of Canadians said they had a great deal of confidence in the police, while about half said they had some confidence (Ibrahim, 2020). Additionally, survivors often report feeling shocked, embarrassed, and unheard when police officers fall in line with false narratives that blame victims for their assault. Police officers have also been found to develop a habit of acting insensitively towards sexual assault survivors' trauma by disregarding their personal needs (Jordan, 2002).

The decision to close a sexual assault case is critical for police. It occurs when the officer doubts the victim's account of events or believes that the chance of arrest and prosecution is low. Investigations can be traumatic for victims as investigators are required to look for gaps and inconsistencies, potentially leaving complainants feeling blameworthy and unsupported. Research has found that contact with the police may actually lead to negative interactions, and in turn, typically result in the victim developing symptoms of PTSD (Ullman, 1996).

Rape myths are also very common when police interact with survivors, and evidence suggests that they do not treat every case equally due to these preconceived notions (Alexa & Ackerman, 2022). Police culture has been described as masculine and authoritarian, which therefore may contribute to the emergence and preservation of rape myths (Alexa & Ackerman, 2022). As a result, it is not surprising that victims who consider themselves to not have had a 'real rape' are less inclined to report their assault to the police. As previously mentioned, this

includes harm caused by a previous intimate partner, situations where the victim did not actively fight back, and circumstances where the victim does not adhere to traditional gender norms.

Misconceptions around sexual assault are present at every stage of the legal system. Evidence suggests that rape myths made by police officers play a significant role in the decision to prosecute, along with other legal factors such as the offender's criminal record and the strength of the evidence (Cassia, 2001). In order to prevent this, it is crucial for victims to be present throughout the entire prosecution process. The prosecutions of sexual assault cases are typically difficult to pursue without the involvement of the survivor. This is mainly due to the fact that prosecutors are able to exercise their power of discretion, and in most cases where the victim is not present during proceedings, results in charges being dropped (Cassia, 2001).

The trial process is a difficult time in a victim's life. Their psychological - mental and psychological mean the same thing state is likely to still be in shock from the assault, and after being constantly interviewed by police and forced to recount a traumatic event, a survivor may be hesitant to describe their experience during a criminal trial. Not only can the trial take an emotional and psychological toll on the victim, but it also takes a toll on what victimologists describe as secondary victims, typically being the families and loved ones of the complainants. Both the primary and secondary victims must relive the traumatic event continuously in order to achieve any form of justice.

Conclusion

Survivors of sexual harm often seek validation and recognition of the significance of their experience. However, this does not necessarily mean they desire severe punishment for the perpetrator. Instead, many survivors want the perpetrator to take responsibility for their actions and engage in sincere reconciliation efforts. Meaningful consequences do not necessarily equate to suffering or harsh punishment that Canada's current adversarial system is based on. Generally, survivors of sexual violence prioritize accountability and responsibility for those who caused them harm (Zinsstag & Keenan, 2019).

Case Study: R v Milovanovic (2020)

R v Milovanovic (2020) is a valuable example as to how sexual assault cases are handled within the current criminal justice system. Milovanovic was accused of forcibly confining and sexually assaulting an Indigenous woman, known only by the initials 'N.I', on numerous occasions from August to September of 2017. N.I was described as an Inuit woman who struggled with substance abuse, specifically alcohol, and is therefore considered a vulnerable person on several counts under section 718.201 of Canada's Criminal Code (1985). Milovanovic had elected to represent himself while presenting beliefs that current legislation suggests are aggravating factors in cases of sexual assault, primarily holding the conviction that the offender had a strong bias towards Indigenous women and sexual violence.

Milovanovic was found guilty on 4 of the 9 counts presented before the court. He was found guilty of sexual assault, assault causing bodily harm, uttering threats, and forcible

confinement. Although Milovanovic represented himself throughout his trial, as per section 486.3(2) of the Criminal Code, a court-appointed counsel was required to perform the cross-examination of the complainant. During the cross-examination, several questions were brought forth, which may be known to some as 'whacking the complainant', in an attempt to discredit or confuse the victim (Tanovich, 2014). N.I's sexual history with the accused, prior convictions, credibility, and medical history were disputed during the trial. It was found that, due to N.I being unconscious during the first sexual encounter, this instance of sexual assault was proved beyond a reasonable doubt, however, those following this occasion were not deemed as having sufficient evidence to support these allegations, and therefore dismissed. N.I's credibility was disputed due to a lack of transparency when sharing information regarding her prior convictions, in addition to the inconsistencies presented when speaking to her numerous experiences with Milovanovic before the court. An important consideration to be made aware of, however, is that victimologists suggest the memory of survivors who had lived through a traumatic incident is influenced due to one's emotional state, shock, and other variables (Allen, 2012). Further, the court had found that N.I's medical examination was not indicative of the amount of sexual assaults she alleged had occurred, a result in which may have been influenced by the misconception that sexual assault must always be a violent act.

According to Canada's Criminal Code (1985), section 276 is what is widely known as Canada's 'rape shield laws' (Koss & Achilles, 2008). Section 276 of the Code states that the sexual activity of the complainant is not admissible, whether it be with the accused or any other individual, unless specific conditions are met such as its relevance to trial and that any prejudicial concerns will not interfere with the administration of justice. The essential premise of the 'rape shield' involves a reasonable expectation of privacy while ensuring the integrity and dignity of the victim are upheld during court proceedings, as the rights of the accused do not surpass those of the complainant.

Also under the Criminal Code (1985) are aggravating factors that aid in the determination of guilt. As such, under sections 718.04, 718.2(a)(ii), and 718.201, factors suggesting increased culpability of the criminal acts in question were brought forth to be considered before the court and trial judge. Under section 718.04, offence against a vulnerable person is considered. In this case, the complainant was both a woman and identified as Indigenous, and was therefore found especially vulnerable due to multi-faceted oppressive factors. Section 718.2(a)(ii) states that, when imposing sanctions upon the accused, the court must consider the fact of intimate partner violence. It was determined that, due to the frequency of events transpiring between N.I and Milovanovic, they were determined by the court to be intimate partners, therefore resulting in an additional aggravating factor. Lastly, 718.201 combines the aggravating factors of both of the prior sections mentioned, stating that an additional consideration yet again must be made in regard to increased vulnerability in circumstances related to one's social demographic and whether or not they are considered an intimate partner of the accused.

With these instances stated, it is apparent that criminal court proceedings are quite difficult for the complainant, especially considering testimonials and the often re-victimizing cross-examinations. What aids in upholding the respect and dignity of the victim during criminal justice procedures, in addition to Canada's 'rape shield' laws, is the Victims Bill of Rights (2015). This piece of legislation was drafted in 2015 and establishes the right to privacy, information, protection, and participation of the victim. Perhaps the most integral piece of this is the right to participation. Section 14 states that victims have the right to voice their opinion on sanctions imposed upon the accused, and section 15 allows for the right to present a victim impact statement before the court during sentencing. In the case of Milovanovic, N.I had elected to read aloud her own victim impact statement, describing both the physical and emotional damage the court process had subjected her to with a specific focus on the harm caused by testifying and unrelenting cross-examination.

Restorative Justice

Victim impact statements are an integral part of victim participation within the criminal justice system. In Canada, they have become increasingly popular within the past decade, primarily due to the push for alternative sanctioning methods, such as restorative justice. Restorative justice is described as a system that focuses on rehabilitation and reconciliation rather than retribution and punishment, with a strong focus on healing including those involved in the act, being the victim, offender, and the community (Wormer, 2009). Restorative justice and its effectiveness in cases of sexual violence, or gendered crime, has been a long-debated topic.

Questions associated with the effectiveness of restorative justice which are often brought forth are typically under the impression that restorative approaches to sanctioning do not hold offenders accountable for the harm their actions have caused and do not effectively deter criminals from reoffending. The first step of restorative justice is to ensure the accused admits to the wrongdoing and takes responsibility for the harm they have caused. Before moving forward with any form of reconciliation, this crucial element must be met and ground rules must be established to determine appropriate topics of conferencing (Koss & Achilles, 2008). Moreover, due to the several models of restorative justice approaches, accountability is at the forefront of repairing harm (Keenan, 2022). Methods of restorative justice related to sexual assault crimes typically include victim-offender conferencing, support or healing circles, and sentencing circles. Restorative justice, in each method presented, has victim-offender reconciliation at its core. Victims are given the opportunity to share impact statements and provide suggestions for repairing harm all while ensuring they are supported by a qualified group facilitator in a safe and secure environment. In addition, secondary victims and members of the community, or tertiary victims, are also able to attend conferencing groups (as approved by the primary actors) and share their feelings. In the context of sexual assault or gendered crimes, preparation and ground rules for group facilitation are important to ensure the victim feels both heard and safe during the

encounter. Unlike the criminal justice system, restorative justice is victim-centered, and their needs and personhood are less likely to be overlooked in the pursuit of justice (Ubell, 2018).

Canada's criminal justice system is based on methods of deterrence. While specific deterrence is aimed toward the individual, general deterrence is based on the community as a whole and it has been found through numerous research studies that the likelihood of being caught, rather than the severity of imposed sanctions, is what deters offenders from committing criminal acts (Linden, 2020). With the latter being an integral part of criminal justice proceedings, restorative justice appears to be an alternative that is based on both specific and general deterrence. With sexual assault having high cases of attrition and significant rates of under-reporting, restorative justice methods seem to hold offenders accountable while maintaining the primary aim of the current judicial system, community safety, through reducing rates of recidivism and suggesting methods of both specific and general deterrence.

Restorative justice is a method of deterrence in the sense that it humanizes the victim and provides context to the harm caused. While the criminal justice system is based on punishment rather than restoration, understanding that the victim and offender are human beings often gets lost during the efforts of truth-seeking and sanctioning. While there are different methods of deterrence, some may hold the view that restorative justice leans more towards specific deterrence through its reduction in recidivism in both violent and non-violent offences (Marie, 2022). Specific deterrence is aimed towards an individual offender and their likelihood to re-offend. Through restorative justice methods ensuring accountability, discussion, and acknowledgment of harms caused, numerous examples of empirical data suggest that recidivism rates for sexual assault offenders who partook in restorative justice is greatly reduced in comparison to those who received court-appointed sanctions (Alexa & Ackerman, 2022). By completing restorative programming, recidivism rates were found to be significantly lessened and offenders responsible for the harm caused to the victim were able to reintegrate successfully back into society (Koss, Bachar, & Hopkins, 2022).

Restorative justice has victims' needs at its center. Victims' needs are often not met within the typical judicial framework in dealing with sexual assault cases, such as autonomy, safety, education, support, accountability, healthy coping mechanisms, and attaining answers (Alexa & Ackerman, 2022). While restorative approaches to dealing with cases of sexual assault or gendered crime are victim-centered, it is important to consider the differing needs of each victim as unique to the individual and their social location. For example, it is supported that Indigenous facilitators are integral to the healing process and security of Indigenous victims (Griffiths & Murdoch, 2018). By utilizing an intersectional approach, often known as intersectional feminism, to support victims of sexual assault within the environment of restorative justice, victims' needs are more likely to be met, offenders are more likely to understand the significance of the harm their actions have caused, and the community may be more receptive to the needs of the victim, where services are offered to both victim and offender in relation to what they may require in order to move forward (Daly, 2001).

As mentioned in our case study of R v Milovanovic (2020), the victim, N.I, was an Indigenous woman who struggled with substance abuse. Due to these demographics, N.I was placed in an extremely vulnerable position and was subject to risk heterogeneity due to her biological characteristics of being Indigenous and female, in addition to an increased vulnerability of being an individual suffering from substance use. N.I had stated in her victim impact statement the re-traumatization of testifying and being subjected to unrelenting cross-examinations - a key component in why restorative justice is often sought after when sexual assault is involved. The current adversarial system and the ideology of absolute justice are problematic when it comes to sexual assault cases especially, as victims' needs are often neglected in the pursuit of fundamental justice (Wormer, 2009).

Restorative justice, if facilitated from an intersectional feminist perspective, allows for not only accountability and reparation, but it also enhances the collective rhetoric and awareness related to the victimization of vulnerable populations. Restorative justice takes into consideration power imbalances, the special needs of female victims, and autonomy - all areas in which the current judicial system has trouble maintaining (Wormer, 2009). Intersectionality acknowledges the unique circumstances one's social location has in their victimization, such as race, class, gender, and ability. Victimologists have found that vulnerable populations are at a significantly increased risk of being victimized (Wemmers, 2017), demonstrating a crucial need to take into consideration the conditions which led to their victimization, but will also ultimately lead to their healing. It is integral for restorative justice approaches to consider the harm from a concrete point of view while understanding the historical treatment of women in regard to gendered harms and sexual violence (Daly, 2001) when it comes to the implementation and application of best practice.

Best Practices

In January of 2022, Éducaloi, a non-profit organization that explains the law to Québecers while avoiding the use of often puzzling legal jargon, published a guide titled Accompanying Sexual Assault Victims in Vulnerable Situations (2022). It was designed for social workers who closely support victims of sexual assault in order to educate the public on the uncomfortable vulnerability victims' often feel when involved in the criminal justice system. In addition, the guide poses helpful suggestions for best practices in overcoming these challenges - sentence was super long. The guide focuses particularly on four sections of the criminal legal system: police complaints, police investigation and role of the criminal and penal prosecuting attorney, the court process, and assistance and accompaniment resources. Each of these sections will be examined to review what an ideal sexual offences system would look like. Not only can these recommendations to pressing issues be implemented in Québec's tribunal system, but they may also act as a model for all provinces and territories across Canada.

Police Complaint

Police interactions can be an extremely stressful and degrading experience for victims of sexual assault. The guide identifies major issues with victim-police interactions and provides recommendations on how law enforcement may improve in their ability to support victims of sexual assault. It indicates that a fear of the criminal justice system is a major factor in a victim's discomfort with police interactions. Due to past experiences with other institutions, victims believe that the criminal justice system will treat them with the same disdain and incredulity they have typically received. This is especially true for marginalized communities (Ibrahim, 2020). Best practices in order to rebuild trust and reduce fear with law enforcement interactions may include: practicing mindfulness in regard to victim experiences, as well as creating specialized response teams in handling gender-based violence. Implementing these practices can aid in rebuilding the trust and confidence within the reporting stage of the justice system that has long been lost by victims of sexual violence.

Police Investigation and Role of the Criminal and Penal Prosecuting Attorney

As outlined earlier, a police investigation is launched subsequent to a police complaint. A police officer can decide to unfound a case or transfer it to the prosecutor. If the officer decides to transfer the case, the prosecutor evaluates the evidence and decides whether to lay charges. The guide describes the main issues with this process as leaving the victim feeling "feelings of powerlessness and vulnerability" (Educaloi, 2022, p. 15). Avoiding unnecessary legal jargon to ensure survivors of sexual assault understand the legal proceedings in which they will become involved in is a crucial element in the application of best practices. Keeping victims informed of the process will decrease levels of discomfort and uncertainty.

The Court Process

The legal proceedings commence when the criminal prosecuting attorney initiates criminal charges. The process must go through several stages before reaching a verdict. During this time, the victim plays a crucial role in the progress of the case and may be required to testify. It is essential to note that in sexual assault cases, the victim may be the sole witness, which can be a stressful and overwhelming experience for them. Thus, it is vital to provide support and understanding to the victim throughout the legal process. An all too common occurrence during testimonials when the victim must also act as a witness is the issue of credibility and poorly contextualized memory due to trauma. Acknowledging the difficult circumstance of the victim and amending certain questions or procedures in order to adapt to their needs may consolidate their recollection and description of events.

Assistance and Accompaniment Resources

Victims of sexual assault typically require assistance in navigating the challenges posed post-trial. Obtaining support is crucial for these individuals since sexual assault can be traumatic and emotionally taxing. Concerns around the victims' ability to acquire assistance or support

through crisis intervention are primarily due to the lack of available agencies and resources. Social agencies and frontline crisis support workers are typically overwhelmed with the capacity of current case loads, and are therefore often unable to provide adequate, demographically appropriate, assistance to those who do reach out (Educaloi, 2023). Ensuring the proper means to assistance and accompaniment resources while utilizing an intersectional approach for especially vulnerable victims is a best practice suggestion which should be swiftly employed.

Conclusion

Members of underrepresented communities face prevalent issues in every step of the criminal justice system. As explained in the Educaloi (2022, p. 37) article, from police interactions to the courts, the marginalized peoples face "a variety of significant challenges the moment they decide to seek justice". In order to ensure that justice is accessible for everyone, it is imperative that Quebec's judicial system is made aware of the current issues certain communities face and that they adhere to the best practices presented by the Accompanying Sexual Assault Victims in Vulnerable Situations article.

Conclusion

A specialized sexual assault court system for the province of Québec has been in development for the past several years. Bill-92, An Act to create a court specialized in sexual violence and domestic violence and respecting training of judges in these matters, was introduced in November of 2021 in response to gendered violence primarily impacting women and other gendered minorities. The project is a promising initiative in improving the often complex and unjust adversarial system Canada's criminal justice system is based on.

Victims of sexual violence are often left feeling vulnerable and unsupported by criminal justice actors. The current framework for handling cases of domestic and sexual violence has made amends over the past decade in the pursuit of victims' rights, such as section 276(1) of the Criminal Code (1985), to avoid further perpetuating harmful myths and beliefs surrounding sexual assault and the concept of what a 'real rape' or 'ideal victim' looks like. Concerns surrounding the complexities of the retributive system have developed primarily due to methods of prevention and response to sexual violence. High rates of case attrition, underreporting, negative interactions, and erroneous assumptions have a significant impact on both primary and secondary victims of sexual violence. These conditions ultimately lead to a diminished sense of confidence in the justice system, demonstrating a crucial need for change.

The foundation of Canada's current retributive system has illustrated a lack of support for victims of sexual violence. The Victims Bill of Rights (2015) has established groundlines for the protection, restitution, information, and participation. The system, however, often neglects these needs and the victim typically feels excluded and re-victimized by criminal justice actors. As seen in the case study of R v Milovanovic (2020), the complainant had exercised her right to participation by reading aloud a victim impact statement to the court. Like many of these statements, the focus of the statement was not only on the act of sexual violence itself, but the

re-victimization the court process had subjected her to. Through the development of Québec's specialized court system, victims of sexual assault may feel their needs are taken seriously and the contempt and lack of confidence in the justice system may be restored through meaningful practices and initiatives proposed within this legislation.

Restorative approaches may be a helpful development in the revisions Canada's adversarial system of justice requires in order to deal with both offenders and victims of sexual assault. Oppressive factors contributing to the victimization of marginalized groups makes sexual assault both a social and legal issue. By including the societal portion of sexual violence into criminal justice practices and sanctions, this specialized court system may then contribute to best outcomes for both victim and offender. Alternative sanctioning, such as restorative justice, has been proven to have an increased rate of satisfaction for both victim and offender. The acknowledgement of harm is the first step in reconciliation, which may be advertised through Québec's initiative in amending the current judicial framework to include a specialized court system whose focus is on victims of sexual violence and the revictimizing aspects which are often experienced.

Québec will be the first province or territory in Canada to introduce legislation proposing an alternative court system for victims of sexual violence. This paper has provided an outline of what the province of Québec aims to address with the inception of a specialized court by analyzing the current judicial system, which has been determined by many as a problematic and re-victimizing process. By establishing a framework via best practices and empirical evidence, the remainder of Canada may use Québec's ingenuity to advance their own judicial systems in the pursuit of fundamental justice and the restoration of confidence within the criminal justice system for survivors of sexual violence.

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Radiopharmaceuticals for Cancer Treatment–Applications, Commercial Use, and Associated Limitations By Dev Patel

Abstract

Historically, cancer patients have been treated by non-targeted treatment methods such as radiation therapy and chemotherapy. These treatments aim to "poison cancerous cells faster than poisoning the rest of the body." These treatment methods are flawed and often leave patients worse than they had started due to heavy collateral damage to somatic cells. In recent decades, the cancer treatment field has been moving away from these traditional treatment methods and into newer, more safe methods. One example is radiopharmaceuticals, which have been developed with an altered mechanism of action to prevent collateral damage to normal somatic cells. Radiopharmaceuticals, also known as radiopharmaceutical therapy (RPT), have demonstrated success, although in practice are heavily limited. Certain radiopharmaceuticals can specifically bind to cancerous cells, severely limiting toxicity. Recent FDA approval of several RPT agents has increased the recognizability of this treatment for cancer, and further developments could lead to RPTs becoming the future of cancer treatment with the hope of eventually finding a universal cure. This review covers the differences between traditional radiotherapy and radiopharmaceutical therapy, applications of RPTs, commercial utilization of radiopharmaceuticals, and interrelated challenges associated with the RPT treatments as a whole.

1. Introduction

Shortly after Wilhelm Conrad Roentgen presented the X-ray to the scientific community in 1896, scientists found that beaming X-rays at cancerous patients had some beneficial effects. In the early 20th century, French scientists unveiled the idea that short-spaced-out doses of radiation had a beneficial impact in treating cancer. Nevertheless, traditional radiation therapy was far from perfect. Scientists often experimented on their own hands by intermittently increasing dosage levels until they reached an erythema dose, producing a pink reaction on the scientists' skin, which looked like a sunburn. Unfortunately, many of these scientists developed leukemia later because of their continued exposure to radiation (American Cancer Society Medical and Editorial Content Team).

This practice was not sustainable in the future. Even though traditional radiation therapy has become safer for administrative doctors, it is not practical for patients. Patients experience fatigue, hair loss, memory and concentration issues, vomiting, raging headaches, skin changes, throat problems, and more (National Cancer Institute, "Radiation Therapy Side Effects"). Delivering widespread radiation throughout the body with the hope of doing more damage to cancer than the cells necessary to sustain life is not pragmatic.

The discovery of radiopharmaceutical therapy (RPT) via radionuclides has uncovered a new treatment method that is often more safe and efficient for patients. As shown in Figure 1, the unique mechanism of action involves causing irreparable DNA damage specifically to cancerous cells, minimizing collateral damage (Huang and Zhou; Morris, Wang, et al.). Toxicity

levels associated with radiopharmaceuticals are relatively lower than traditional radiation therapy (Sgouros et al.). Various RPT agents and their combinations can be used depending on the type of cancer and the stage of metastatic spread, meaning treatment is more personalized depending on the patient's needs.
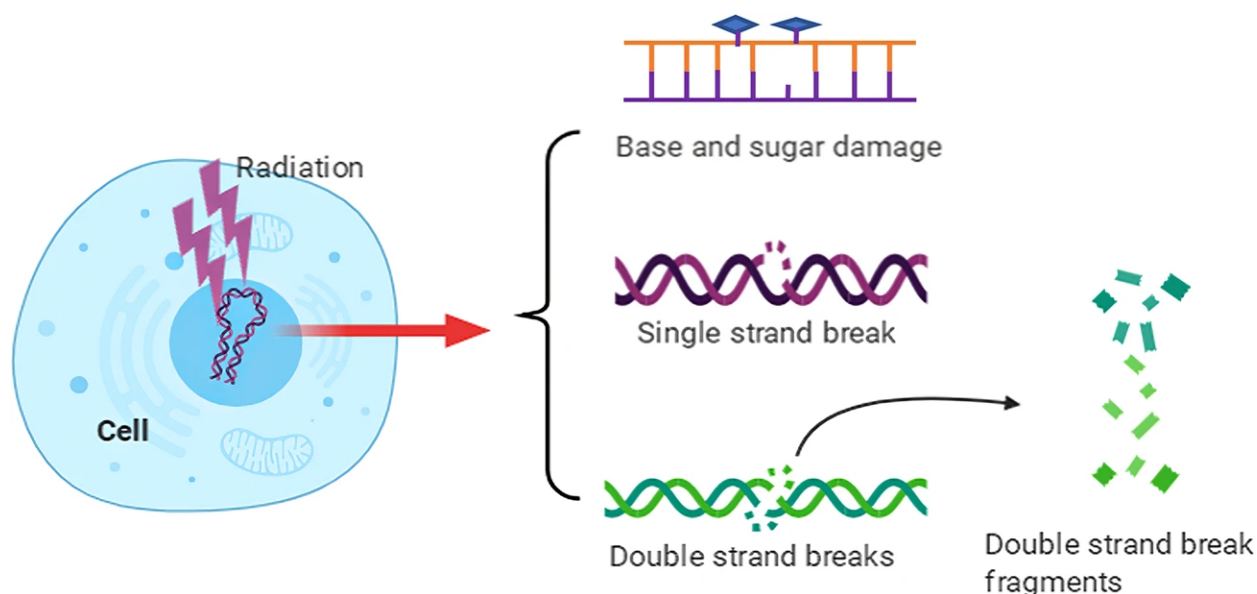
Fig. 1. Radiopharmaceuticals induce cell death via irreparable DNA damage. Reproduced under Open Access license from (Huang and Zhou).
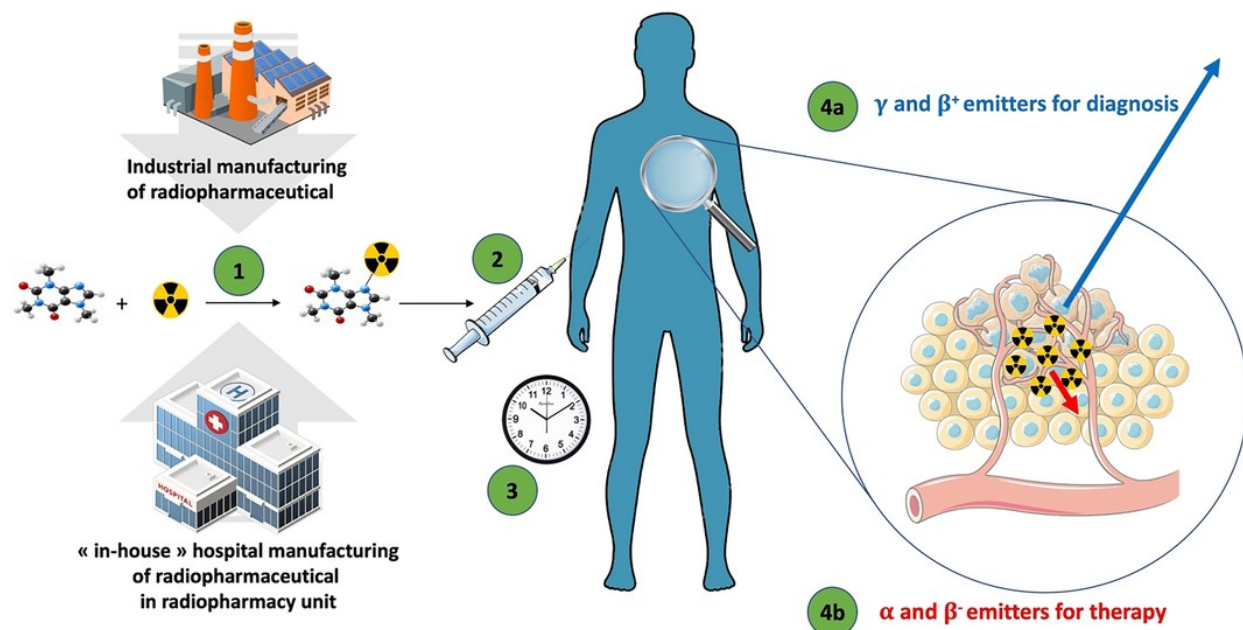
Fig. 2. Mechanism by which RPT agents deliver radiation into cells. Reproduced under Open Access license from (Faivre-Chauvet et al.).

In the last decade, radiopharmaceuticals have increased prevalence in the cancer treatment industry. In the early 2010s, the FDA approved multiple RPTs for commercial use

(National Cancer Institute, "Radiopharmaceuticals Emerging as New Cancer Therapy - National Cancer Institute"). The early FDA approvals have sparked a wave of new research and treatment options in the radiopharmaceutical industry as scientists hope to discover even more consistent and efficient RPT agents for clinical use while overcoming the challenges and limitations that radiopharmaceuticals pose.

This review aims to cover the differences between radiopharmaceuticals and traditional radiation therapy, the applications of radiopharmaceuticals, current commercial radiopharmaceuticals, and the challenges and limitations associated with radiopharmaceuticals.

2. Radiopharmaceutical Therapy vs. Traditional Radiation Therapy

RPTs have three components: the radioactive molecule, the targeting molecule, and the linker molecule between the two. These components, together, ensure that the drug delivery, Ctargeting, and treatment processes are seamless. One example of an RPT, radioactive iodine, was used to treat thyroid cancer in the 1940s because it naturally accumulates in thyroid cells (National Cancer Institute, "Radiopharmaceuticals Emerging as New Cancer Therapy - National Cancer Institute"). During preclinical research, scientists and pharmaceutical researchers must uncover the mechanism of delivering particular RPTs to the cancer site and ensure that the radioactive material lingers in the region long enough for the cancer cells to die. Heavy planning during preclinical and clinical trials involves dose calculation, dose distribution, and dose volume to secure an approval from the FDA.

As stated previously, radiopharmaceutical therapy has revolutionized cancer treatment as an alternative to traditional radiation therapy and chemotherapy because of its unique mechanism of action. Radiopharmaceutical therapy involves using a radionuclide containing a small amount of radioactive material combined with a cell-targeting molecule to treat cancerous and non-cancerous diseases (Sapienza and Willegaignon). Radiopharmaceuticals take advantage of their binding molecule to specifically attach to the desired cancer cell. For example, Cr-51 radiopharmaceuticals specifically bind to intracellular hemoglobin in red blood cells (AnazaoHealthCorporation). Cr-51 functions to determine red blood cell volume (Ponto). Alongside other treatments and imaging radiopharmaceuticals, Cr-51 can be useful for scientists trying to diagnose cancer. While both traditional radiation therapy and radiopharmaceuticals use DNA damage, or the impairment of DNA synthesis, as the mechanism by which cancer cells are killed or forced to stop dividing, only radiopharmaceuticals can ensure that radiation does not reach healthy somatic cells (Morris, Wang, et al.).

3. Applications of Radiopharmaceuticals

Radiopharmaceuticals can produce images of organ or tissue matter of interest for patient prognosis determination, a process called scintigraphy (IAEA). Radiopharmaceuticals contain a radiolabeled compound that spreads throughout the body and is visualized by a gamma camera (Sriselvakumar, DeSai, et al.). The scope of radiopharmaceutical imaging is broader than cancer detection and even extends into determining the extent of infection or inflammation in the body

(Boerman et al.). However, one example of a radiopharmaceutical used for cancer imaging is Gallium Citrate (Ga-67), which is administered intravenously and can be used to detect Hodgkin's Disease, lymphoma, or lung cancer (Mayo Clinic).

90% of Ga-67 is bound to transferrin in blood plasma and very quickly binds and is transported by white blood cells, making Ga-67 most efficient in detecting lymphoma and Hodgkin's disease. However, Ga-67 has recently become outdated as the image quality cannot compete with other radioactive molecules. Its half-life of 3.26 days also poses a high radiation burden, whereas other isotopes like Ga-68 are just as effective with a shorter half-life (Dittrich and De Jesus).

Despite its advantages, radioactive imaging with Ga-67 and associated isotopes like Ga-68 has rare complications. These may include erythema, rash, pruritus, nausea, vomiting, tachycardia, dizziness, and syncope. Additionally, precautions with radioactive imaging, in general, must be taken with pregnant patients, breastfeeding patients, patients utilizing somatostatin analog therapy, and in pediatrics (Dittrich and De Jesus).

3.2. Theranostics

Theranostics utilizes radiopharmaceuticals to combine imaging and treatment. Theranostic treatments are revolutionary in cancer because they are a way to personalize medical treatment with direct diagnosis and treatment. Imaging tests via a RPT agent determine if a target is present in the patient's cancerous cells utilizing processes like scintigraphy (Gomes Marin et al.). If a target is found, the patient can receive the specific RPT to identify the target and destroy the surrounding tumor cells. Identification of the target and its destruction is coordinated through the radioactive molecule and binding molecule as shown in figure 3 (Yordanova et al.). Theranostic treatments are currently limited to the following types of cancer: non-Hodgkin lymphoma, bone metastases, prostate cancer, and neuroendocrine tumors ("Theranostics - Dana-Farber Cancer Institute | Boston, MA").
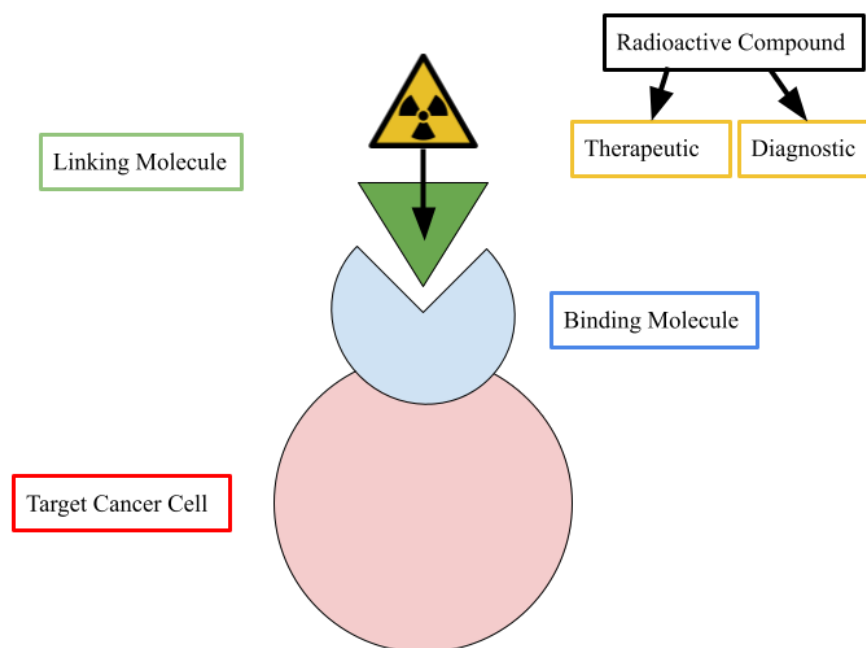
Fig. 3. Theranostic Mechanism of Action. Adapted from (Yordanova et al.).

3.3. Direct Treatment

Radiopharmaceuticals that emit beta minus particles, alpha particles, or Auger electrons are used in medicinal treatment to minimize collateral damage because of their effectiveness as a targeted cancer treatment method. The relatively small tissue range of less than a single cell diameter allows these particles to target the nucleus of cells (Holik et al.). Additionally, the particles' high linear energy transfer (LET) allows them to disperse their radiation within a tissue quickly thus increasing efficiency.

One example of a direct treatment molecule, 225 Actinium (225Ac), emits alpha particles when complexed with specific bifunctional chelating agents, which ensures stability between the radioactive and targeting molecular structures of a radiopharmaceutical. With all radiopharmaceuticals, leftover radioactive substances must be able to be processed by the excretory system to avoid as much harm to the patient. 225Ac has an associated recoil event when used clinically because there is excess energy released from the alpha particle emitter as depicted in the second diagram of Figure 4. The excess energy can potentially be dangerous for the patient treated. To minimize correlated damage, Piotrowska et al. used zeolites, nanocarriers, as a 224Ra transporter released from 225Ac. They found that 224Ra escape from zeolites is minimal, making this treatment option a good prospect for future radiopharmaceuticals (Holik et al.).
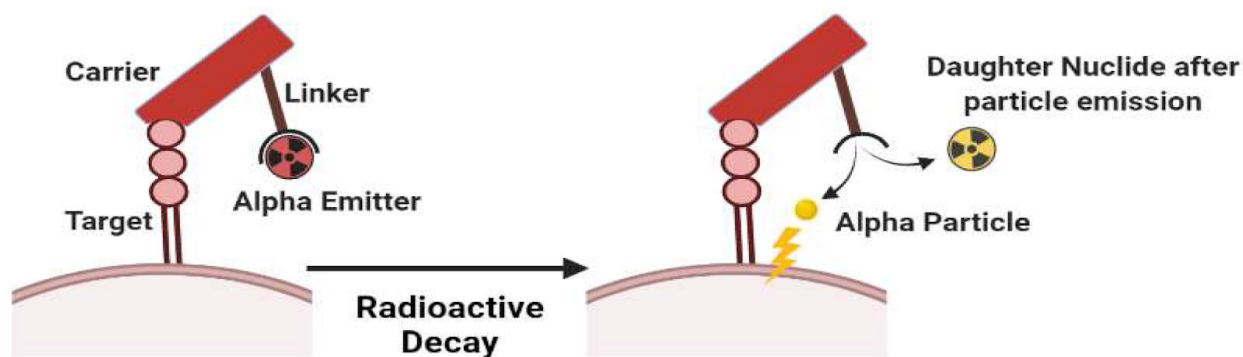
Fig 4. MOA of ^{225}Ac showing the complex's instability and emission of radioactive material into surrounding microenvironments. Reproduced under Open Access license from (Holik et al.).

Zeolites and related liposomes are an exciting prospect to minimize collateral damage by administering radiopharmaceuticals. However, another critical limitation of radiopharmaceuticals is the actual drug delivery process. Brain cancer, glioma, is notoriously difficult to treat using drugs due to the infamous blood-brain barrier. While the blood-brain barrier is helpful in limiting toxic materials from perfusing into human brain matter, it makes drug transport into the brain significantly more difficult. Approximately 98% of small molecule drugs cannot transport past the blood brain barrier(Pardridge). Nevertheless, a study by Tang et al. has undercovered targeted DNA nanoparticles that can specifically bind to U87MG cells, a particular glioma cell line, while inducing apoptosis. Other molecules like Gint4.T-tFNA-GMT8 (GTG) are showing promise as a treatment method for glioma and can also serve as a delivery agent past the blood brain barrier for other radiopharmaceuticals in the future (Shi et al.).

4. RPTs in Commercial Use–4.1. Background

Despite the difficulties in the drug development process associated with radiopharmaceuticals, the treatment method has made notable progress in the last decade. In the mid-2010s, the FDA approved two radiopharmaceuticals for non-Hodgkin lymphoma. However, few doctors were trained to administer these drugs, and eventually, a few years later, newer drugs began to outperform these radiopharmaceuticals (National Cancer Institute, "Radiopharmaceuticals Emerging as New Cancer Therapy - National Cancer Institute").

4.2. Lutetium 177-dotatate

Nevertheless, the most significant jump in progress in the development of the radiopharmaceutical industry was made in 2018 when the FDA approved Lutetium 177-donate. This RPT slows neuroendocrine tumor growth (Center for Drug Evaluation and Research). Lutetium 177-dotatate is co-administered with an amino acid solution, which acts as a renal protectant. The RPT is administered intravenously, with 30 minute administration periods. The treatment lasts eight weeks, consisting of 4 total doses. Common side effects were seen in 4% of the patients from the NETTER-1 data, which is the study on which the FDA based its approval. Side effects included lymphopenia in 44 percent of those experiencing side effects, increased

GGT (20%), vomiting (7%), nausea (5%), elevated AST (5%), and increased ALT, hyperglycemia, and hypokalemia (4% each) (Center for Drug Evaluation and Research). The demonstrated success of this RPT and subsequent FDA approval for clinical use has opened the curtains for many other RPTs and their respective applications.

4.3. Radioiodine

      Since iodine tends to naturally accumulate in the thyroid, radioiodine has been a targeted treatment for metastatic thyroid cancer since the 1940s, with scientists seeing a definite increase in long-term benefits (Catz et al.). Additionally, there was a low risk of developing secondary leukemia due to radiation exposure (Lamartina et al.). However, more extensive studies have shown that two-thirds of metastatic thyroid cancer patients gain immunity to the radioiodine treatment. This happens as thyroid cancer cells differentiate with a mutation that makes them refractory to radioiodine (Lamartina et al.). The mutation impairs the uptake and organification of iodine within mutated thyroid cancer cells due to an abnormal expression of the sodium/iodine symporter (NIS) and thyroid peroxidase (TPO) genes (Lamartina et al.).

      Researchers have also explored the potential of radioiodine in non-thyroid cancers by attempting to induce the expression of the NIS gene, thus increasing iodine uptake in cancer cells. Liu et al. designed an experiment to suppress MAP kinase, PI3K/Akt pathways, and histone deacetylase (HDAC) to induce the expression of the NIS gene. They concluded that the three inhibitors, RDEA119, perifosine, and SAHA (for MAP kinase, Akt, and HDAC, respectively), were positively influential in melanoma and epithelial carcinoma-derived cells which is shown in the western blot analysis in Figure 5; however, they could not induce the expression of the NIS gene in brain cancer-derived cells (Liu and Xing). The vast successes in non-brain cancer-derived cells indicate promise for radioiodine treatments alongside NIS expression inducers in the future.
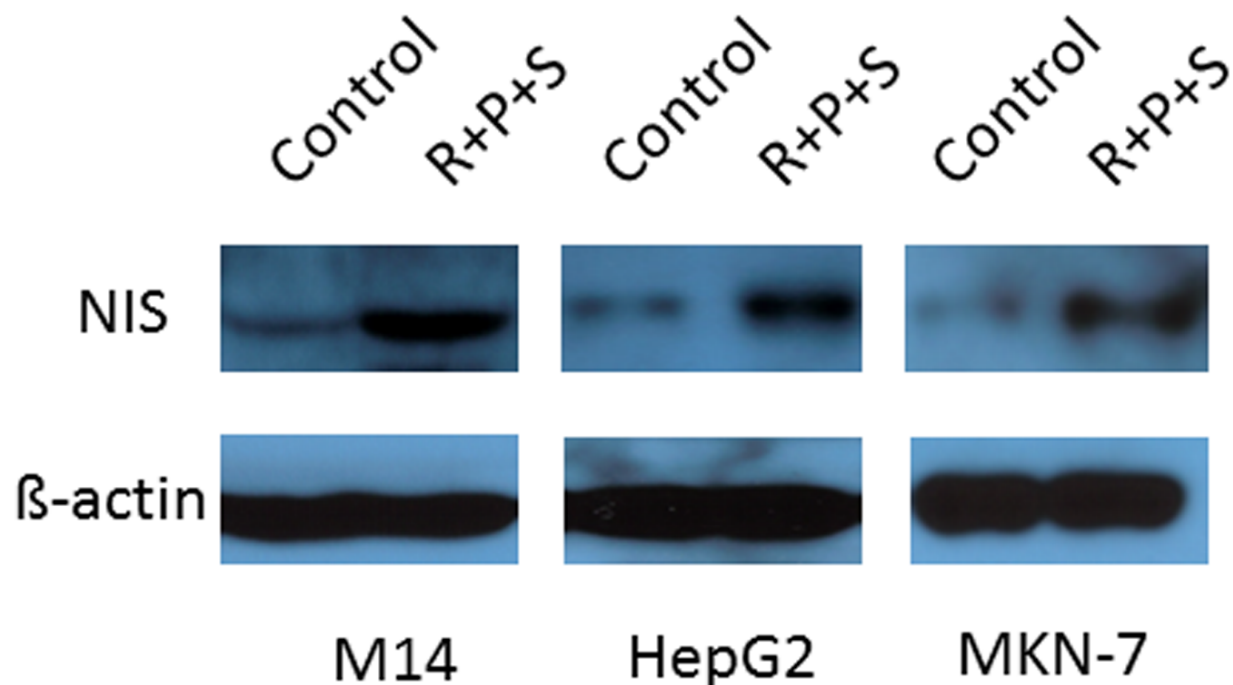
Fig. 5 Western blot analysis of NIS expression in different cancerous cell lines after treatment with R+P+S. Reproduced under Open Access license from (Liu and Xing).

4.4. Radium-223

Radium-223 was one of the first alpha-emitters approved by the FDA, trailblazing a path for other alpha-emitting radiopharmaceuticals. One of its clinical applications is in treating metastatic prostate cancer. The drug is used for pain relief, especially for patients whose cancer has spread to their bones ("Radium 223 (Xofigo) for Metastatic Prostate Cancer | Cancer Research UK"). Metastases typically happen after the patient stops responding to hormone therapy, and the cancer spreads to the bones, causing immense pain, weakness, and increasing the likeliness of fractures (National Cancer Institute, "Radium-223 for Advanced Prostate Cancer"). 90% of patients with metastatic prostate cancer have evidence of bone metastases, a major cause of death (National Cancer Institute, "Radium-223 for Advanced Prostate Cancer"). Like radioiodine, Radium-223 drugs have minor collateral damage. Studies have demonstrated a correlation between the administration of Radium-223 and a higher survival rate as opposed to a lower survival rate when treated with a placebo (Parker et al.). Henriksen et al. conducted biodistribution studies, concluding that Ra-223 was selectively concentrated in bone material concerning soft tissue (Henriksen et al.). Alpharadin, a Ra-223-based pharmaceutical, has demonstrated substantial bone-alkaline phosphatase decreases, indicating reduced cell growth compared to a placebo drug (Knut Liepe).

Xofigo, another radium-223-based drug, emits alpha particles that cause double-stranded DNA breaks. The severe DNA damage is irreversible and causes widespread cell death in the tumor and microenvironment ("Treat Prostate Cancer Where It Lives"). Ra-223's mechanism of

action is multi-faceted. It kills both tumor cells and the effector cells of bone metabolism–osteoblasts and osteoclasts, killing cells and preventing metastasis simultaneously (Morris, Corey, et al.).

5. Challenges Associated with Radiopharmaceuticals

Despite its attractive resume, radiopharmaceuticals are not mainstream. The treatment comes with a slew of limitations. Clinical dosimetry, determining the dose of radiation that will be the most effective while limiting side effects, poses a difficult task (Sapienza and Willegaignon). Additionally, radiopharmaceuticals have manufacturing and clinical administration issues, all of which are interrelated and compound the difficulties of the industry.

Radiopharmaceutical dosimetry often poses a challenge for researchers and scientists. The biological effect dose, or a quantifiable efficacy report of a radiation treatment, is calculated using the product of the relative effectiveness and the total dose. For radiation treatments, the biological effect dose (BED) can be represented by a linear quadratic model. The model is flawed, however, as the dosage rates increase as the actual curve deviates from the traditional linear model as shown in Figure 6. This makes dosimetry of radiopharmaceuticals complex as the predictability of the drug decreases as its lethality increases. Nevertheless, there is a future for radiopharmaceuticals in cancer treatment.
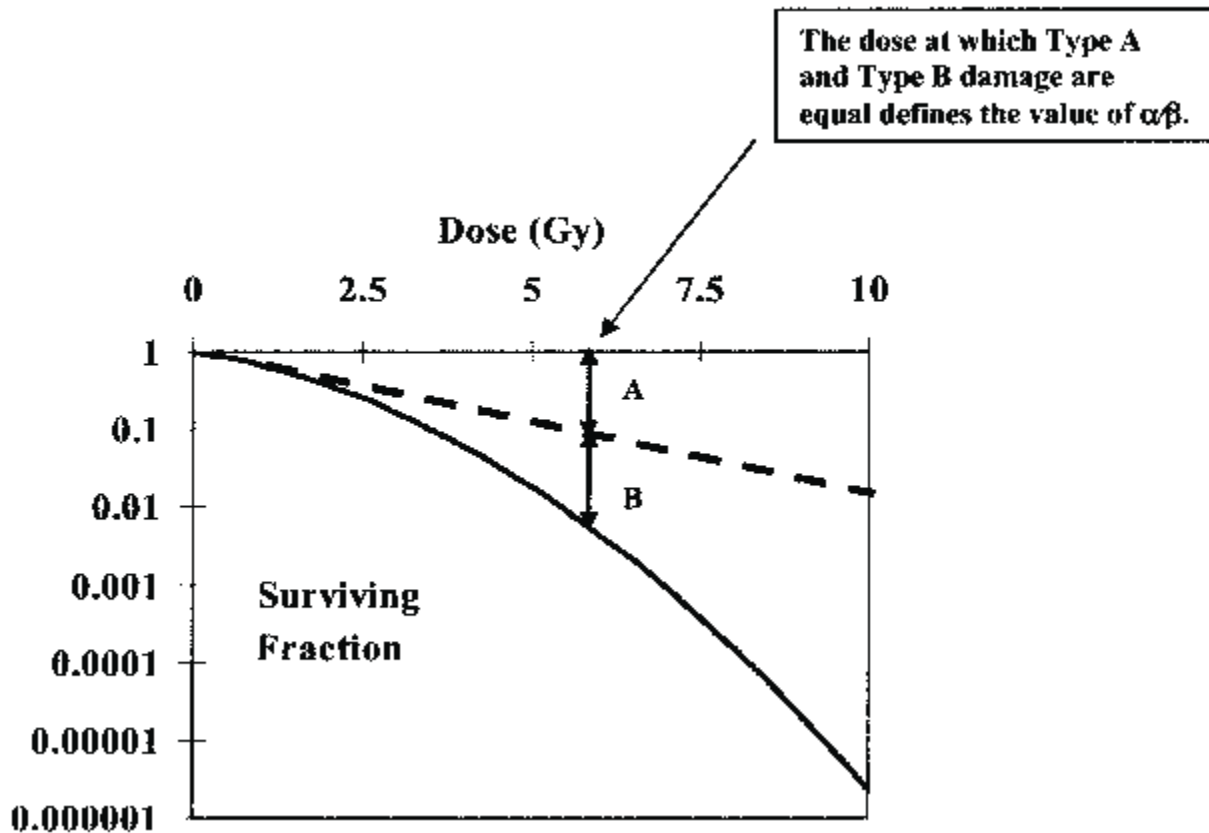
Fig. 6. The effectiveness of radiation dosage rates (BED) as per the percent of cells that survive modeled linearly and quadratically. Reproduced under Open Access license from (Dale)

6. Conclusion

        The field of cancer treatment is evolving, with new treatment methods being undercovered by thousands of scientists in the area. Radiopharmaceuticals, in particular, have been around for the last 80 years and have been popularized in the last decade. Radiopharmaceuticals have revolutionized the field of cancer treatment to some extent. Still, in retrospect, they have been heavily limited by administrative issues and complications with side effects. Nevertheless, radiopharmaceuticals are a step away from the detriments that chemotherapy and radiotherapy have been for patients historically. The radiopharmaceutical industry for cancer treatment, due to its versatility, will continue to grow, either as standalone treatments, theranostics, or in combination with other revolutionary cancer treatments.

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AF Detection Using Single Lead ECG Recordings By Sahasra Dayal

Abstract

Atrial Fibrillation is a prevalent heart arrhythmia that affects a large number of individuals. Given the challenges associated with current diagnosis methods, the development of automatic algorithms for detection has become a crucial research area. In this paper, we leveraged the PhysioNet 2017 challenge data to create a model that automatically detects Atrial Fibrillation. Our pre-processing involved applying the Butterworth filter and Pan Tompkins algorithm to clean the signals. Subsequently, we extracted relevant features from the pre-processed signals and employed machine learning algorithms to evaluate our model. The results were promising, with precision, recall, and F1 scores reaching 97.6%, 97.5%, and 97.4%, respectively. Overall, our model demonstrated robustness and achieved high accuracy, suggesting its potential utility in Atrial Fibrillation detection.

Keywords: Atrial Fibrillation, ECG signals, Pan Tompkins Algorithm, Feature Extraction, Machine learning, Evaluation Metrics,

1. Introduction

Atrial Fibrillation (AF) is a type of arrhythmia, or abnormal heartbeat. It is caused by extremely fast and irregular beats and affects more than 12 million people in the US and America. Electrocardiogram (ECG) is currently the main test for diagnosing AF. Doctors also often use blood tests to rule out thyroid issues and detect substances in the blood that might indicate AF.

However, the current method for AF detection is challenging for many reasons. AF can present differently in each patient and is sometimes even asymptomatic, making it difficult for healthcare providers to perform regular AF testing. AF episodes can also be sporadic, making detection during a single assessment challenging. Moreover, manual detection has a considerable potential for human error; hence, the presence of an automatic algorithm is crucial to improve accuracy and reliability in AF detection.

ECG signals can be used to create an automatic algorithm for AF detection. ECG is a test that records the heart's electrical activity over a period of time. It helps healthcare workers assess the heart's electrical impulses and identify any arrhythmia. During AF, the atria do not contract normally, leading to an irregularity in the QRS complex of ECG signals. This can help us use ECG for automatic detection of AF.

There are several methods to develop an automatic algorithm for ECG analysis. In one research paper [7], the authors focused on pre-processing techniques such as QRS detection and the Pan-Tompkins algorithm [9]. They then employed various configurations of random forests in machine learning. Notably, their study emphasized pre-processing methods rather than extensive feature extraction. On the other hand, in another research paper [5], the authors adopted a different approach. They applied limited pre-processing, utilizing only the

Pan-Tompkins algorithm and a few normalization techniques. However, their emphasis was on feature extraction, particularly using Poincaré plots to derive numerous frequency features. Additionally, they employed a hierarchical classifier structure to classify ECG records based on rhythm. Both studies demonstrate diverse methodologies in developing automatic algorithms for ECG analysis, with one focusing on pre-processing techniques and the other on comprehensive feature extraction and classification strategies.

In this study, we initiated the analysis by pre-processing the ECG signals to eliminate any noise and enhance peak-detection accuracy. We achieved this by employing the Pan-Tompkins algorithm, which effectively improved the quality of the signals. Subsequently, from the pre-processed ECG signals, we extracted several frequency features, capturing relevant information about the heart's rhythm and characteristics. These carefully selected features were then organized into a matrix, which also included corresponding labels for each signal. Finally, to evaluate the performance of our approach, we applied Machine Learning techniques to the feature matrix. Through rigorous testing and analysis, we obtained the results, providing valuable insights into the effectiveness of our model for ECG signal analysis and diagnosis.

2. Materials and Methods

The dataset that we have used is from the Physionet 2017 Challenge [6]. The data was collected using the AliveCor device and contains over 8528 single lead ECG recordings lasting between 9 to 60 seconds. The signals were recorded at 300 Hz and were band pass filtered by the AliveCor.The data was split into noisy, AF, normal, or other but for our study we decided to focus on AF and normal signals.
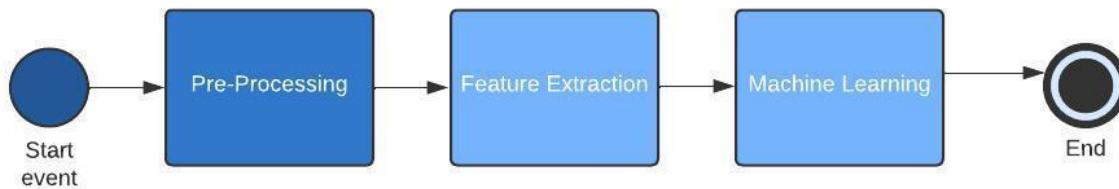
Figure 1: Methods Flowchart

2.1 Pre-Processing

The first step in developing our model was to pre-process the signals to make them more amenable to analysis. We began by cleaning the ECG signals to remove any noise and enhance peak detection. To achieve this, we passed the signals through a 0.5 Hz high-pass Butterworth filter [5], followed by powerline filtering [14]. Once the signals were appropriately cleaned, we applied the Pan-Tompkins algorithm.

The Pan-Tompkins algorithm [9] is specifically designed to detect the R waves from the QRS complex in ECG signals. It accomplishes this by analyzing the slope, amplitude, and width

of the QRS complexes in the filtered ECG signals. Additionally, the algorithm incorporates other essential pre-processing steps, such as low-pass filtering for high-frequency noise elimination and high-pass filtering for low-frequency noise removal. Furthermore, the algorithm includes Baseline wander removal [8], which addresses the slow drift of the ECG signal caused by external factors. The Baseline wander removal step effectively eliminates the drift, leading to improved accuracy in QRS complex detection.

2.2 Feature Extraction

The next step in our model was extracting features from the filtered signals. We extracted 5 features and included a column with the label to help in later steps of machine learning. After this process we had a table with the following format:

Table 1: Feature Extraction Table

Signal	Maximum	Minimum	Mean	Range	Standard Deviation	Label
1	0.310971	-0.332418	0.000379	0.643389	0.079043	0.0
2	0.174487	-0.184070	-0.000094	0.358557	0.050263	0.0
3	0.080332	-0.105320	-0.000037	0.185652	0.033894	1.0
4	0.380436	-0.296685	-0.000493	0.677121	0.121481	0.0
5	0.487723	-0.449728	-0.000161	0.937451	0.116675	1.0

2.3 Data Visualization

After completing feature extraction, we utilized various data visualization methods to determine whether our features were useful in achieving our goal of detecting AF (Atrial Fibrillation). Our first step was to plot each feature separately for both label categories: label 0 for normal signals and label 1 for AF signals. After generating these plots, we obtained the following visualizations:
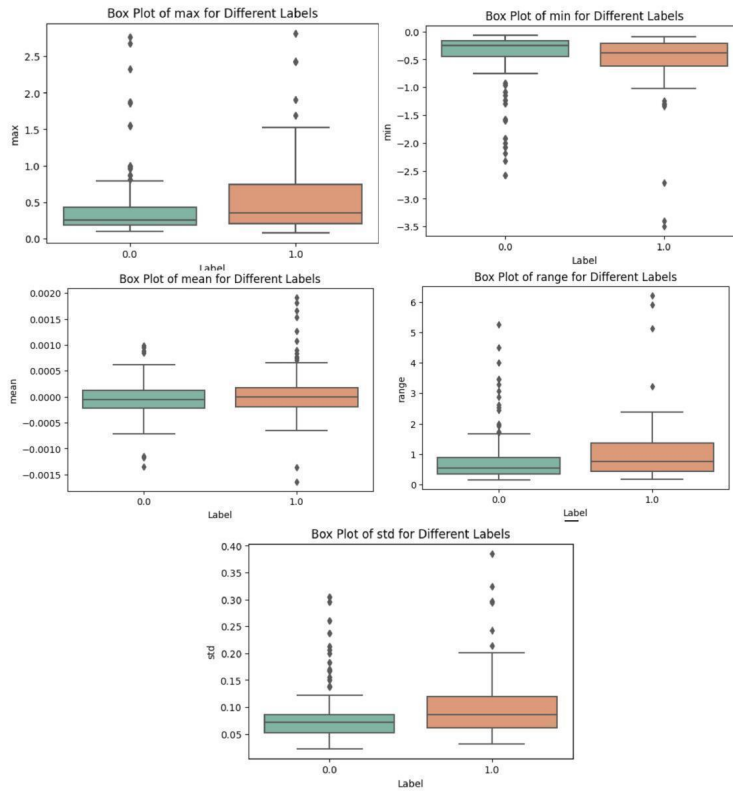
Figure 3: Feature Plots

Additionally, we created a correlation matrix to aid in identifying correlations between different variables, understanding multicollinearity, and facilitating feature selection. The correlation matrix provides valuable insights into the relationships between the features, helping us make informed decisions during the model-building process.
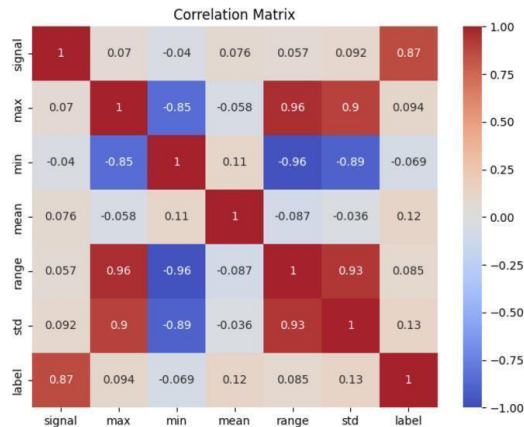
Figure 4: Correlation Matrix

3. Machine Learning

Finally, we utilized machine learning to assess the performance of our model. The initial step in the process involved splitting our data into training and test sets. The test data comprised 20% of the dataset, chosen randomly, while the remaining 80% constituted the training data.

Subsequently, we applied various supervised learning algorithms that are well-suited for binary classification tasks, specifically predicting whether a signal is normal or AF (Atrial Fibrillation) in our test data.

The first model we applied was logistic regression [12] which models the relationship between input features and probability of a binary outcome using the logistic regression curve. The curve is calculated using the following formula where P(y=1x) is the probability that the binary outcome y(class label 1) is true given the input features x. w is the weight vector, representing the coefficients for each feature.x is the input feature vector, with each element representing a specific feature value. w raised to T denotes the transpose of the weight vector.

$$P\,(y\,=\,1|x)\,=\,\frac{1}{1+e^{-w^T x}}$$

Next we applied Linear Discriminant Analysis (LDA) which is a supervised learning algorithm that aims to find a combination of features that maximizes separation between classes. The equation for Linear Discriminant Analysis (LDA) is given by:

$$y\,=\,w^T x$$

Where:
- y is a 1×1 scalar representing the discriminant score.
- x is the $1\,\times\,p$ feature vector of a data point.
- w is the $p\,\times\,1$ weight vector (coefficients) that determines the projection direction.

In LDA [3], the goal is to find the optimal weight vector w that maximizes the between-class scatter while minimizing the within-class scatter, which enables efficient class separation.

The next algorithm we used was K neighbors Classification(KNN) [4]. The K refers to the number of nearest neighbors considered for making a prediction. Given a data point the algorithm identifies the 'K' closest points in the training set. The KNN classification rule is calculated using the following:

$$Prediction\,for\,x\,=\,arg\,max\,\sum_{i=1}^{k} 1(y_i = y)$$

Where:
- y is a class label (the label we want to predict).
- x is the feature vector of a new data point.
- x_i represents the feature vector of the i-th training sample.

- K is the number of nearest neighbors considered for prediction.

- The distance between the new data point x and all the training samples x_i is calculated using a

distance metric (e.g., Euclidean distance).

The next model we applied was Gaussian Naive Bayes(Gaussian NB) [11] which is a popular algorithm based on Bayes theorem and assumes normal distribution. The algorithm learns the probability distribution of each feature for each class from the

training data. It calculates the probability of the data point belonging to each class based on the learned distributions and uses Bayes' theorem to estimate the most probable class label. It is calculated using the following equation:

$$P(y_k|x) = (P(x_1|y_k) * P(x_2|y_k) .... P(x_p|y_k))/P(x)$$

Where:

- $P(y_k)$ is the class prior probability, which represents the proportion of data points that belong to class y_k in the training set.

- $P(x_j|y_k)$ is the conditional probability of a feature x_j given class y_k, assuming a Gaussian (normal) distribution for each feature in each class. It is calculated using the mean μ_{jk} and standard deviation σ_{jk} of feature x_j for samples belonging to class y_k.

- P(x) is a normalization constant to ensure that the sum of the probabilities for all classes is equal to 1.

The class label for the new data point is assigned to the class y_k with the highest $P(y_k|x)$

Finally, the last model we applied was the Support Vector Classifier [1], which is a type of support vector machine that aims to find the optimal hyperplane to separate data from different classes. The main goal of SVC is to maximize the margin between 2 classes while minimizing error. It is calculated using the following formula:

$$min_{w,b} \frac{1}{2}||w||^2 \text{ subject to } y_i(w * x_i + b) \geq 1 \text{ for all training samples } (x_i, y_i)$$

Here,

- w is the weight vector (normal vector to the hyperplane).
- b is the bias term.
- y_i is the class label of the ith data point.

- x_i is the feature vector of the ith data point.

After applying the algorithms, we conducted cross-validation on each of them to evaluate their performance and identify potential issues. For this purpose, we employed the Stratified K-fold cross-validation technique [13], which divides the data into k folds of approximately equal size. In each iteration, the model is trained and evaluated k times, with a different fold acting as the validation set and the remaining folds serving as the training set. In our model we created 5 folds, this approach ensures a thorough and accurate evaluation of the model's performance.

Furthermore, we assessed the precision, recall, and F1 scores [10] to gain insights into the model's predictive capabilities. These metrics are commonly used to evaluate performance of binary classification and are calculated using the following formulas.

-(True Positives) - the number of correctly predicted positive instances.
-(True Negatives) - the number of correctly predicted negative instances.
-(False Positives) - the number of incorrectly predicted positive instances (false alarms).

-(False Negatives) - the number of incorrectly predicted negative instances (missed detections).

$$Precision \ = \ \frac{TP}{TP+FP}$$

$$Recall \ = \ \frac{TP}{TP+FN}$$

$$F1 \ Score \ = 2 \ \cdot \frac{Precision \cdot Recall}{Precision \ Recall}$$

4. Results and Discussion

Logistic Regression	**0.937**
Linear Discriminant Analysis	**0.975**
K Neighbors Classifier	**0.994**
Decision Tree Classifier	**0.988**
Gaussian NB	**0.950**
Support Vector Classifier	**0.981**
Precision	**0.976**
Recall	**0.975**
F1	**0.974**

Table 2: Results Table

We conducted a comprehensive analysis of the results, comparing the performance of different algorithms, as presented below. Notably, the K-Nearest Neighbors (KNN) Classifier algorithm achieved an impressive accuracy of nearly 100%. However, it's worth mentioning that the other algorithms also exhibited very high accuracy scores, with all five algorithms consistently maintaining accuracy levels between 96% and 98%. Additionally, we also received high precision, recall, and F1 scores between 0.974 and 0.976. These consistently high scores indicate the overall effectiveness of the models in accurately predicting AF.

During our analysis, we observed that the logistic regression algorithm and the Gaussian Naive Bayes (Gaussian NB) algorithm had larger standard deviations compared to the other algorithms. This larger standard deviation suggests that their scores varied more widely across different iterations or data splits. In contrast, the scores of the other algorithms were more tightly

clustered, indicating greater consistency in their performance. Additionally, the remarkable nearly 100% accuracy achieved by the KNN Classifier algorithm solidifies its position as the highest-scoring algorithm in our evaluation.
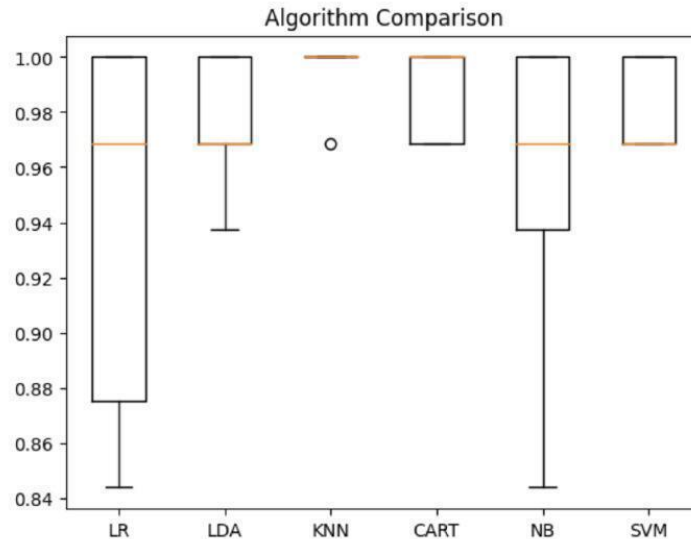
Figure 6 : Algorithm Comparison Plots

In application, we believe that the K-Nearest Neighbors (KNN) model should be used because it has demonstrated the highest accuracy. Additionally, we anticipate that adding more features to the feature matrix could be beneficial. The inclusion of additional features could provide more information about underlying patterns related to atrial fibrillation (AF) in ECG signals. This increased information has the potential to enhance the model's ability to distinguish between normal sinus rhythms and AF signals. Furthermore, in real-life scenarios, ECG signals may exhibit variations due to noise or other factors, and thus, we believe that the model should be further expanded to detect such noisy or other signal patterns, as ECG signals are not always exclusively normal or AF in nature.

5. Conclusions

This study explores the application of machine learning to develop an automatic algorithm for atrial fibrillation (AF) detection. The implementation of an automatic algorithm can significantly enhance the accuracy and speed of detection, contributing to better patient outcomes. Our model begins with data pre-processing, where we apply filtering and the Pan Tompkins algorithm to obtain clean signals. These signals are then further processed to extract relevant features. Next, we trained our data on multiple machine learning models and analyzed their performance scores. Our analysis revealed that the K-Nearest Neighbors (KNN) classifier algorithm achieved the best results, making it the most suitable option for this model.

While our model demonstrated impressive performance, it represents a foundational approach to automatic AF detection. To further enhance its capabilities, we plan to include more features to better discriminate between AF and normal signals. In real-life scenarios, ECG signals can be affected by noise and other factors, necessitating additional training of the model

on noisy and diverse signal patterns. ECG signals are rarely exclusively normal or AF, and therefore, the model's versatility is crucial for its applicability in real-world situations. In conclusion, our model provides accurate predictions and demonstrates flexibility for future enhancements.

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Music Recommendation Using Collaborative Filtering By Sahasra Dayal

Abstract

Recommendation systems have become increasingly useful in the modern age. They have shifted from their focus on e-commerce to social media and other entertainment platforms. In this paper we employed the item-item collaborative filtering method by Amazon (G. Linden, B. Smith and J. York, "Amazon.com recommendations: item-to-item collaborative filtering,", 2003) and adapted it to create a music recommendation model. This model utilizes the million playlist dataset published by Spotify (Spotify Million-Song Dataset (Version 2.1). Kaggle., 2020) . We focused on using item-item collaborative filtering technique on playlists to recommend individual songs for each playlist. The recommendations were then evaluated based on a novel validation method that measured the performance with various metrics.

Introduction

Recent advancements in technology along with opportunities for new talent has increased the amount of content available to users exponentially. The increase in data complicates the process of finding content that users enjoy. Due to this, recommendation algorithms have gained significant attention. The primary aim of these systems is to reduce users' effort and time required to find new content that they enjoy.

There are various types of methods that are used when building a recommendation model, the one we have focused on however is collaborative filtering. Collaborative filtering models rely on the users preferences and data unlike content based collaborative filtering which focuses on similarity in content features. A type of collaborative filtering algorithm introduced by Amazon (G. Linden, B. Smith and J. York, "Amazon.com recommendations: item-to-item collaborative filtering,") is item-item collaborative filtering- which is what we have adapted.

Unlike other recommendation models that match users to other similar users, item-item collaborative filtering matches the customers' purchased items to similar items and combines that list to create a recommendation list. While our project follows a similar model, rather than computing the similarity between 2 individual items, we computed similarity between a playlist of songs and individual songs. Due to the fact that our recommendation method is not a common scenario, we have also developed a novel evaluation method to test our model.

Data and Methods
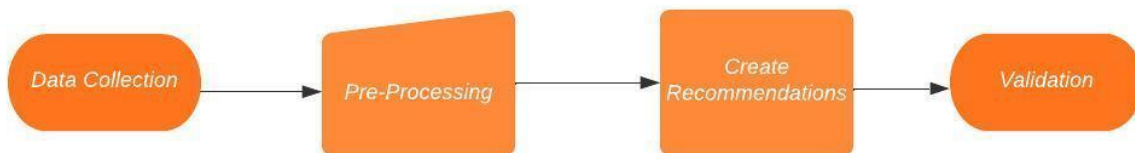
The dataset we have used is Spotify million (Spotify Million-Song Dataset (Version 2.1). Kaggle). This data contains a million playlists created by American Spotify users from ages 13 and above. Each playlist contains anywhere from 3 to 250 songs, and has at least three unique artists and two unique albums; the playlists were created from January 2010 through October 2017 and includes information on the playlist title, track list with information on each track, and editing information like the last edit time or number of playlist edits.

Pre-processing

In order to start with a workable dataset we first limited the data to the first 100k playlists. We then worked on converting all the json files to csv for a more efficient dataframe. We also removed the features of the dataset we didn't find useful for the project. After filtering, the dataset includes every track number, track name, album name, artist name, track url, playlist ID, and playlist name. Once we had the dataset in a csv file, we were able to start pre-processing the data. In order to further filter the data we found the number of playlists each track existed in, and only included songs that exist more than 1000 times in the dataset. With this our preprocessing was complete and we were able to start creating recommendations.

Creating Recommendations

In order to create individual song recommendations for playlists, we started by creating an item-item matrix with all the songs in our dataset. We created the item-item matrix and calculated the similarity using the following format:

For each track i in playlist:
      For each playlist with track i:
            For each track j in playlist:
                  Record running sum of number of times tracks i and j were in the same playlist:
      Compute item-item matrix with number of times tracks i and j were in the same playlist
      Compute average of all tracks in each playlist to create a representation of each playlist
      Calculate similarity between playlist and each track

After completing the step of computing the matrix we had a table with the following format:

<div align="center">Item-Item Matrix</div>

	Track 1	Track 2	Track 3	Track 4
Track 1	1318	50	8	144
Track 2	50	1579	13	186

| Track 3 | 8 | 13 | 1835 | 10 |
| Track 4 | 144 | 186 | 10 | 2086 |

If the same songs are present in multiple playlists, this indicates some level of similarity between the songs. Although the diagonal row has to be ignored, this creates a clear vector representation of each track. Until this point we have followed Amazon's item-item collaborative filtering model (G. Linden, B. Smith and J. York, "Amazon.com recommendations: item-to-item collaborative filtering,"); however, rather than calculating similarity between 2 individual items we further processed the matrix so we could calculate similarity between a group of tracks and individual tracks.

In order to compare a group of tracks to individual ones we had to find a way to represent a playlist. To create representation of a playlist, we averaged the vectors of each track in the playlist to create a vector for each playlist. If a playlist had 3 songs it would like like the following:

Playlist Representation

Track 1	Track 2	Track 3	Playlist 0
+1318	+50	+8	/3 = 458.67
+50	+1579	+13	/3 = 547.33
+8	+13	+1835	/3 = 618.67
+144	+186	+10	/3 = 113.33

Using the playlist vector column, we now have a way to compare a playlist of tracks to individual tracks and actually create similarity scores.

The similarity measure we used for this was cosine similarity. Cosine similarity measures the cosine of the angle between 2 vectors. It's a measure of the degree between two vectors pointing in the same direction. The formula for cosine similarity is as follows:

$$Similarity(\vec{A}, \vec{B}) = cos(\vec{A}, \vec{B}) = (\vec{A} * \vec{B})/(||\vec{A}|| * ||\vec{B}||)$$

After creating the similarity values between each playlist vector and every individual track vector, we have a dataframe with the playlist Id, each individual track url, and the cosine

similarity. With this information we can actually create recommendations by selecting the top 10 scores for each playlist and recommending those tracks to the user.

Cosine Similarity Table

Playlist ID	Track	Cosine Similarity
0	Track 1	0.783
0	Track 2	0.55
…	…	…
5	Track 1	0.104

Results

To evaluate our model, we had to come up with a new way to check our results because it is not a common situation. The typical test train split for machine learning models could not be applied to this situation so we came up with a new method.

We decided to first include all the songs that are already in the playlist in our recommendations. We then created a function that calculates the number of recommendations that actually exist in the playlist. If the recommendation we make actually does exist in the playlist, this indicates that the model is working to a certain level. Finally, we selected a list of 1,017 playlists that had at least 65 songs and then performed different metrics like precision, recall, and Mean Average Precision (MAP) on this set of playlists using the function mentioned above. We had a MAP value of 0.89 and the following values:

Precision @10

Maximum	1.0
Minimum	0.1
Mean	0.74
Median	0.8

Recall

Maximum	0.77
Minimum	0.15

Mean	0.45
Median	0.45

<center>F1</center>

Maximum	0.85
Minimum	0.14
Mean	0.55
Median	0.56

Discussion

Due to the fact that our validation method isn't standard we had to come up with a unique way to find our metrics. The first metric we used was precision which measures the purity of recommendations. Precision is generally calculated using the following formula.

$$P = \frac{\#\text{ of our recommendations that are relevant}}{\#\text{ of items we recommended}}$$

In our interpretation, we calculated precision @10 which would mean dividing the number of recommendations actually in the playlist over 10 - the total number of recommendations. The distribution of our precision scores are shown below:

<center>Precision Score Distribution</center>
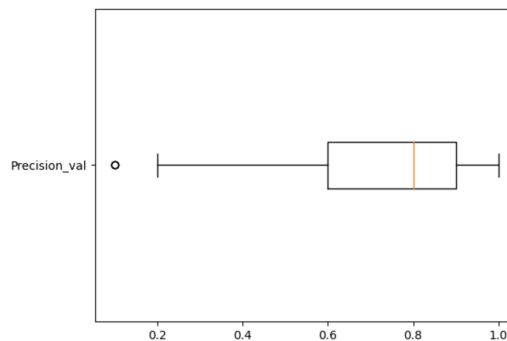
According to our precision scores, on average about 7/10 recommendations were in the playlist, and there was at least one true positive across all the playlists. There was also at least one time when 100% of the recommendations were in the playlist indicating a strong model.

Recall is generally calculated using the following formula:

$$r = \frac{\# \text{ of our recommendations that are relevant}}{\# \text{ of all the possible relevant items}}$$

However, it does not closely align with our model so we had to come up with a better measurement. In our interpretation we calculated recall by creating recommendations equal to the length of the playlist first. For example if a song had 65 songs we created 65 recommendations. We then calculated recall by dividing the number of recommendations in the playlist over the number of songs in the playlist. Although our method does not exactly follow the traditional recall formula we received the following results:

<u>Recall Score Distribution</u>
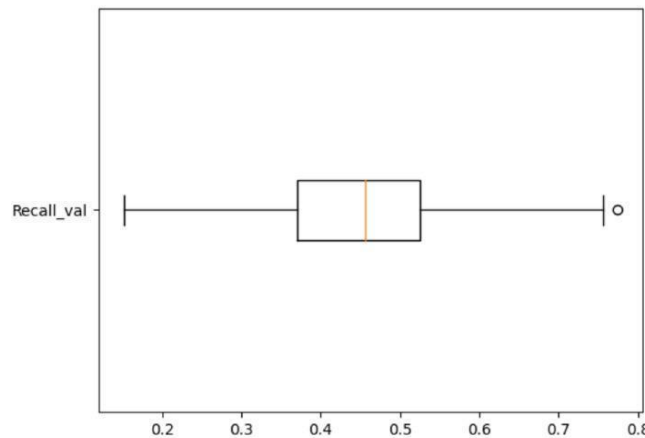
Given that the validation was only performed on playlists with more than 65 songs, when at least 65 recommendations were made the average recall score was 45%. So about half of the recommendations made actually existed in the playlist. Additionally, at least 15% of the recommendations existed in the playlist throughout all the playlists.

With the precision and recall metrics, we then calculated the F1 score which combines precision and recall to create a measurement of the accuracy of the model. It is solved using the following formula which we followed exactly:

$$F_1 = 2 * \frac{precision * recall}{precision + recall}$$

Our average F1 score was about 55%. This score reflects the number of the balance between precision and recall on average. At least 14% of the recommendations always existed in the playlist and there was at least one point where 85% of the recommendations were in the playlist.

F1 Score Distribution
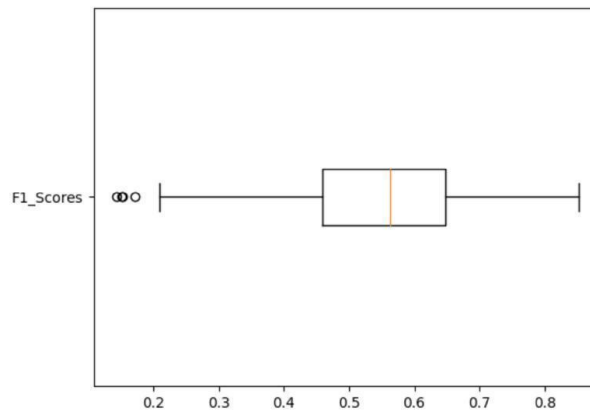
Finally we calculated the MAP Value which is calculated by the following formula. In our case the MAP takes the precision value among multiple playlists and the order of the recommendations to create a score. After considering both the order of the recommendations and the precision value we received a score of 89%:

$$\mathrm{mAP} = \frac{1}{N} \sum_{i=1}^{N} \mathrm{AP}_i$$

Analysis

Given that our validation strategy does not follow the traditional model, how can we know for sure how good our recommendations really are? In order to answer this question we performed several analysis methods using our metrics and model.

Although we calculated accuracy based on how many of the recommendations exist in the playlist, in reality we would want to be recommended new items. When we plotted the precision values across different numbers of recommendations we found that although precision values decreased the number of new items (items not already in the playlist) increased.

Precision vs New Values @k
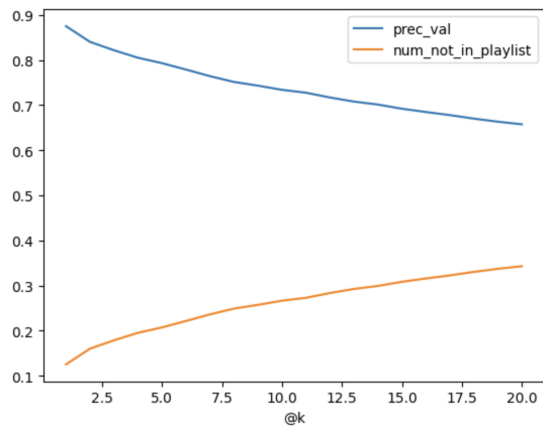
This indicates that even though there is a decrease in precision value, there is actually an increase in new tracks which is what we would look for in a real life model. When we studied the cosine similarity values of the new tracks we found that although they decreased marginally they still remained very high. At 20 recommendations the average cosine similarity of the new songs was 0.944 indicating that the recommendations not in the playlist are also very strong.

Similarity Scores for New Values @k
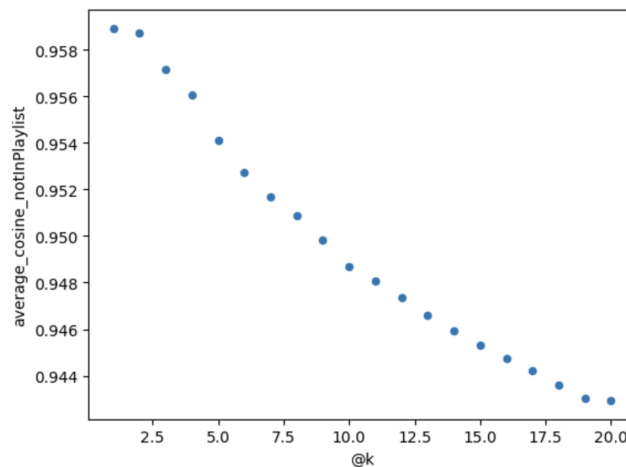
Additionally when we further analyzed the rankings in cosine similarity value of the recommendations we found that the new songs were often equally or more accurate than songs actually in the playlist.

In order to analyze rankings of recommendations, we tracked the rankings of recommendations not in the playlist given 50 recommendations and plotted it as shown below.

Rankings of New Values Plot
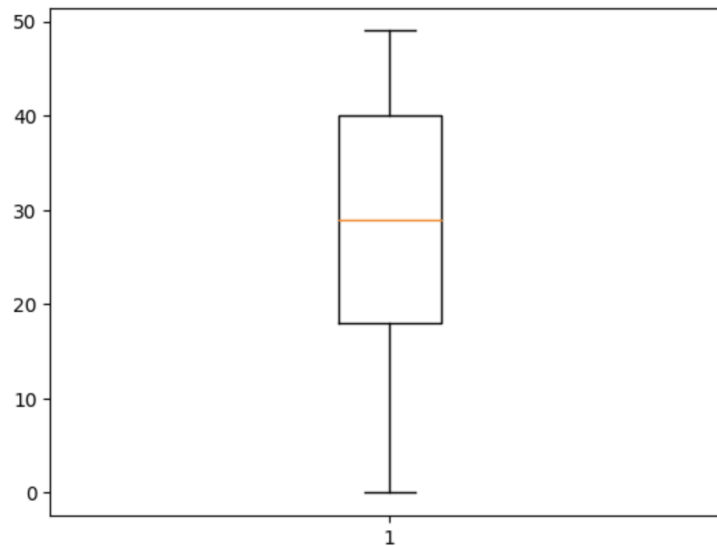
On average the false positives were ranked at around 28th place. However there were also incidents where the new songs ranked in first place- higher than the songs actually in the playlist. The recommendations not in the playlist were also ranked at least 29th place meaning that there were always at least around 20 songs that were in the playlist, but ranked lower than the new songs.

The analysis of the cosine similarity values, shows the new recommendations are still accurate, however we further analyzed the false positives by spot checking the new songs. We looked at the general theme of playlists, and the recommendations; In our analysis we found that almost every new recommendation matched with the artist, genre, or album of other existing songs in the playlist. Given this analysis and our metrics, we are confident that our model performs well and can be applied.

In application we believe that the number of recommendations should actually be capped at 20 songs. For 20 recommendations we received a precision score of 64% meaning there are about 4-5 new songs being recommended. Additionally the cosine similarity score remains very high for new recommendations in the top 20 tracks, between 0.958 and 0.942. This means the user would be able to get very similar songs to their existing playlist, but also new tracks with high similarity, making 20 the ideal number of recommendations.

Conclusion

This study explored how we can use collaborative filtering to create a music recommender system. Rather than creating individual track recommendations given another track, we were able to create a model that can create recommendations to add to a playlist. We also created a unique validation method, followed by analysis which indicates that our model can create accurate recommendations. We were also able to conclude that twenty recommendations is the ideal number to recommend to a user in real life. This gives the user a variety of tracks very similar to their existing playlist but also new options. Due to the structure

of our model, it can be adapted to include a variety of types of recommendations. With little change it can be used to create track to track recommendations and playlist to playlist recommendations. In the future, it could also be further advanced using user based filtering to recommend the recommendations from one user's playlist to another similar user. Overall, the model we have put together has the ability to be very versatile while also creating accurate recommendations.

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Cell Transplantation Therapy for Traumatic Spinal Cord Injury: An Overview of Cell Types, Transplantation Methods, and Outcomes By Shalin Reddy

Abstract

This essay provides an overview and analysis of cell transplantation therapy as a potential treatment option for traumatic spinal cord injury (SCI). It examines different types of cells used in transplantation, methods of transplantation, and an in-depth analysis of ongoing clinical trials for cell regeneration therapy. It focuses on different clinical trials that aim to test the efficacy and safety of cell regeneration therapies in treating various diseases and injuries, such as spinal cord injury. The essay concludes that cell transplantation therapy has shown promise as a novel and promising therapy for SCI but much work remains to be done before it can become a routine treatment. The optimization of cell transplantation protocols, careful assessment of outcomes, and continued research into immunological compatibility are necessary to develop viable cell transplantation treatment options for traumatic spinal cord injuries.

Introduction

Traumatic Spinal Cord Injury (SCI) is a devastating condition that affects millions of people worldwide. SCI is a major cause of disability and often results in lifelong physical and psychological impairments. The recovery phase that follows SCI frequently demands an extended timeline, which can lead to substantial financial burden for both the affected persons and their families. [2] On top of this, there are a large number of issues that can occur after the injury. [3] Spinal cord injury (SCI) can lead to a host of systemic medical problems. Motor functional deficits such as paralysis and increased spasticity are typical manifestations of SCI while sensory disturbances, including severe analgesia below the level of injury and allodynia, can also be present. [1] SCI can also impact an individual's mental health, leading to depression and even suicide. [4]Additionally, individuals with SCI may experience circulatory, digestive, and urogenital impairments and may require treatment for skin issues. [5] Therefore, it is critical to address all these areas of concern to improve the overall well-being of individuals with SCI. Consequently, there is a great deal of anticipation for the emergence of state-of-the-art therapies to treat spinal cord injury. Recent advances in cell transplantation research have opened up new avenues for the treatment of SCI. Cell transplantation therapy has shown great potential to reconstruct the injured spinal cord and promote functional recovery.

Trials

	Journal	Country	Cell Type	Route	No. of Patients	Characteristics (ASIA)	Outcome
[26]	Journal of	USA	Schwann	Spinal	6	All A	Improvement in

	Neuroscience					FIM
[27]	Neuroscience letters	Iran	Schwann	Spinal	4	A: 2 C: 2	25% ASIA improvement
[28]	Cell Stem Cell	USA	NSC	Spinal	4	A	EMG improvement
[29]	Journal Of Neurotrauma	USA	NSC	Spinal	24	A,B	Improvement in motor assessment
[30]	Stem Cells and Dev	South Korea	ASC	Venous	8	A,B	12.5% ASIA improvement
[31]	J Spinal Cord Med	South Korea	ASC	Thecal	3	A:2 B:1	ASIA sensor change
[32]	Neurosurgery	South Korea	BMSC	Spinal and Thecal	10	A:4 B:6	SEP/MEP improvement (30%)
[33]	Neurosurgery	South Korea	BMSC	Spinal and Thecal	20	B	Scale improvement
[34]	Exp Clin Transplant	India	BMMNC	Thecal	264	A:233 B:7 C:22	30% ASIA improvement

[35]	Bull Exp Biol Med	Russia	BMMNC	Venous and Spinal	18	N/A	Original scale improved compared to control

The American Spinal Injury Association (ASIA) Impairment Scale is a standardized tool used to assess sensory and motor function in people with spinal cord injuries. The patients in the trials were organized using the scale. The scale comprises five different grades or levels, referred to as Tiers: A, B, C, D, and E. The AIS A classification indicates complete loss of sensory and motor functions below the level of injury, while AIS B, C, and D indicate incomplete or partial preservation of these functions. In AIS B and C, there is some preserved sensory function below the neurological level of injury, while in AIS D, there is preserved motor function below the injury level of injury. Finally, AIS E indicates a normal level of sensory and motor function. ASIA Impairment Scale is a widely used tool to categorize, describe, and monitor the extent of spinal cord injury as well as to facilitate communication between healthcare professionals involved in the care of patients with spinal cord injuries. As cell regeneration is a relatively new and experimental treatment method, it is often seen as a last resort by many patients. Consequently, the majority of patients participating in clinical trials for this treatment are in tier A.

Types of Cells Used in the Trials

A wide range of neural stem and progenitor cell types derived from the developing and adult central nervous system (CNS) has been investigated as potential transplantation candidates for traumatic SCI. The neuroprotective capacities of oligodendrocyte precursor cells (OPCs), Schwann cells, and adipose-derived stromal/stem cells (ASCs) have shown promise. Additionally, neural stem cells (NSCs) and induced Pluripotent Stem (iPS) Cells have attracted attention as candidates for cell transplantation in SCI.

Schwann Cells

Schwann Cells have been identified as a promising therapeutic agent for spinal cord injury repair [8][26]. These cells are specialized glial cells that support the growth and regeneration of damaged nerve cells. When transplanted into the injured spinal cord, Schwann cells have demonstrated the ability to provide ensheathment and a myelin sheath to newly regenerated propriospinal axons as well as demyelinated axons [6][27]. This has resulted in the improvement of regenerative growth and more efficient signal conduction. Additionally, the Schwann cells have displayed compatibility with the host system and have maintained their integrity, promoting successful nerve regeneration in animal models [9].

Combining cell therapy with human autologous Schwann cells and bone marrow-derived mesenchymal stem cells has shown promise in treating patients with subacute complete spinal cord injury.[26][27] Both cell types have shown positive effects on treating spinal cord injuries. When combined, the therapy has displayed an even greater potential for repair and recovery. The mesenchymal stem cells are thought to provide trophic support and immunomodulatory effects while the Schwann cells provide mechanical and functional support. This combination approach aims to enhance the survival and differentiation of the transplanted cells and improve the environment for regeneration [7][27].

Bone marrow-derived mesenchymal stem cells (BMSCs): Bone marrow-derived mesenchymal stem cells (BMSCs) have emerged as a promising source for stem cell therapy in spinal cord injuries (SCI).[32] They possess superior paracrine potential and a more favorable safety profile than other types of MSCs, such as umbilical cord-derived and adipose tissue-derived MSCs.[10] BMSCs can differentiate into multiple cell types, including neurons, astrocytes, and oligodendrocytes, and play a crucial role in tissue regeneration, neuroprotection, and anti-inflammation after SCI.[11] A number of preclinical studies have shown that BMSC transplantation can improve motor function, reduce the lesion size, and promote axonal regeneration and myelin preservation in SCI models.[12] Over 20 clinical trials have been conducted involving BMSC transplantation for SCI, offering important insights into their therapeutic potential and limitations.[10]

However, the use of BMSCs for SCI still faces several challenges, such as the optimal dose, timing, and route of administration, as well as their tendency to differentiate into unwanted phenotypes and form tumors in some cases.[11] The heterogeneous quality and potency of BMSCs from different donors and laboratories also require standardized criteria and protocols for their isolation, characterization, and quality control.[10][33] Further efforts are needed to optimize the therapeutic efficacy and safety of BMSCs for SCI and to explore their potential in combination with other modalities, such as drugs, biomaterials, and physical therapy.[11]

Adipose-Derived Stromal/Stem Cells (ASCs): Recent studies suggest that Adipose-Derived Stromal/Stem Cells (ASCs) could play a vital role in regenerative medicine and could provide a promising strategy for spinal cord injury treatment [15][30][31]. ASCs have the potential to secrete a range of bioactive molecules, including cytokines, chemokines, and growth factors that promote neuroprotection and tissue regeneration. Additionally, preclinical studies have evaluated the therapeutic potential of ASCs in treating SCI using animal models, and the transplantation of ASCs has shown promising results. A study on a mouse model of SCI demonstrated that the intravenous injection of ASCs improved functional outcomes, decreased the lesion size, and promoted myelin regeneration [13]. Although the precise mechanisms behind these benefits remain to be fully understood, the positive data obtained thus far suggests that ASCs may hold significant promise for the clinical treatment of spinal cord injuries.

Furthermore, human clinical trials using ASCs in the treatment of SCI are underway to test their regenerative potential in human subjects. Participants with SCI underwent transplantation of their own ASCs in a clinical case series study, and the authors of the study

observed that ASC transplantation was safe and well-tolerated.[14][29] However, the study's limitations included a small sample size, the lack of randomization, and the lack of a control group. Still, the results suggest that ASC transplantation is a promising and relatively safe approach to treating SCI, calling for the need for larger, randomized clinical trials to validate this approach's efficacy [14].

Neural Stem Cells (NSCs): Recent evidence has suggested that neural stem cells (NSCs) have significant therapeutic potential in spinal cord injury. Preclinical studies have demonstrated that transplanting neural stem cells can lead to the restoration of functional connectivity at the site of SCI, functional recovery, and improved motor function [16][28]. NSCs have been shown to promote axonal regeneration and remyelination, improving the level of neuroprotection and promoting increased re-establishment of neural circuitry.

Clinical trials have also demonstrated the safety and feasibility of using NSCs to treat spinal cord injury in humans. A study on a small number of patients with acute spinal cord injury showed that NSC transplantation is feasible and safe, opening up the door for further research in this area [17][29]. Despite these promising results, several obstacles remain that must be addressed before clinical translation is possible in this section. These include the limited availability of NSCs, the challenges in creating an ideal delivery technique, and the limited understanding of the mechanisms behind NSC-mediated regeneration in the spinal cord.

Bone Marrow-Derived Mononuclear Cells (BM-MNCs): Bone Marrow-Derived Mononuclear Cells (BM-MNCs) are a viable option for stem cell therapy in spinal cord injuries (SCI).[34][35] In a phase I/II clinical trial, autologous BM-MNC transplant via lumbar puncture was found to be safe for SCI patients, and about a third of them showed improvement in muscle strength and sensation.[20] Another randomized controlled trial showed that BM-MNC augmentation improved neurological functions in acute SCI patients compared to standard therapy alone.[21]

Moreover, BM-MNCs have been shown to have an analgesic effect on neuropathic pain after spinal nerve injury in mice by reducing inflammation and promoting neural regeneration.[22] Unlike BMSCs, BM-MNCs do not require ex-vivo expansion or differentiation and can be isolated through common centrifugation techniques, which add to their practicality and cost-effectiveness for clinical applications.[20] However, further studies are needed to optimize the transplantation protocols and assess the long-term outcomes and side effects of BM-MNC therapy for SCI.[21]

Methods of Cell Transplantation

Due to the wide range of applications for cell transplantation therapy in spinal cord issues, there are several approaches to the administration of mesenchymal stem cells. Intravenous injection, intraspinal injection, and intrathecal injection are among the routes of mesenchymal stem cell (MSC) administration for SCI patients. These methods involve delivering stem cells directly into the bloodstream, spinal cord, or cerebrospinal fluid, respectively. Intravenous and intrathecal injection of MSCs have been found to be safe and

feasible for treating neurological diseases, such as amyotrophic lateral sclerosis (ALS) and multiple sclerosis (MS).[23][24] Intraspinal injection, on the other hand, requires a more invasive procedure and carries a higher risk of complications, such as infection and bleeding, but allows for more targeted delivery and potential regeneration of damaged neural tissue.[25] The choice of injection method depends on the specific needs and conditions of the patient and should be based on careful evaluation and consultation with healthcare professionals.

Intravenous Injection

Intravenous injection of stem cells has emerged as a promising approach to improving motor function in patients with spinal cord injuries. Several studies have investigated the safety and efficacy of this mode of stem cell delivery.[30][35] For instance, bone marrow-derived stem cells were intravenously infused into patients with spinal cord injuries, and significant improvements in motor function were observed. Similarly, intravenous infusion of mesenchymal stem cells (MSCs) derived from adult bone marrow has been found to promote functional recovery in rat models of chronic spinal cord injury. These studies suggest that intravenous injection may offer a safe and effective route for stem cell therapy in the treatment of spinal cord injuries. Further research is needed to determine the best dosage, timing, and patient selection criteria to optimize the therapeutic effect of stem cell therapy for spinal cord injury patients while minimizing the risk of adverse effects.[36][37]

Intraspinal Injection

Intraspinal injection of cells has been explored as a method to promote tissue regeneration and functional recovery in SCI. The injection of stem cells or neural progenitor cells directly into the spinal cord tissue has been shown to help repair neuronal connections and improve motor function.[26][27] This approach is invasive, requires specialized equipment and trained personnel, and carries some risk of damage to the spinal cord itself. [28] However, the intraspinal injection method is preferred over systemic delivery because it can provide a more concentrated and targeted delivery of cells. The potential benefits of this approach include greater efficacy and reduced side effects. However, there are still challenges to be addressed, including optimizing the optimal dose, timing, and delivery method for the injections. Further studies are needed to determine the safety and effectiveness of intraspinal injection for cell regeneration after spinal cord injury and to develop new approaches that can enhance the regeneration of spinal cord tissue.

Intrathecal Injection

The intrathecal route requires injecting cells adjacent to the spinal cord through cerebrospinal fluid which surrounds and bathes the spinal cord. This route is less invasive than intraspinal injection but still allows for target delivery to the site of injury. Intravenous infusion of stem cells has shown promising results for spinal cord injury patients.[31][32][33][34] Studies have found that bone marrow-derived stem cells and mesenchymal stem cells derived from adult

bone marrow can both have a positive effect on motor function in spinal cord injury patients. Some studies have also shown that stem cell therapy can regenerate injured neurons in the spinal cord. [31][33]While further research is needed to optimize the therapeutic effect of stem cell therapy and its long-term safety and efficacy for spinal cord injury patients, these findings suggest that intravenous injection of stem cells could present a promising option for the treatment of spinal cord injuries.[34]

Ethical Concerns

The use of cell regeneration therapy for spinal cord injury raises several ethical concerns that must be taken into account before widespread clinical application. The use of stem cell therapies for spinal cord injury presents a number of ethical concerns. These concerns differ depending on the source of the stem cells that are used. Embryonic stem cells are known to be a potent source of stem cells, but their use is controversial due to ethical issues surrounding their procurement, which involves the destruction of embryos. In contrast, adult stem cells are less controversial, since they are sourced from ethically permissible sources such as bone marrow, skin, or other body tissues, and can be acquired without harming the donor. Some ethical concerns, however, remain when sourcing adult stem cells, such as the long-term safety and ethical implications of harvesting tissues from such donors.[38] Another ethical issue related to the use of stem cell therapy for spinal cord injury is safety concerns. A meta-analysis of 62 clinical trials using stem cell therapy for spinal cord injury revealed that safety remained a primary concern, as stem cell therapy carries the risk of tumor formation, inappropriate cell migration, and other adverse effects in some cases.[39] Nonetheless, early research on intravenous injection of stem cells for spinal cord injury has shown promise in terms of its safety and efficacy, suggesting that intravenous delivery of stem cells could hold the potential for treating spinal cord injury patients safely and effectively.[40]

While cell regeneration therapy holds immense promise and potential in treating spinal cord injuries, all ethical considerations must be evaluated and taken into account during the research and treatment process. Intensive adherence to ethical guidelines must be enforced to guarantee that the benefits of such treatments outweigh the potential risks, and the effort to resolve ethical debates related to stem cell treatments must be continued.

Limitations of the Treatment and Future Research

Before cell transplantation can become a routine therapy for SCI, much work remains to be done. Despite the successes of the studies discussed above, there are still several issues to be addressed, including immunological rejection, cell differentiation and integration, tumorigenesis, and optimization of transplantation protocols [18]. While initial results are promising, further exploration is necessary to identify the optimal treatment strategies. The use of stem cell sheets, both with or without scaffolds, offers a potential solution, as they offer efficient and non-invasive delivery that could potentially overcome the challenges typically associated with direct transplantation.

It is crucial to acknowledge that many of the clinical trials being conducted in this field are currently single-centered and investigator-oriented. Approval for drug release necessitates rigorous external monitoring procedures and adherence to good practices established by regulatory authorities in each country. However, these practices can be expensive and vary among nations, acting as a barrier to the development of effective treatment approaches. Consequently, standardizing regulations between regulating bodies is an urgent requirement [19].

Conclusion

In conclusion, the application of cell transplantation as a therapeutic intervention for traumatic SCI has shown promising outcomes; however, it is not yet a standard part of clinical practice. The use of various cells, including Schwann cells, OPCs, ASCs, NSCs, and iPS cells, have demonstrated potential for treating SCI, thus offering hope to many patients with SCI. The optimization of cell transplantation methods and careful assessment of outcomes will be required to maximize the effectiveness of this novel and promising therapy. Continued research into cell transplantation techniques, including immunological compatibility and optimization issues, will be necessary to develop viable cell transplantation treatment options for traumatic spinal cord injuries.

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Patient Preferences as it relates to Intraoral Bone Defect Treatment Options By Mahi Saheba

Abstract

In recent years, regenerative medicine has begun to gain attention. The use of buccal fat pad stem cells has been noted in several studies as effective in treating intraoral bone defects. This study thus aims to identify the impact of identity factors, specifically education levels, on patient preferences for this emerging treatment option and those used in the past (e.g., bone grafts and bone substitutes). This study utilized a two-part methodology with a literature review and a survey-based analysis of patient preferences to achieve this goal. The sample size consisted of roughly 50 participants with ranging education levels. It was evaluated using a p-value test for the significance of data collected by the adapted Likert scale and a thematic content analysis of the free-response question "after taking this survey, which of the five techniques would you opt for if necessary and why?". The study found no statistical significance between patient preferences related to higher or lower education levels. Thus, it suggests decision-making and patient autonomy as being of crucial importance. Additionally, it was found that external factors such as fear, ethics, or religion played a more significant role in decision-making and implied the need for future directions to be focused on policies to uphold patients' individual choices and ensure that patients are well-informed before determining a treatment plan.

Keywords: Tissue Engineering, Mesenchymal Stem Cells (MSCs), Buccal Fat Pad, Adipose tissue, Adipose-derived stem cells, Parotid Duct, Osteocytes, Osteogenic differentiation, Intraoral Bone Defects, Scaffolds, Active Biomolecules, Growth Factors, Osteogenesis, Biology, Autografts, Autologous Bone Grafts, Xenografts

Introduction–General Background

The bioengineering subfield, tissue engineering, emerged as the top R&D (research and development) trend in 2020 because of its thriving innovations and advancements when considering living tissue and construction via biologically active cells (Crawford, 2020). From its widespread utilization of 3D bioprinting, tissue creation has been brought to a new level. Using human cells as "bioinks" for creating live tissue has allowed implantation success when coupled with this thriving tissue (Crawford, 2022).

Now, when shifting gears and narrowing focus on bone regeneration, it is essential to note the recent discoveries and studies conducted concerning stem cell usage for differentiation and construction into bone tissue. Bones are a fundamental aspect of the human body due to their structural support roles, binding placements for muscles, "ligaments and tendons, mechanical support," and their function of shielding essential tissues and organs (Ansari, 2019). Thus, an intraoral bone defect, a defect present in the oral cavity, is a significant medical issue, and traditional treatment options vary in efficiency due to their reliance on bone grafting. Bone

grafting relies on the body accepting this treatment to be successful. Once this is done, another process is initiated where the body must use this graft to generate new bone cells and make them susceptible to intraoral bone defect treatment ("How to Slow Down Bone Loss in Teeth," 2022).

On the other hand, recent studies suggest the usage of buccal fat-derived mesenchymal stem cells for usage in bone regeneration due to their "high proliferation rate and differentiation potential" (Saber et al., 2020). Mesenchymal stem cells are "pluripotent cells that can transform into various cell types, including fat cells, bone cells, cartilage cells," and more (Hernández, 2022). Mesenchymal stem cells also differentiate to form adipose tissue (a form of connective tissue) (Hernández, 2022). This is a core concept throughout the development of this paper as buccal fat is primarily classified as a white adipose tissue and thus holds the primary function of storing energy and thus has great implications in relation to treatment options (Hernández, 2022; Patricia et al., 2014). Additionally, it is essential to mention that buccal fat in infants contains both brown adipose tissue (BAT) and white adipose tissue (WAT), where the brown adipose tissue's primary function of generating heat is essential for the early stages of a child's life (Hernández, 2022; Patricia et al., 2014).

A specific benefit of using MSCs derived from buccal fat is that "factors such as age, gender, obesity, and vascular diseases" have little to no effect on cell concentration and potential (Saber et al., 2020). To give a brief overview of the buccal fat pad, it is classified as a "mass of specialized adipose tissue" that was first described in a medical literature piece as the "boule de Bichat" by a French anatomist named Xavier Bichat in 1801 (Marzano et al., 2005). It is important to note that the first description of buccal fat was recorded in Lorenz Heister's (an anatomist and surgeon from Altdorf, Germany) Compendium Anatomicum where he painted the buccal fat or formally written "glandula molaris" (Marzano et al., 2005). Recently, this fat mass has been targeted in the cosmetic industry for buccal fat removal procedures and fat transfers in the face. Buccal fat removal procedures are minimally invasive and are conducted via a small incision inside the cheeks and with local anesthesia. Often the cosmetic removal of buccal fat is for achieving a more contoured facial structure by creating "hollowed-out areas between your cheeks and jawline" (*Buccal Fat Removal*, n.d.). Now, as more research is done on the properties of buccal fat and its concentration of mesenchymal stem cells, scientists and researchers are beginning to shift lenses from the formally cosmetic relation of this fat to a more scientific and regenerative approach.

Buccal Fat, Parotid Duct, and Facial Fat Transfer

Buccal fat is in the maxillofacial region and has specific functions to "fill the deep tissue spaces" and "act as gliding pads when masticatory and mimetic muscles contract" (Liu et al., 2002). Additionally, the fat also serves as a cushion for "important structures" and protects from the "extrusion of muscle contraction or outer force impulsion" (Liu et al., 2002). As previously mentioned, the buccal fat bad is located between an individual's jaw and cheekbones and between the "buccinator muscle and the mandibular ramus" and can be extracted via a minimally invasive procedure (Bither et al., 2013). These qualities present unique acquisition-related

advantages when considering this fat in stem cell therapy and regenerative uses. Additionally, buccal fat exhibits "reliability, ease of harvest, low complication rate, [and] rich blood supply," ensuring the patient has minimal discomfort. (Bither et al., 2013). Thus, effectively performing this surgical procedure in "isolation or as an adjunct to other facial aesthetic procedures with minimal added morbidity" is a significant observation that allows for facial rejuvenation and acquisition of this fat pad for stem cell therapy susceptible (Weidman & Weniger, 2019).

However, there is a limitation in acquiring buccal fat due to the risk of injury to the facial buccal branches and the parotoid duct. The parotoid duct's primary function is to "drain saliva from the parotid gland into the oral cavity" and is important because of its role in facilitating digestion, protecting teeth from cavities, reducing "harmful bacteria in [the] mouth," and keeping the mouth lubricated (Jones & Deng, 2020; *Parotid Gland, n.d.)*. In a 2015 study, it was observed that in 5 out of 19 cases, there were "two twigs passing through the buccal fat extension of the buccal fat," thus leading to a "26.3% chance of injury to the buccal branch" and because the parotoid duct runs through the buccal extension, it was also a risk of injuring the parotoid duct in 26.3% of cases (Buttuvshin et al., 2005).

In a plastic surgery setting, this form of fat reinjection can be to the face's upper cheek or cheekbone region and is done via fat extraction, "decanting, centrifugation, and processing of the fat" (Rodriguez, 2015). Observable benefits of this procedure have included improving skin due to the fat pad's rich concentration of regenerative and nutrient-rich properties (Vu, 2022). On the other hand, the risks of this procedure have included swelling, bruising, and minor asymmetry (Fawzy, 2021).

Mesenchymal Stem Cells, Stem-Cell Therapy, and Regenerative Potential

Mesenchymal stem cells were originally identified "in bone marrow as multipotent cells" and are characterized for their "self-renewable ability and multi-potency" (Tsuji et al., 2014). Additionally, they have been studies to both secrete multiple growth factors and be more susceptible/sensitive towards them and thus can be noted to mediate tissue regeneration (Tsuji et al., 2014). Adipose-stem cells (ex. mesenchymal stem cells) can be observed in terms of differentiation ability in two stages, (i) *in vitro*, and (ii) *in vivo*. *In vitro* differentiation of the adipose stem cells allows for "multiple lineages under culturing with specific conditions" and thus allows the cells to be differentiated for multiple/specific clinical adaptions (Tsuji et al., 2014). On the other hand, *in vivo* differentiation studies suggest that adipose stem cell "translation can be challenging" due to cell survival and it can be noted that poor survival rates for *in vivo* injections and implantations are normal (Tsuji et al., 2014).

Mesenchymal stem cells are utilized in cell-based therapies to treat several problems or defects related to bone fracture or disease. Treatment with the usage of mesenchymal stem cells can involve two main methods, "(i) systematic or local injections and (ii) engineering techniques" (Oryan et al., 2017, as cited in Bononi et al., 2019). The first approach is via a direct intravascular injection and is effective in enabling mesenchymal stem cells to widely distribute "throughout the body using specific cell numbers defined as the effective cell dose" or in simpler

terms, the minimum number of required cells when observing a "therapeutic effect" (Horwitz et al., 200, as cited in Bononi et al., 2019). On the other hand, a more tissue engineering focused approach cab involve "autologous bone grafting" that is more efficient in defects "less than 50 mm in length" as opposed to larger ones (Dumic-Cule et al., 2015, as cited in Bononi et al., 2019). At this point it is also important to note that approaches such as the tissue engineering approach described, generally require the combined use of scaffolds and biomaterial, mesenchymal stem cells, and growth factors when aiming to "improve bone repair in fractures greater than 50 mm" (Decambron et al., 2017). Scaffolds, biomaterials, and growth factors will be discussed in more detail in another section of this paper.

Now shifting back to acquisition method. Mesenchymal stem cells have been traditionally derived from bone marrow but in recent years more studies conducted on buccal fat derived mesenchymal stem cells have allowed for a promising new "cell source for bone tissue engineering in the oral and craniofacial regions" (Salehi-Nik et al., 2017). In addition, because the buccal fat pad is a "easily accessible source of stem cells that can be obtained easily via the oral cavity without injury to the external body surface" (Salehi-Nik et al., 2017). This is a keynote observation in several sources that will later serve in explanation on my hypothesis of increased patient preference for bone regeneration using stem cells derived from the buccal fat pad.

Bone Structure and Bone Cells

As the primary focus of this study will be on bone regeneration and stem cell differentiation to bone cells, it is important to understand what characteristics and properties bones contain. Bone is characterized as a "rigid and highly dynamic tissue" whose primary purpose is to protect organs in the body, provide an environment for "red and white blood cell production," maintain a role in mineral homeostasis, and give "a solid base for skeletal muscles" (Abdel Meguid et al., 2018, as cited in Iaquinta et al., 2019). Two identified osseous tissue types include the "solid cortical or compact bone" and the trabecular bone (Vico et al., 2017, as cited in Iaquinta et al., 2019). Cortical bone is characterized as the "hard-outer layer of bone," while the trabecular bone is "organized to optimize load transfer" and can be found at the "end of long bones, as well as in the pelvic bones, the skull, ribs, and vertebrae" (Bayraktar et al., 2004, as cited in Iaquinta et al., 2019).

Specifically, in bone tissue, four main types of cells are observable in constructing the "basic multicellular unit" associated with "bone regeneration and structure" (i) osteocytes (primary function: maintain bone tissue), (ii) osteoblasts (primary function: form bone matrix), (iii) osteogenic cells (primary function: stem cells), and (iv) osteoclasts (primary function: reabsorb bone) (Ansari, 2019). To give some brief definitions of these, osteoblasts are "stimulated through bone morphogenetic proteins" and are "responsible for growing or remodeling of bone" (Standring, 2016, as cited in Ansari, 2019). Osteocytes are highlighted as the most "abundant cell type in bone tissue" and are derived from mesenchymal stem cells that have gone through "osteoblastic differentiation" (Noble and Reeve, 2000, as cited in Ansari,

2016). Lastly, osteoclasts are "large cells with more than one nucleolus" whose prominent role is to "break down bone" by "releasing enzymes and acids" that work to dissolve and digest minerals in bone (Boyle et al., 2003, as cited in Ansari, 2019).

Bone Regeneration Strategies–Scaffolds, Active Biomolecules, and Growth Factors

The use of scaffolds and active molecules in regenerative medicine primarily relates to three classifications (i) "recombinant growth factors" and a "combination of growth factors … with a natural medium or calcium phosphate substantial carrier," (ii) targeting cellular receptors with the "application of proteins," and (iii) the use of small molecules to "target the signaling pathway" (Ansari, 2019). The primary function of these two strategies is to "support structures designed to facilitate cellular growth and proliferation upon implantation" and "controlling cell response on the implant surface" (Gomillion & Burg, 2011; Kepekçi et al., 2021). A few of the growth factors already used in the clinical setting include "BMP-2, BMP-7, and rhPGDF-BB" (Ho-Shui-Ling et al., 2018, as cited in Ansari, 2019). These factors work to activate "chemical signaling pathways [that] result in bone development" and are primarily utilized in regenerative medicine to ensure success in cell differentiation and can "trigger events such as cell migration, survival, adhesion, proliferation, growth, and differentiation" (Ansari, 2019; Mitchell et al., 2015).

Osteocytes

Osteocytes are an essential player in understanding bone regeneration and producing viable methods for cell regeneration. Recent findings have suggested that osteocytes "release biochemical signaling molecules involved in bone remodeling such as prostaglandins, nitric oxide, Wnts, and insulin-like growth factor-1" (IGF-1) (Cao et al., 2020). An important takeaway from this finding is that the use of these biochemical signaling molecules with the "treatment of mesenchymal stem cells … improves osteogenesis" (i.e., bone formation) (Cao et al., 2020). This takeaway is instrumental when coupled with the fact that "osteocytes are the most abundant cell type in bone tissue," and their originate from MSCs that have undergone "osteoblastic differentiation" further alludes to the potential of MSCs found in buccal fat to yield similar results (Noble & Reeve, 2000, as cited in Ansari, 2019).

Role of Barrier Membranes

While research on the role of barrier membranes in bone regeneration is limited, studies that have been conducted have noted that the "biocompatibility, ... space-making, tissue integration, and clinical manageability" of barrier membranes make them an exceptional candidate for use in guided bone regeneration and have had promising effects in surgery for the maxillofacial, oral, and orthopedic regions of the body due to their "structural integrity during implantation" (Dimitriou et al., 2012).

Additional Treatment Options for Intraoral Bone Defects–Bone Grafts

Currently, one of the most common treatments for intraoral defects is bone grafts which is a standard treatment utilized in the dentistry field of medicine as a method to "replace or recover bone volume that has been resorbed" (Fernández, 2015). Among the bone graft options provided to patients, it was noted in a 2015 study that allografts and xenografts had the "highest rate of refusal," while autologous grafts and alloplastic had the "lowest rates of refusal" with no specific relations "observed between a specific religious affiliation and the acceptance/refusal rates of the various types of grafts" (Fernández, 2015).

Bone Substitutes

Bone substitutes such as "hydroxyapatite, calcium sulfate, calcium phosphate ceramics, bioactive glasses, etc." are generally selected for clinical applications related to "bone defects, such as spine fusion, periodontal procedures, vertebroplasty, management of long bone fractures, etc." (Fernández, 2015). In particular, bone substitutes provide benefits such as their ability to "promote healthy bone metabolism, bone regrowth, and the development of osteoblast-induced bone mineralization" (Marella et al., 2018).

The Gap

The current gap in the topic is on patient preferences for the treatment option. In other words, many studies have been done to test the viability of the treatment. Still, none have been done to see its eligibility for acceptance in the medical service industry. Recent studies suggest the usage of buccal fat-derived mesenchymal stem cells for use in bone regeneration due to their "high proliferation rate and differentiation potential" (Saber et al., 2020). Mesenchymal stem cells are "pluripotent cells that can transform into various cell types, including fat cells, bone cells, cartilage cells," and more (Hernández, 2022). These characteristics have sparked academic conversation on their potential and meaning for the medical industry; however, researchers do not know the acceptance rates of this treatment regardless of its effectiveness in the regenerative medicine field. Therefore, the need arises for this aspect of care to be studied.

For this experiment's design, a two-part study will be conducted where the topic will first be introduced via a literature review. Then the paper will go into an experimental, survey-based analysis of patient preferences and their implications on this emerging topic. The idea of buccal fat stem cell usage in regenerative medicine has been one of the latest biological and biomedical research trends in the past five years alone. While most research has remained strictly experimental, this technology/advancement will be utilized shortly. Thus, the need is ever growing for scientists to explore its potential and viability in real-world medical applications. This concept pertains to two things: 1) patient preferences and 2) feasibility and success rate. This study will look at the prior concept aspect to aid in filling the gap currently present in the medical community.

At this point, it is essential to note that the treatment options the study will be exploring are bone grafts, bone substitutes, and regenerative medicine options via stem cell usage, and the study will ask for education levels and/or field of specialties to then analyze the findings as they relate to the research question.

Methodology–Design

The design will consist of a two-part study where the topic will be introduced via a literature review. Then the paper will be going into a survey-based analysis of patient preferences and their implications on this emerging topic. Essentially, the idea of buccal fat stem cell usage in regenerative medicine has been one of the latest biological and biomedical research trends in the past five years alone. While most research has remained strictly experimental, this technology/advancement will be utilized soon. Thus, the need is ever growing for scientists to explore its potential and viability in real-world medical applications. This concept pertains to two things: 1) patient preferences and 2) feasibility and success rate. The prior concept will be analyzed to aid in filling the gap currently present in the medical community. The research will be centered around the question: to what extent do education levels effect patient preferences for intraoral bone defect treatment options? In this study, the independent variable will be the education level of the survey respondent, and the dependent variable will be the respondent's preferences on buccal-fat-derived stem cell usage for bone regeneration.

Subjects/Participants

The participants will include a sample size of around thirty people with ranging education levels. Additionally, the study will initiate with high school students and then expand to individuals who have obtained a master's, doctorate, or Ph.D. The participants were recruited via email requests and (if applicable) via club point opportunity. Additional variables that will be asked in the survey include demographic information about age, race, and gender.

Instruments/Data Collection Methods

This study will utilize two instruments, 1) a patient preference Google survey/ questionnaire (found in Appendix B), and 2) the Excel spreadsheets app for data record collection and graph/table construction. Additionally, an informed consent document will be attached to the Google survey as a required field for the respondents. The copies of the informed consent can be found in Appendix C (Figure 1 and Figure 2).

Inclusion criteria for this research project included being a Georgia state resident, having a minimum education level corresponding to a high school, being of 14 years or above, and having English as their primary language. Therefore, exclusion criteria included being under the age of 14, being a non-US or Georgia resident, being non-English speaker, and having no known educational background corresponding to a high school level. Additionally, vision impairment fell under the exclusion criteria for this study as understanding of the schematic representation and/or prompts in the survey were critical for accurate preference-related responses.

To ensure the reliability and validity of the project's findings, the survey will be constructed to be parallel to the survey given to the French population in the 2019 study conducted by Offner et al. for the differences in medicine acceptance for the use of bone grafts, bone substitutes, and regenerative medicine in bone defects among the French population. In addition, a thematic content analysis will be conducted to collect qualitative data on the free-response questions given in the survey. A p-value test will also describe the quantitative data and its relationship to both the hypothesis (there will be a significant difference between patient preferences of lower and higher education levels) and the null hypothesis (there will not be a significant difference).

Procedures

The questionnaire will contain scale rating, multiple choice, and short answer questions on patient education levels. It will then be studied to determine the correlation to acceptance for the usage of buccal fat pad stem cells on bone regeneration. For data collection, the forms will be sent out on December 12, 2022, for the preliminary sites of Milton High School and medical sites in/around the Milton-Alpharetta community. Subsequently, the survey will be extended to teachers and faculty at Milton High School, Northwestern Middle School, Alpharetta Elementary, Crabapple Crossing Elementary, etc., on January 17, 2023. Finally, the final survey requests will be sent to neighborhoods, community centers, offices, etc., for a broader community reach on January 23, 2023.

For ethical and safety concerns to be satisfied, the information collected from the surveys will be kept anonymous and with no survey requesting names/ other personal identification factors. For increased data security, the information gathered from the surveys will also be stored in a password-protected folder on a password-protected laptop, with the backup drive being stored in a secure and locked safe. The study will also uphold additional steps such as informed consent and access to the respondents' final published analysis and conclusions.

Analyses

The data collected from the survey will be displayed in tables organized for inclusion of the multiple-choice questions and the free response questions will be coded using thematic content analysis for further analysis via a qualitive approach.

A thematic content analysis will be conducted to collect qualitative data on the free-response questions given in the survey. A p-value test will be conducted to determine statistical significance of data and describe the quantitative data and its relationship to both the hypothesis and the null hypothesis.

In the qualitative data set, responses will be coded using thematic content analysis and thus will allow for the free answers to the questions to be understood and analyzed in the context of the data gathered. In addition, this organizational method will allow for trends to be highlighted and distinguished amongst the respondents' preferences.

On the other hand, in the quantitative data set, the true or false will be utilized to justify or disprove the hypothesis that patient preferences will be positively correlated to higher levels of education (master's or Ph.D.). A p-value test will be utilized to form a conclusion from the data on whether the null hypothesis or hypothesis is accepted. Suppose the p-values are more significant than the significance levels being tested. In that case, the corresponding statement can be accepted, thus proving a significant trend in the collected data set. This form of analysis will be helpful for the implications of the study and its findings for medical preferences and treatment acceptance.

Results

Fifty-one subjects participated in this study, with 62.7% of respondents having higher education and 37.3% having lower education. The raw data for education levels can be seen in Figure 1. Figure 1 displays data collected for six significant education categories: 12 grade or less, high school diploma or GED, some college but no degree, associate degree, bachelor's degree, or master's degree.

Figure 1: Education levels of the study participants (*n*=51)
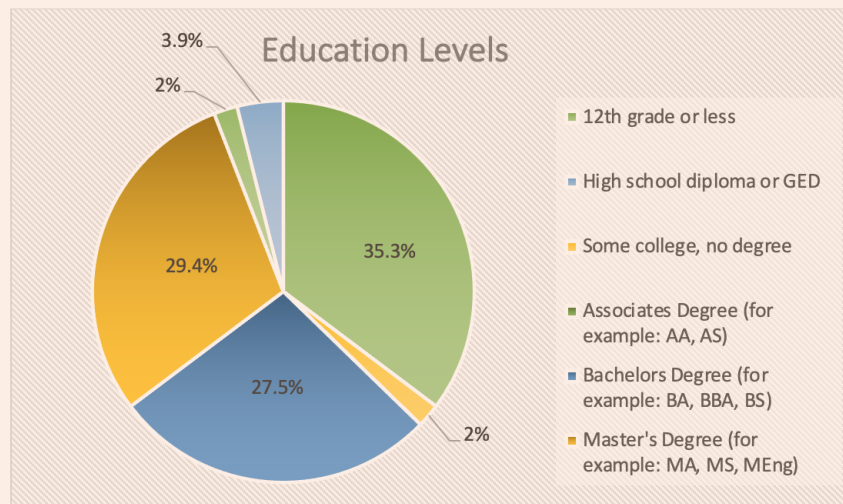
A categorized data chart was compiled to display higher and lower education as the two study groups using the raw data results. To do this, the six major categories obtained from the survey were categorized with 12 grade or less, high school diploma or GED, and some college but no degree becoming part of the lower education category and associate degree, bachelor's degree, and master's degree being part of the higher education category. Figure 2 displays this categorized data.

The overall acceptance ratio for autologous bone graft, allograft, xenograft, synthetic bone substitute, and bone regenerative medicine was 78.4%, 70.6%, 29.4%, 78.4%, and 80.4%. The xenograft had the highest rate of refusal or neutrality, with the refusal rate being 51%. Autologous bone grafts and synthetic bone substitutes had the lowest refusal rates at 7.8%.

Figure 2: Categorized education levels of the study participants (*n*=51)
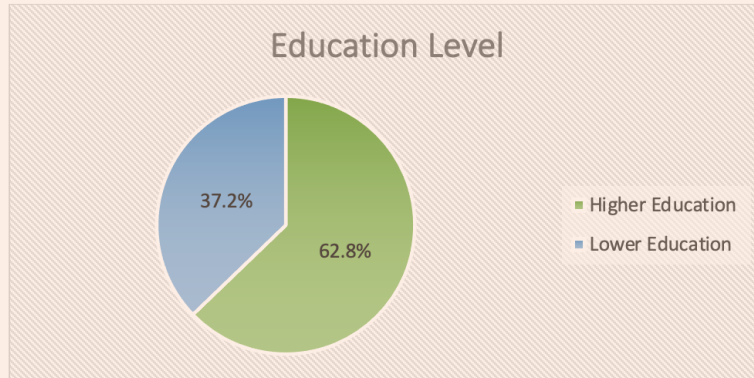
Figure 3 is shown below to illustrate the acceptance and rejection responses for the five intraoral bone defect treatments and their frequency and percentages. In addition, Figure 4 compares education levels for the two categories of higher and lower education and the frequency and percentage rates for the acceptance or rejection rates of the survey responses.

Figure 3: Frequency and percentage of acceptance/rejection response to the different types of intraoral bone defect treatments (*n*=51)

Type of Bone Graft	Never (%)	Unlikely (%)	Neutral (%)	Likely (%)	Yes (%)	Total (Acceptance and conditional acceptance) (%)
Autologous Bone Graft	0 (0)	4 (7.8)	7 (13.7)	12 (23.5)	28 (54.9)	40 (78.4)
Allograft	1 (2)	4 (7.8)	10 (9.6)	22 (43.1)	14 (27.5)	36 (70.6)
Xenograft	3 (5.9)	23 (45.1)	10 (19.6)	10 (19.6)	5 (9.8)	15 (29.4)
Synthetic Bone Substitute	1 (2)	3 (5.9)	7 (13.7)	20 (39.2)	20 (39.2)	40 (78.4)
Bone Regenerative Medicine	1 (2)	6 (11.8)	3 (5.9)	18 (35.3)	23 (45.1)	41 (80.4)

Figure 4: Comparison of acceptance and rejection ratio among education levels (*n*=51)

Variable	Group	*n*=51	Autologous Bone Graft		Allograft		Xenograft		Synthetic Bone Substitute		Regenerative Medicine	
			Accept	Reject	Accept	Reject	Accept	Reject	Accept	Reject	Accept	Reject
Education Level	Higher Education	32 (51)	26 (81.3%)	3 (9.4%)	22 (68.8%)	5 (15.6%)	10 (31.3%)	14 (43.8%)	23 (71.9%)	3 (9.4%)	24 (75%)	5 (15.6%)
	Lower Education	19 (51)	14 (73.6%)	1 (5.3%)	14 (73.6%)	0 (0%)	5 (26.3%)	12 (63.2%)	17 (89.5%)	1 (5.3%)	17 (89.5%)	2 (10.5%)

After compiling Figure 4, the acceptance and rejection p-values were calculated for each treatment option. The significance level of 0.05 was used to eliminate any sampling bias that could have resulted from having a smaller sample size. Figure 5 is shown below to display the p-value findings.

Figure 5: Comparison of acceptance and rejection p-values among education levels

	Autologous Bone Graft		Allograft		Xenograft		Synthetic Bone Substitute		Regenerative Medicine	
	Accept	Reject	Accept	Reject	Accept	Reject	Accept	Reject	Accept	Reject
p-values	0.26255	0.298715	0.354239	0.034823	0.354425	0.090123	0.069784	0.298715	0.104069	0.304465

Finally, a thematic content analysis was done to evaluate the responses to the question, "after taking this survey, which of the five techniques would you opt for if necessary and why?". Figure 6 displays the findings of this analysis with a key showing the six codes that were determined to be ER1 (ethical reasoning), IR1 (fear of invasive technique/reasoning based on invasiveness of treatment option), SR1 (safety reasoning/ reasoning based on the perceived safety of each technique), BM1 (reason based on conservation of one's bone material), CO1 (reason based on confidence in technique), and OC1 (reasoning based on the use of own cells for treatment).

Figure 6: Thematic Content Analysis

Analysis–Results & Findings Analysis

In the medical industry, treating intraoral bone defects has often been studied based on patient responses to highlight what demographical factor plays the most inherent role in decision-making and treatment preference. One study on patient preferences in bone graft therapy used in dentistry highlighted their findings on "gender and education level" having an association with the "acceptance and rejection rates" (Almutairi, 2019). On the other hand, another study on the analysis of patient's preferences for bone grafts used in dentistry found that there were "no differences in the acceptance/refusal rates for the different bone grafts due to the sociodemographic variables or religious affiliation" (Fernández et al., 2015).

This study's results and findings were most coherent with the latter studies. No statistical difference was observed in the acceptance and rejection rates of patient responses for the five different types of intraoral bone defect treatment options studied. Thus, the null hypothesis was accepted for the experiment on education levels not significantly affecting patient preference for intraoral bone treatment options. Consequently, the alternative hypothesis on education levels significantly affecting patient preferences for intraoral bone treatment options was rejected.

These conclusions can be seen explicitly through the findings depicted in Figure 5, where the p-values calculated for each acceptance and rejection rate of the five treatment options are more significant than the determined significance level of 0.05. As an exception to this trend, it is essential to note that the p-value for the rejection rate for allografts was 0.034823, which is less than 0.05 and thus displays statistical significance. This discrepancy is because of the significant difference in general responses between lower and high-education-level groups. It was seen that out of the 32 respondents with higher education, five respondents rejected allografts as a viable treatment option. In comparison, out of the 19 respondents with lower education levels, 0 rejected the treatment option. As a result of this difference, a statistical difference was seen, but further analysis and data collection would be needed to determine whether this statistical significance was because of sampling error due to small sample size or if there was indeed a statistically significant trend to be noted. Due to all other data points exhibiting p-values greater than 0.05 and thus being of no statistical difference, an inference can be made on a sampling error being the predominant conclusion to this trend. However, further observations must be made to make a definite conclusion.

At the end of the survey, respondents were asked the free response question, "After taking this survey, which of the five techniques would you opt for if necessary and why?". This question was specifically intended on gather data on the thought-processes of the respondents and their correlation to the trends seen in the data. Through a thematic content analysis, it was determined that there are six key factors that were taken into consideration when developing responses. These six categories were ethical reasoning, invasive reasoning, safety concerns, idea of conserving one's own bone material, confidence in technique, and reliability based on use of own cells. This thematic content analysis can be seen in Figure 6.

Limitations

The predominant limitation with this experiment is a small sample size. Due to the smaller size in number of participants observed a greater significance level (0.05) was taken to avoid and sampling error or bias when conducting analysis. Despite the assumption of a 5% risk on evaluating the data for determining a difference, it is a noteworthy takeaway that not significant difference was observed, and this observation falls into coherence with the conclusions described in the study done patient's preferences for bone grafts used in dentistry that was conducted by Fernández et al., 2015.

Additionally due to random sampling, the survey experienced a greater number of responses from those with higher education levels than from these with lower education levels. Due to this the sample sizes of the two populations differenced and could be responsible for any discrepancies observed. In order to bridge the gap between these two study groups a greater number of samples could be effective.

Finally, the study conducted had a sample group from the Milton-Alpharetta community in Georgia and therefore should not be used to make a vast generalization for state, national, or global trends.

Significance, Implications, and Future Directions

The significance of this survey is a better understanding of patient preferences and their influences. Oftentimes in medicine, demographical variables are noted as key influencers in a patient's decision-making for treatment options, however this experiment demonstrates the importance of personal beliefs as major contributors in this process.

Response analysis indicated how educational factors influence the spread of data but when analyzed there is no significant difference in preferences. In fact, the thematic content analysis fortifies the conclusion on ethical reasoning, invasive reasoning, safety concerns, idea of conserving one's own bone material, confidence in technique, and reliability based on use of own cells playing a more significant role in patient responses. This implication also suggests the need for further research into individual reasoning and thought processes rather than an overview of individuals based on demographically determined categories such as age, gender, etc.

While education levels were found to not be a major contributing factor of respondent preferences, additional questions found that 2-29% of individuals rejected the use of bone treatment options due to ethical reasons. Additionally, it was found that religious reasons did not play a key contributor to the refusal rates in all of the treatment options with the exception of the allograft where 2% of respondents and xenograft where 9.8% of respondents found the treatment to be in conflict with religious beliefs. These additional responses when paired with the thematic content analysis further implies the importance of individualized care and patient autonomy when choosing a treatment plan.

While patient perception and decision-making is highlighted in the study, more research is needed to understand the subject with a broader and applicable scope in the medical

community. For the present the conclusion and implications on the importance of patient autonomy and patient decision-making can be supported and to accomplish this successfully maintaining policies to uphold patient's individual choices and ensuring that patients are well-informed prior to determining a treatment plan is crucial.

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The Big Three in Semiconductors—Intel, NVIDIA and AMD By Huanyu Liu

Introduction: Overview of the competitive rivalry between Intel, NVIDIA and AMD

Intel, NVIDIA and AMD are three of the world's largest manufacturers of computer chips and have recently branched out into other areas such as specialized gaming chips, artificial Intelligence, cloud computing, etc. These companies are pursuing many of the same objectives but each has its own unique strategy; it remains to be seen which approach will result in the most rapid technological advancement and profitability.

Competition: The competitive relationship between these three companies can be summarized as follows

NVIDIA and Intel compete directly in the datacenter and Artificial Intelligence (AI) space, especially in deep learning training and inference. Nvidia's Graphics Processing Units (GPUs) are a major competitor with their strengths in parallel computing.
Collaboration: although they compete fiercely in some areas, these companies may also collaborate. For example, some vendors may use Intel's processors and NVIDIA's GPUs to build AI solutions. As another example, NVIDIA is collaborating with Intel to provide attestation services for Nvidia H100 GPUs. Attestation ensures the safety and security of these GPU chips. Different markets: they also specialize in different markets and areas. In addition to the AI space, Intel and AMD compete in personal computers, servers, and other areas.
In addition to the competitive relationship between Intel, NVIDIA, and AMD, these companies face others as competitors in the AI space, especially in the areas of AI hardware, AI solutions, and cloud computing. Here are some other important competitors.

Competitors

Google is a tech giant with a strong presence in the AI space. Google's Tensor Processing Units (TPUs) are AI chips specifically designed to accelerate deep learning tasks. Google has also developed TensorFlow, a widely used open-source deep learning framework. (Deep learning means that a computer model learns from data; for example, facial recognition software.) Google also has leading positions in cloud computing, natural language processing, and computer vision.

Microsoft is also a global technology company with its own AI research and development division. Microsoft has the Azure cloud platform in the cloud computing sector, which offers a wide range of AI solutions and tools. In addition, Microsoft is also developing deep learning frameworks such as Microsoft Cognitive Toolkit (CNTK).

Amazon has Amazon Web Services (AWS) in the clouds, which provides powerful AI services and solutions such as Amazon SageMaker, which is a machine-learning service. Amazon has also developed its own AI technologies in natural language processing and computer vision.

Apple's focus in AI is primarily on the integration of AI applications such as Siri (voice assistant) and Core ML (machine learning framework for iOS devices). Apple has also invested in AI chip design to improve the AI performance of its mobile devices.

Huawei is a Chinese tech company that has also demonstrated strong R&D in AI. Huawei has invested and innovated heavily in AI chips (e.g., the Ascend series) and cloud services in an effort to expand its AI solutions globally.

Competition between these companies is driving the development of AI technology and fostering more innovation and collaboration. It is worth noting that due to the rapid changes in the technology industry, new competitors may have emerged or the position and competitive relationship between the aforementioned companies may have changed.

Gaming Hardware and Technology

Intel, NVIDIA and AMD all play important roles in the gaming space, especially in providing gaming hardware and technology.

NVIDIA is known for its powerful graphics processing units (GPUs) that excel in the gaming space. NVIDIA's GeForce family of GPUs is widely used in gaming PCs and gaming laptops, providing superior graphics performance and gaming experience. NVIDIA has also introduced many innovations in the gaming space, such as real-time ray tracing (a technique for producing 3D images) (Ray) and DLSS (Deep Learning Super Sampling Technology), which improve game quality and performance.

AMD also has a presence in the gaming space. AMD's Radeon family of GPUs is used in a wide range of gaming PCs and gaming consoles (e.g., PlayStation and Xbox). AMD's GPUs typically excel in price/performance ratio, which makes them attractive to many gamers. AMD is also continually adding new features to its Radeon software suite to improve gaming performance and experience.

While Intel does not have the market share in the gaming space that NVIDIA and AMD do, it is still a significant competitor. Intel's integrated graphics cards perform well in some light games and general applications, and they can provide playable performance in some lightweight gaming scenarios. However, Intel has been working hard to improve the performance of its graphics cards and plans to launch discrete graphics cards designed specifically for gaming to gain a larger market share in the gaming space.

The competition between these three companies in the gaming space has pushed gaming hardware technology forward, with gamers benefiting from ever-increasing graphics performance and gaming experiences. The gaming industry is a highly dynamic sector and these companies are striving to innovate and meet the growing demands of gamers. As a result, the future is likely to see more advanced technology and product launches to further enhance the gaming experience.

Performance of INTEL, NVIDIA and AMD

Intel is a large American technology company known for making computer chips. They supply microprocessors for PCs and have been a major player in the industry. They compete

with AMD in PC chips and ARM in mobile devices such as modems. Intel has also faced antitrust disputes and is working to reduce its carbon emissions[1].

Intel has a strong history of innovation and dominates the data-centric market. The company's main revenue comes from selling its products to manufacturers. Despite facing competition and some challenges, Intel remains a prominent player in the tech industry.

Intel's strategy is to provide top semiconductors for a data-centric world. They focus on growth, execution, capital deployment and culture. Targeting a $300 billion market by 2024, their main areas are data-centric and PC-centric businesses. They lead in AI, 5G (5th generation mobile network), and the Intelligent edge. They have six technology pillars, allocate capital wisely and bet on memory, autonomous driving and 5G. Transforming their culture is a priority[2].

The intelligent edge is a concept in computing and networking that refers to data processing and analysis taking place at the edge of the network or close to the source of the data, rather than sending it all to a centralized cloud server. It achieves the benefits of reduced latency (i.e., reduced delay in network communication), optimized bandwidth, enhanced security and support for offline operations by performing some of the processing on local devices, sensors or edge servers. Smart Edge is part of Edge Computing and is designed to optimize the performance and efficiency of IoT (Internet of Things) and data-driven applications.

Intel has restructured its graphics chips business into two parts: one for discrete GPUs and another for high-performance computing. A discrete GPU has its own memory distinct from the CPU, which improves performance but requires more power. This change aims to compete better with rivals Nvidia and AMD. Despite facing challenges, Intel sees graphics and accelerated computing as crucial for growth[3].

Intel reported a significant drop in earnings and revenue for the first quarter of 2023[4], but it performed slightly better than expected. The CEO's turnaround plan aims to compete with other chip manufacturers by 2026. The PC chip business is struggling, but there is growth in the self-driving car sector. Intel is cutting costs and improving gross margins to save money.

In Q1 2023, Intel reported a significant drop in revenue across all key businesses, with losses in client and data center segments. The net loss was $2.8 billion. However, the CEO sees it as steady progress amid transformation efforts. Mobileye (the division responsible for "autonomous vehicles") was the only segment with growth. For Q2 2023, Intel expects similar results with revenue of $11.5 to $12.5 billion.[5]

Nvidia is an American technology company famous for designing powerful graphics cards used in gaming, AI, and other applications. They also provide software for data science and high-performance computing. The company was founded in 1993 and has become a major

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[1] https://en.wikipedia.org/wiki/Intel
[2] https://www.intc.com/strategic-priorities
[3] https://qz.com/Intel-split-graphics-unit-nvidia-amd-dgpu-competition-1849922166
[4] https://www.fudzilla.com/news/56798-Intel-reports-its-q1-2023-financial-results

[5] https://www.fudzilla.com/news/56798-Intel-reports-its-q1-2023-financial-results.

player in the tech industry[6].

NVIDIA and Intel are introducing new products with AI technologies[7]. NVIDIA has an AI-powered supercomputer platform for tech enterprises and an advertising service to reduce costs. They also offer AI for gaming experiences. Intel's upcoming CPUs will have an integrated AI engine and improved power management. Both companies use AI to stay competitive and meet growing demand for AI tasks.

Nvidia's revenue forecast surged, driven by the growing use of artificial Intelligence[8]. The demand for AI chips is increasing, reshaping the tech sector. Nvidia's AI chips are faster and more efficient than traditional CPUs for AI tasks, making them highly valuable. The strong guidance reflects the rising importance of AI in the tech industry.

Nvidia is predicted to have over 90% of the AI chip market share[9], with AMD in second place. An analysis showed Nvidia's AI chips are about 80% faster than AMD's. Nvidia's superior speed and ecosystem give it an advantage in AI performance. Both companies have released new AI chips this year. Nvidia's market dominance is likened to Intel's position against AMD in the past.

Nvidia's stock surged to almost $1 trillion in market cap after a strong outlook[10]. The demand for its GPUs in AI applications is driving sales growth. GPUs are becoming more important than CPUs for AI tasks. Nvidia's high-end GPUs are favored for AI applications due to proprietary software. The company remains a leader in AI chips despite competition.

AMD (Advanced Micro Devices) is an American semiconductor producer based in California. The company was founded in 1969 by Jerry Sanders and other computer professionals. Originally the company focused on memory chips for computers. Later it began to compete with industry leader Intel in the microprocessor market. Due to the success of its Athlon and Opteron processors, the company experienced rapid growth in the 2000's. By the 2010's, its Ryzen processors helped it keep up with Intel. AMD's microprocessors are widely used in personal computers, servers and gaming consoles. By 2009, the company had gone "fabless" which means designing microprocessors but outsourcing the actual production to other companies. Currently AMD has achieved a market capitalization of just under $200 billion, making it one of the larger companies in this area.

AMD is challenging Nvidia's AI market dominance with its new AI chip, the AMD Instinct MI300X. This chip is a strong competitor to Nvidia, the current leader in the AI chip

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https://en.wikipedia.org/wiki/Nvidia#:~:text=Nvidia%20is%20a%20dominant%20supplier,scientific%20research%2C%20and%20manufacturing%20design.

7 https://www.spiceworks.com/tech/artificial-Intelligence/news/nvidia-and-Intel-to-leverage-ai-in-latest-offerings/

8 https://apnews.com/article/nvidia-stock-artifical-Intelligence-earnings-f6b9df3a4cafe1a4ee041cc736b97a89

9

https://www.marketwatch.com/story/nvidia-should-have-at-least-90-of-ai-chip-market-with-amd-on-its-heels-13d00bff#:~:text=Nvidia%20Corp.,in%20servers%20a%20decade%20ago.

10

https://www.visualcapitalist.com/nvidia-joins-the-trillion-dollar-club/#:~:text=Chipmaker%20Nvidia%20is%20now%20worth,Apple%2C%20Amazon%2C%20and%20Microsoft.

market. AMD aims to tap into the growing AI accelerator market, which is expected to reach $150 billion by 2027. (An AI accelerator is designed to optimize the performance of an AI system.) The MI300X is designed for generative AI (a form of machine learning that can produce text, videos, graphics, etc.) and is likely to interest cloud providers like Amazon and Microsoft. AMD aims to challenge Nvidia's leading position in AI chips. Nvidia has experienced strong revenue growth with its AI chips, contributing to its trillion-dollar valuation. The MI300X is designed for large language models and offers more memory capacity than Nvidia's H100. AMD also introduced an Infinity Architecture that combines eight M1300X accelerators in one system.

AMD presented its AI roadmap, featuring two key products: the MI300A APU accelerator and the MI300X GPU. The MI300X is designed for large language models in generative AI and is claimed to be the fastest GPU in this field[11]. AMD aims to compete with Nvidia's GPUs and is focused on providing a full range of AI hardware. The company is also working on developer education and collaborating with the Hugging Face AI community. Hugging Face is an open source community which creates tools that enable users to implement machine learning models.

FINANCIAL PERFORMANCE

The past year (July 2022 – July 2023) saw strong performances by NVIDIA and AMD with a very poor performance by INTEL. The mean returns, variances and standard deviations (on an annualized basis) are shown in the following table:

	INTEL	NVIDIA	AMD
Mean	-0.031991162	1.136232273	0.376255541
Variance	0.164216989	0.336329448	0.283148446
Standard Deviation	0.405236954	0.579939176	0.532116947

Source: finance.yahoo.com

The statistics show that on an annualized basis, Intel lost over 3% while AMD made nearly 38% and Nvidia earned returns of about 114%. The risk of Intel stock, as measured by the standard deviation of its returns, was the lowest of the three companies at about 40.5%, but this was only somewhat lower than the 58% of NVIDIA and 53% of AMD.

The poor performance of Intel can be at least partially attributed to the company's recent move to restructure its development process based on technology modules. The goal is to accelerate the development of new technology and create the next generation of computer chips. This is expected to increase the competitive position of the company, attract new external customers and cut costs. In the short run, these innovations will likely be very expensive and new revenue sources will not become available right away, so that profits are likely to suffer over this period. In the long run, though, these investments have the potential to greatly improve Intel's competitive position and profitability.

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[11] https://www.datacenterfrontier.com/machine-learning/article/33006628/amd-outlines-their-ai-roadmap

NVIDIA and AMD are experiencing rapid growth due to their innovations such as developing the latest graphics chips and their entry into the AI market.

Applications

There are many potential applications of computer chip technology, including:

- artificial Intelligence (AI)
- cloud computing
- graphics

AI

The rise of AI, particularly generative AI tools like ChatGPT, has driven significant growth in the tech industry post-pandemic. Generative AI can be used for:

- image generation and enhancement
- text generation and summation
- music and audio generation
- video generation and prediction
- drug discovery and molecular design
- virtual avatars and characters
- style transfer and image-to-image translations
- data augmentation
- simulation and training
- anomaly detection

AI hardware manufacturers, such as NVIDIA, AMD, TSM, and Micron, have seen soaring stock prices due to the AI surge. Software companies like Meta (formerly Facebook), Microsoft, and Alphabet (Google's parent company) are also benefiting from the AI boom. AI is reshaping the tech sector and becoming a dominant force in driving innovation and market growth.

WPP, the world's largest advertising agency, has teamed up with Nvidia to use artificial Intelligence (AI) for creating ads. This AI-powered platform allows WPP's creative teams to efficiently produce advertising campaigns on a large scale. It can customize ads for different countries, cities, and digital channels, making them more engaging. The technology enhances productivity and enables brands to deploy realistic and immersive content like never before. However, there are concerns about AI potentially impacting jobs in the advertising and media industries.

CLOUD COMPUTING

Simply put, cloud computing is the delivery of computing services—including servers, storage, databases, networking, software, analytics, and Intelligence—over the internet ("the cloud") to offer faster innovation, flexible resources, and economies of scale.

Intel provides a trusted foundation for organizations' cloud strategies, supporting private, public and hybrid clouds, and the Intelligent edge. They offer an open-source approach, ensuring compatibility with existing systems. Intel helps with AI implementation, cost optimization, and microservices migration through a sophisticated toolset. They collaborate with major cloud providers and offer a variety of products for better cloud performance[12].

GeForce Now is a cloud gaming service by Nvidia. It lets users play video games remotely through streaming. It offers a library of games or allows users to play their own purchased games. It supports various devices and uses Nvidia graphics cards for high-quality streaming[13].

A study by CockroachDB[14] showed that AMD's processors outperformed Intel's in cloud performance on AWS (Amazon Web Services), Azure, and Google Cloud. AMD was both the overall performance and price-for-performance leader. GCP's (Google Cloud Platform) AMD-based instance performed the best, followed by GCP's Intel-based and AWS's Intel-based instances. The study highlighted the importance of considering storage and data transfer costs when choosing a cloud provider.

AMD's processors are gaining ground in the datacenter market, with over 130 cloud instances launched by major providers like Amazon, Microsoft, and Google[15]. Their server market share reached 16% last year. AMD's strong performance resulted in a 49% revenue increase in Q4. The acquisition of Xilinx was approved in China, adding to their chip design capabilities. AMD's multi-core performance is superior to Intel's, making it popular for cloud-based applications. Cloud vendors are investing more in AMD-powered instances due to their performance and power efficiency.

GRAPHICS CHIPS

Nvidia's A100 GPU has become a critical tool for the AI industry and is being used by companies like Microsoft and Google to power their AI applications. As AI technology continues to advance, the need for powerful GPUs like the A100 is increasing, leading to a surge in demand and driving Nvidia's earnings growth. Other companies are also developing AI-specific chips, but Nvidia remains a dominant player in the AI hardware market.

POLITICAL CONSIDERATIONS

The Biden administration is considering an AI chip ban to restrict the export of technology with military applications to China[16]. This could severely impact companies like

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[12]

https://www.intc.com/news-events/press-releases/detail/1543/Intel-announces-new-cloud-to-edge-technologies-to-solve

[13] https://en.wikipedia.org/wiki/GeForce_Now
[14] https://www.cockroachlabs.com/blog/2022-cloud-report/
[15] https://www.thestack.technology/amd-cloud-wins/
[16]

https://www.bloomberg.com/news/articles/2023-06-28/us-plans-new-ai-computer-chip-export-controls-aimed-at-nvidia

Nvidia and AMD. The ban may affect their sales and trading, and shares of these companies fell after the news. The new restrictions would require a special U.S. export license for certain AI chips. This move could have a significant impact on the success of Nvidia and AMD, which have seen substantial growth in 2023.

The Risks

Intel, NVIDIA, and AMD all face potential risks such as intense competition, pressure for technological advances, fluctuations in market demand, risk of supply chain disruptions, regulatory and legal issues, and cybersecurity threats. In addition, specific events such as Intel's technology node transition and NVIDIA's acquisition of Arm (a chip producer) could have a significant impact on their future plans. Investors and stakeholders need to pay close attention to these risks in order to make informed investment and business decisions.

Cloud Computing, Artificial Intelligence and Graphics Chips are three interrelated and rapidly growing demand segments in the technology industry. Cloud computing is experiencing exponential growth in demand for its services owing to its flexibility and cost-effectiveness. Artificial Intelligence is widely used in various industries through advantages such as automation and improved decision making. Graphics chips also continue to grow in demand in gaming and other parallel processing areas. Intel, NVIDIA, and AMD all play an important role in cloud computing, artificial intelligence, and graphics applications, providing the appropriate hardware and solutions. Demand in these markets is expected to continue to grow as digital transformation and data-driven decision-making accelerate, and all three companies will continue to drive technology, bringing new innovations and opportunities to a wide range of industries.

CONCLUSIONS

Intel is currently switching its focus from the Next Unit of Computing business, which focuses on mini PC's, a type of core computer that requires the addition of a monitor, keyboard and mouse. Intel is pursuing consumer GPU's (graphics processing unit), data center GPU's, consumer AI chips, etc. Currently Intel's market share of these products is quite small compared with NVIDIA and AMD. Increasing its market share in these areas could be potentially very lucrative for Intel, but is likely to take a significant amount of time.

Intel is also changing the way that it packages together its "chiplets." (A chiplet is a very small chip that is used in conjunction with other chiplets to perform highly complex tasks more efficiently than traditional chips.) Currently Intel is the leader of 3D packaging capabilities. Intel is also expanding its capabilities as a semiconductor foundry (i.e., it produces semiconductors for other companies) which manufactures silicon wafers. This is another area that can be very lucrative for Intel but is likely to take a great deal of time.

Nvidia's overall strategy is to combine hardware and software, algorithms and other services. Nvidia has benefited from being the first to offer various products, such as the GPU,

Computer Unified Device Architecture (CUDA), and created the first deep learning hardware accelerators, such as the Tesla V100 T4 GPUs (data center GPUs).

Another facet of Nvidia's strategy has been to prioritize the quality of its products over the costs of producing them. The GPU, data center and gaming chips consist of the most advanced technology but are more expensive than competing chips.

The company also produces its own GPU's and other hardware components and also develops its own software.

Most of NVIDIA'S revenues come from GPU sales, which can be used in many applications, such as gaming, robotics, automotive applications, etc. Unlike NVIDIA, AMD sells cutting-edge technological products such as microprocessors, GPU's, computer hardware, etc. at relatively low prices. AMD has successfully diversified its offerings past the traditional PC market into data centers and gaming markets. This has made the company less reliant on one or two revenue sources. The company has been able to keep up with technological changes and adapt its products to the latest technology. After many years of competing with established firms such as Intel and NVIDIA, AMD is now highly successful and continues to remain highly innovative in this market.

An Evaluation Of Errors In IEA's And EIA's Forecasts For Solar And Wind Energy 2010-2021 By Kent Huang

Abstract

To mitigate the increasingly severe crisis of global warming, policymakers are hoping to facilitate a transformation into renewable energy to reduce greenhouse gas emissions. Energy forecasting, which will provide policymakers with information and guidance, will be crucial for the future of the transformation of energy. The EIA and IEA, two of the largest organizations in this field, both publish reports regularly in which they include forecasts for the capacity of each major form of energy production. In this paper, we conducted an evaluation of the accuracy of the EIA and IEA's forecasts made between the years 2010 and 2021 for solar and wind energy, two sources of renewable energy with the most potential. Through both qualitative and quantitative analysis, we were able to come to the conclusion that the EIA and IEA significantly underestimated the growth of wind and solar energy. The inaccuracy of their predictions grew significantly as the forecast horizon increased, which may have led to seemingly more accurate results in recent reports. This paper also seeks to provide reasoning for this phenomenon from many aspects. This paper highlights the vitalness of organizations such as the EIA and IEA in improving their forecast accuracy and seeks to provide a framework to facilitate this improvement.

Introduction

Energy, as the cornerstone of modern civilization, powers everything from the handheld devices we depend on daily to the vehicles that move us across different locations. For a long time, humanity's primary energy source has been fossil fuels, with coal, natural gas, and oil driving our industrial progress. However, this comes at a substantial environmental expense since the combustion of fossil fuels contributes to global warming and climate change, creating a significant threat. Recognizing this issue, there is a global push towards sustainable alternatives such as solar and wind power. As we stand at this pivotal point, energy forecasting becomes imperative: by accurately predicting future energy trends, policymakers and industries can make informed decisions, ensuring a reliable and successful energy transition. Moreover, understanding these energy dynamics offers a clearer picture of our current global structure, allowing for deeper insights into the constantly evolving world.

Renewable energies, such as wind and solar energy, stand out for their inherent unpredictability caused by their dependence on natural conditions, making them more challenging to forecast compared to conventional energy sources. While large-scale utilization of wind energy for electricity only took off in the early 2000s, and for solar energy about a decade later (Jaeger 2021), the potential of these green energy alternatives to dominate global energy production is evident. As of 2020, according to the International Energy Agency (IEA), wind and solar together constituted about 9 percent of global energy generation. Yet, this figure is on a rapid upward trajectory to exponentially increase in the coming years. To realize the goal of

achieving net-zero carbon emissions by 2050 - a balance between emitted and removed carbon - renewable energy sources must contribute to 85% of energy generation. Within this framework, solar and wind energy will lead the way, together accounting for an estimated 60% of total electricity generation (IRENA 2018).

In the domain of energy forecasting, numerous institutions provide pivotal insights, but the most notable institutions are the International Energy Agency (IEA) and the U.S. Energy Information Administration (EIA). The IEA is an intergovernmental autonomous organization while EIA is managed and funded by the American government. This research delved into a comparative analysis of their projections on wind and solar capacity. To gauge their forecasting accuracy, I employed graphical representations and error metrics, specifically the mean absolute percentage error (MAPE) and the root mean squared error (RMSE), which will be discussed in depth in later sections. This methodological approach was designed to shed light on the reliability of future energy forecasts from such institutions.

My research differs from prior studies on energy forecasting in several significant aspects. While seminal works such as those by Bezdek and Wendling (2002) and by Winebrake and Sakva predominantly focus on the years preceding 2005, my study aims to examine the period post-2005, questioning whether the IEA has recalibrated its forecasting methodologies to enhance accuracy. Moreover, I endeavor to delve deeper into the rationale behind the forecast accuracies or inaccuracies of both the IEA and EIA, aspiring to present a holistic understanding of the energy forecasting realm.The structure of the paper will be as follows:

Literature Review - An exploration of existing studies that are relevant to my research topic. This will involve a detailed examination of previous works, highlighting their relevance and connections to my own research.

Methodology - This section will detail the error metrics I employed for assessing and contrasting the forecast inaccuracies. It provides a foundation for the subsequent comparative analysis.

Data - A comprehensive discussion highlighting the constraints and limitations associated with the data sources and their potential implications on the study.

Results - Presentation of Results and an in-depth evaluation of forecast errors from both institutions.

Discussion - A deep dive into possible reasons behind any inaccuracies observed and assess the reliability and credibility of the two organizations in their forecasts.

Conclusion - A summarization of the key findings, observations, and implications drawn from the study, capturing its overall essence and significance.

Literature Review

Energy forecasting is essential for the energy sector, illuminating future trends in consumption, demand, and pricing. Such predictions are based on models built from historical data, combined with recent information.

"International Energy Agency"

Each year, the International Energy Agency (IEA) releases its World Energy Outlook (WEO), an extensive document spanning 600-800 pages, charting the potential trajectories of global energy in forthcoming decades. This annual outlook comprises tables forecasting demand, consumption, and generation at 5-year intervals (i.e. 2015, 2020, 2025, etc). Notably, the IEA segments its projections into three distinct scenarios: the current policy scenario, the new policy scenario, and the 450 Scenario (maintaining atmospheric greenhouse gas levels at approximately 450 parts per million of CO2 in order to align with the objective of capping the global temperature rise to 2°C). This paper will center its attention on the "new policy scenario." Defined by the IEA, this scenario "takes account of broad policy commitments and plans that have been announced by countries, including national pledges to reduce greenhouse gas (GHG) emissions and plans to phase out fossil energy subsidies, even if the measures to implement these commitments have yet to be identified or announced." The new policy scenario is usually the IEA's baseline scenario.

"Energy Information Administration"

The Energy Information Administration (EIA) also annually releases its International Energy Outlook (IEO), which contains charts and tables outlining projections for different aspects of the energy landscape. The EIA's goal is to offer independent statistical data and energy analysis. For this study, I will also be drawing upon the baseline scenario provided by the EIA.

Previous Research

Several studies and research have focused on the analysis of forecasting errors of the EIA and IEA energy projections. They analyze the inaccuracies of the predictions and models by using calculations and comparisons. Winebrake and Sakva (2006) tries to uncover the systematic errors in the EIA forecasting model. They use metrics such as MPE(mean percentage error) and MAPE(Mean Absolute Percentage Error) to compare the errors in the forecasts for each sector's energy consumption in EIA reports from 1982 to 2003. Their results prove that the low total errors were a consequence of larger sectoral errors canceling each other out. There is also no sign that shows the forecasting has become more accurate between 1982 and 2003. Auffhammer's (2007) study provides evidence that most level energy-related forecasts published by the EIA are only rational or optimal under highly asymmetric loss functions. The forecasts of oil, coal and gas prices and natural gas consumption, GDP and energy intensity are proved to be consistent with highly asymmetric loss functions. Bezdek and Wendling (2002) assess major US long-range energy forecasting studies conducted over the 1950s to the 2000s. By calculating the percentage error, they come to the conclusion that predictions are not accurate. They think that lessons should be learnt from past inaccurate forecasts and that basic trends should be deduced to help make predictions more accurate.

Additionally, several works continue to focus on investigating possible mistakes or assumptions that could have led to these inaccuracies in forecasts. For instance, Utgikar and Scott (2006) use the Delphi technique to find the reasons behind inaccuracies in energy predictions. They come to the conclusion that improper techniques, technological barriers to the development of technologies, socio-political considerations and economic considerations could all be major reasons that could contribute to the inaccuracies. Simoes et al. (2015) aim to quantify how specific assumptions influence the outcome of scenarios. Results show that the availability of water and the price of oil only affect the outcomes of socio-economic development and have little or no influence on the outcomes of greenhouse gas emissions. O'Neill and Desai (2005) also used MPE and MAPE metrics to measure and analyze the accuracy of predictions for US energy consumption. They find that energy consumption predictions for the US tend to be too low, a product of the extremely inaccurate forecasts for GDP and Energy intensity. They also do not see any sign of improvements in terms of the accuracy of the predictions.

Methodology

My methodology is similar to the approach outlined in Winebrake and Sakva's 2006 study. The focus of my analysis centers on the discrepancy between forecasted and actual values. The primary error metric I've utilized is the Mean Absolute Percentage Error (MAPE), for which the equation is shown in Equation 1. Its inherent strength lies in its ability to prevent negative and positive errors from canceling out each other, thereby offering a contextual percentage-based error. I also employed the Mean Percentage Error (MPE), for which the equation is presented in Equation 2, albeit to a lesser extent. The dominant trend of underestimations in the data renders the MPE, which takes into account whether the inaccuracy was positive or negative, somewhat redundant as the MPE would serve the exact same purpose as the MAPE metric in the case of this study. Furthermore, For comparative ease between the IEA and EIA's predictive errors, I incorporated the RMSE metric, for which the equation is shown in Equation 3. While the isolated values derived from this metric might not be significant just by themselves, they can be instrumental in comparing two datasets.

Equation 1.

$$\text{percent error} = \frac{(\text{average of measured value}) - (\text{accepted value})}{(\text{accepted value})} \times 100\%$$

Equation 2.

$$MAPE = \frac{1}{n} \sum_{i=1}^{n} \frac{|A_i - F_i|}{A_i}$$

A_i is the actual value

F_i is the forecast value

n is total number of observations

Equation 3.

$$RMSE = \sqrt{\frac{\sum_{i=1}^{N} (Predicted_i - Actual_i)^2}{N}}$$

Data

   Due to the quality and availability of the data, There might be some limitations in the analysis. When collecting information from the EIA reports, I noticed that their reference cases, or historical data for a certain year, varied based on the year the forecast was issued. As a result, I used the nearest reference for each case as the actual values because they would be the most accurate. Another challenge was that the baseline year for each EIA report typically preceded the report's publication by 2-3 years, which made certain data less readily available. Moreover, energy reports were not consistently published every year, leading to gaps in forecast data for certain years. Lastly, there may not be a large enough sample size to very accurately determine the scale of error made.

   While calculating the errors, I will categorize the IEA data based on the two distinct years for which predictions were made. For the EIA data, I will organize them by the year each forecast was issued as the EIA provided predictions for a wider range of years.

Results

Figure 1. IEA Wind Installed Capacity Predictions Each Year (GW)

Figure 4. IEA Solar Installed Capacity Predictions (GW)

Figure 2. EIA Wind Installed Capacity Predictions Each Year (GW)

Figure 3. EIA Solar Installed Capacity Predictions(GW)
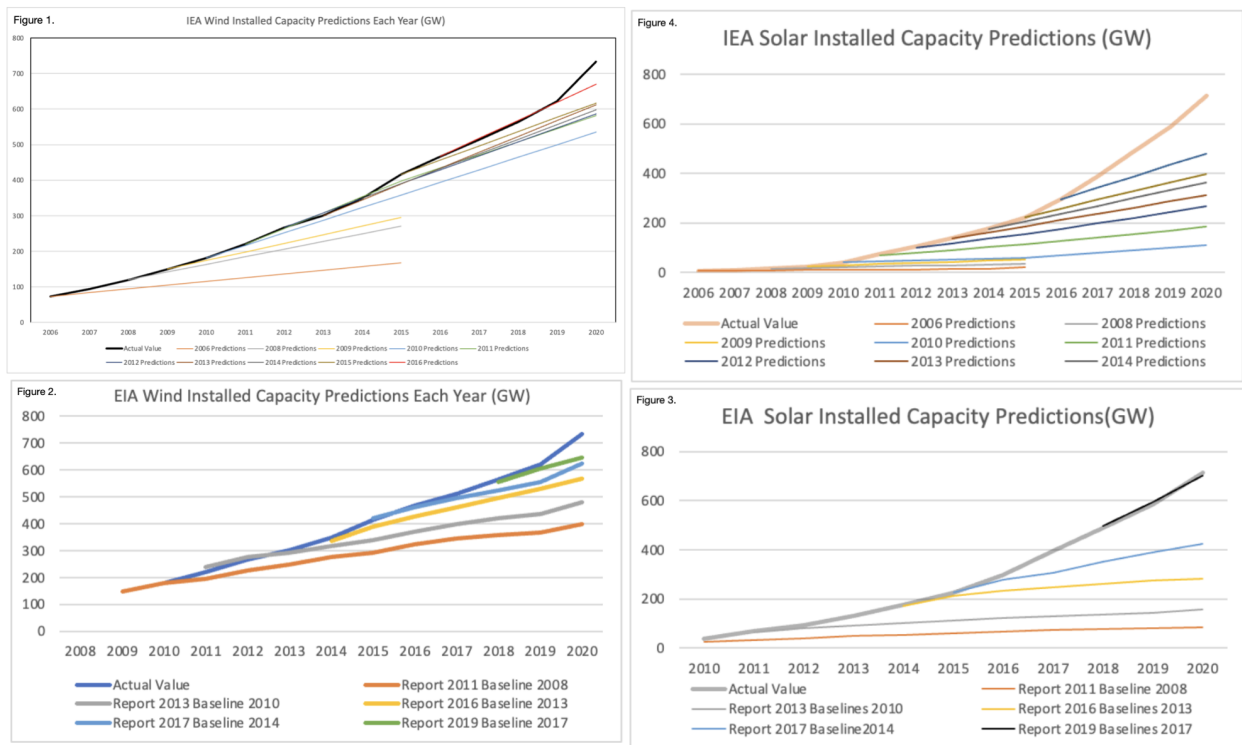
   Both the IEA and EIA underestimated wind installed capacity. For forecasts with a 6-year horizon, the average MPE is below -25% for both institutions. Even some of the more recent predictions struggle to make long-term forecasts. For instance, the EIA's 2016 forecast for 2020 registered an MPE of -22%. The IEA does slightly outperform the EIA in wind forecasts: its 2016 prediction for 2020 had a more accurate MPE of -9%.

Similarly, both the IEA and EIA consistently underestimate solar installed capacity. Overall, the organizations' wind capacity predictions are marginally more accurate than their forecasts for solar capacity. On average, the IEA's error margin for solar is over 50%, while the EIA also has an average MAPE of over 50% when the forecasting horizon is over 3 years. When looking at forecasts with a horizon longer than 8 years, the degree of underestimation becomes even more pronounced, exceeding 80%. This highlights the scale of mistakes the EIA and IEA made in their forecasts in the early 2010s.

There seems to be a slight reduction of error in recent years. From Figure 5, we observe a decrease in the EIA's forecasting errors in recent years: the MAPE error for solar even dropped to 1.6% in 2019's forecast. However, since 2019 is still relatively recent, this value might be subject to change. Similarly, Figure 6 illustrates a gradual reduction of error in the IEA forecasts with a decrease in MAPE by an average of 12% from its past predictions for the year 2010 to past predictions for the year 2015.

From Figure 7, it is evident that the RMSE of the IEA's solar predictions increased when comparing forecasts made for 2020 to those made for 2015. This suggests that although the predictions became more accurate percentage-wise, the absolute gap between the predicted and actual values has grown due to an increase in the magnitude of the actual value. In contrast, Figure 8 showcases a decline in RMSE values for EIA forecasts, potentially indicating enhanced forecasting precision, even as actual values rose over the years.

Figure 5.

Figure 6.

Figure 7.

Figure 8.

Figure 9. EIA and IEA Solar installed capacity forecasting errors for different forecasting horizons
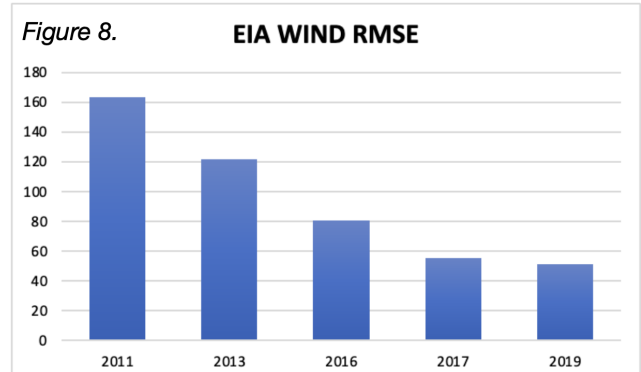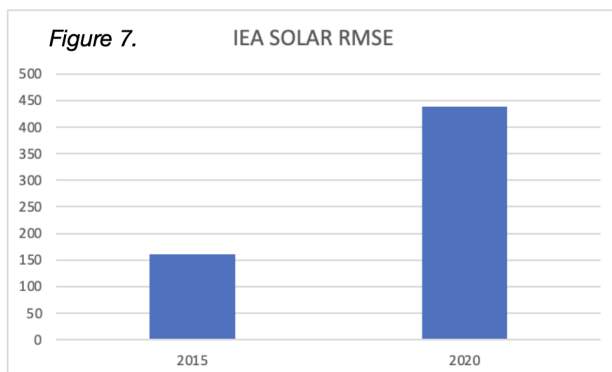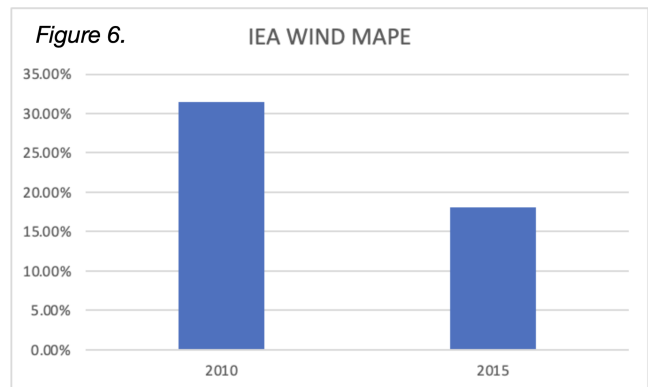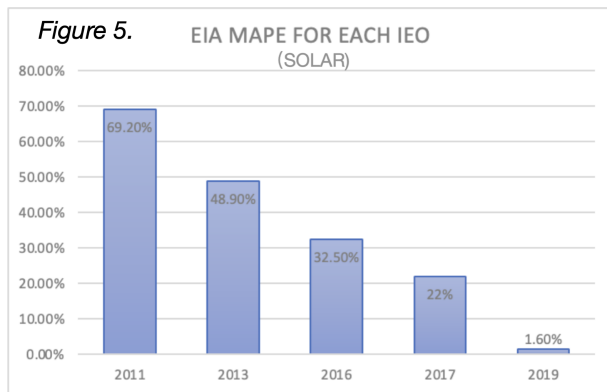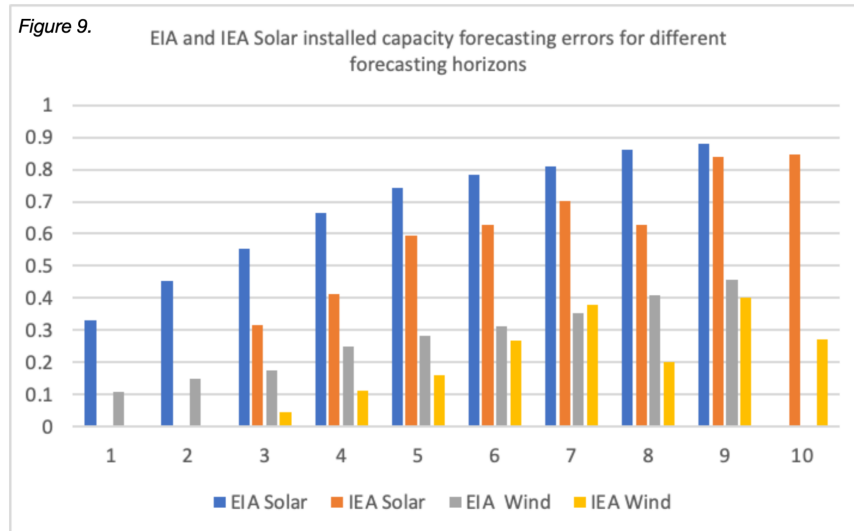
Discussion

There are a lot of different reasons for this consistent underestimation of solar and energy capacity. The first reason could be the complexity inherent to such forecasting tasks. Accurately representing reality through predictions is challenging, especially given the multifaceted nature of the energy landscape. Making predictions involve large amounts of data and intricate data modeling over a long period of time. Moreover, the energy sector often witnesses annual trend variations, complicating the development of a consistently accurate model. Furthermore, the fact that renewable energy such as wind and solar are relatively novel means they are more susceptible to rapid innovations or shifts, making future trajectories even harder to pinpoint accurately.

Secondly, there are also potential biases that can influence the assumptions of energy forecasting organizations. These biases can be related to the economic and political interests of governments and corporations. For instance, the IEA also has a reputation for prioritizing major and powerful countries over less developed countries, despite the fact that wealthy nations had contributed to most of the global warming. According to Oil Change International, The IEA still also seems closely tied to the fossil fuel industry as two of its authors from the 2017 WEO worked for the fossil fuel giant Shell (Watts 2018). As a result, the IEA overestimates the role that fossil fuels play in world energy. However, it could also be argued that the IEA and EIA are purposely underestimating wind and solar growth to incentivize governments into intensifying their investments in renewable energies.

The errors found seem in this study to be similar to the ones reported by Grunwald, (2015), which also criticizes the EIA for not recognizing solar and wind as emerging sources of energy with high potential and failing to predict the falling cost of solar and wind farms. One key takeaway from this finding is that the root of such errors primarily lies in the foundational assumptions regarding wind turbine pricing. There was a lack of foresight in predicting scenarios with dramatic reductions in the Levelized Cost of Electricity (LCOE) for solar and

wind energy. Neither the EIA nor the IEA incorporated scenarios that projected such significant decreases in these technologies' future prices. Interestingly, the cost of solar energy declined more sharply than that of wind energy. This difference might account for the marginally better accuracy observed in wind energy forecasts. According to (Naam), the EIA failed to accurately forecast the steep drop in solar PV energy costs, leading to these erroneous predictions. Another factor contributing to the inaccuracies is the underestimation by both the IEA and EIA of the improved performance of modern renewable technologies. As these technologies have evolved, they have become increasingly efficient at generating electricity, leading to errors in capacity forecasts.

Moreover, key events that could significantly influence projections seem to be overlooked. According to St. John (2019), Adam Sieminski, the EIA's administrator, admitted that prior EIA reports had not considered the implications of President Obama's "Clean Energy Plan," an initiative that aims to "cut US carbon emissions to 30% below 2005 levels by 2030." St John's (2019) study also points out that the EIA does not include any solar project less than 1 Megawatt in size in their forecasts, making forecasts inaccurate. This omission means that the rise in rooftop solar installations, which often fall under this size threshold, is not captured in their projections.

Figure 10. S-Shape Growth Curve (Jaeger, 2021)
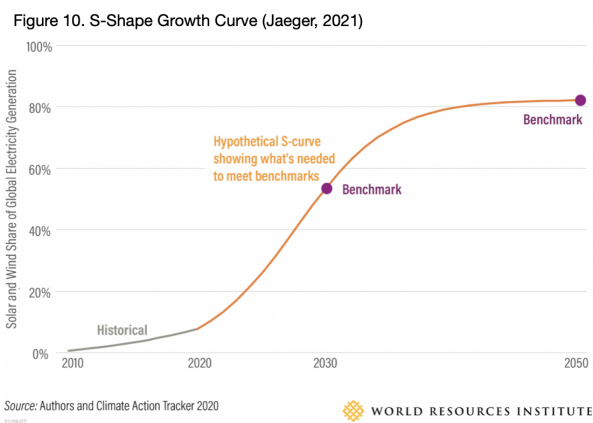
Lastly, in Figures 1 through 4, the growth trajectory of wind and solar energy clearly exhibits an exponential pattern. Jaeger (2021) posits that the Pathway for Solar and Wind energy growth is due to be in an S shape (Figure 10). However, the projections made by both EIA and IEA predominantly display linear trajectories with varying gradients. This could indicate a possibility where the IEA and EIA are repeatedly failing to adapt and rectify their forecasting approaches.

Despite all of the errors, our analysis suggests that both the organizations are improving their forecasts gradually. Their recent forecasts are aligning more closely with the actual data, which could suggest a growing reliability in their predictions. Looking forward, we might find increasing confidence in their forecasts.

Conclusion

In this study, we meticulously assessed the forecast errors in annual outlook reports published by the IEA and EIA from 2010 to 2020, spanning forecast horizons from one to ten years. From our rigorous examination, the following key conclusions emerge:

From the significantly high errors, we observed a consistent underestimation of installed capacities for solar and wind energies, with solar being particularly underscored. This could have been caused by the omission of scenarios that considers extreme drops in the prices of solar panels and wind turbines. Another cause could be that forecasting models lack incorporation of all the parameters and key events, such as the "Clean Energy Plan", that are required to represent reality.

Our analysis indicates a promising trend of diminishing errors, pointing to improved forecasting accuracy. However, it's worth noting that this improvement predominantly pertains to shorter forecast horizons in the latest predictions: future years could yet see variations. As evidenced by our study, there's a clear correlation between heightened accuracy and shorter forecasting horizons.

Projections by both the EIA and IEA predominantly anticipate a linear growth. Contrarily, actual data reveals that solar and wind installed capacities have undergone exponential growth. This discrepancy explains why forecasting errors for both EIA and IEA are relatively minor in the short term, but when the forecast horizon extends, the errors start to increase drastically. The IEA and EIA should invest further effort in examining the different factors that influence solar and wind capacities to enhance the reliability of future forecast

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Advancements in Type 1 Diabetes Management: From Pathology to Personalized Treatment Approaches By Nidhi Sree Perla

Abstract

Type 1 diabetes mellitus is an autoimmune enduring ailment initiated due to the destruction of insulin-producing Beta cells of the Pancreas leading to a rise in blood glucose levels. In a situation worldwide, type 1 diabetes affects 18 to 20 people out of every 100,000 each year, making it one of the most prevalent chronic disorders. Numerous factors are liable for the development of type 1 diabetes including immunologic, environmental and genetic factors. The American Diabetic Association committee suggests using the name Type 1A diabetes to describe diabetes that is caused by the activation of the immune system that results in the loss of pancreatic cells while Type 1B hyperglycemia is thought to be Non-antibody mediated and characterized by significant insulin insufficiency. Our goal is to refer to type 1A diabetes as type 1 diabetes throughout this evaluation. Currently, Type 1 diabetes is a lifelong condition that requires a challenging treatment strategy that is only partially successful in combating acute and chronic consequences. Here, we will focus on recent developments in our knowledge of epidemiological studies, pathology, foreseeing, and new treatment goals for diabetes management.

Introduction

Hyperglycemia (rise in blood sugar levels) is a symptom of Type 1 diabetes mellitus (T1DM), a long-term autoimmune condition caused by an inability to produce adequate amounts of insulin primarily a result of the degeneration of pancreas islet cells that produce insulin (Katsarou et al.). Age at the asymptomatic start used to be a limiting factor for those with type 1 diabetes because it was widely believed as this condition only affects children and teenagers. However, during the past ten years, this perception has altered (Desai and Deshmukh). The depletion of cell lines is an outcome of T1DM-related autoimmune disorders in a large percentage of patients (70–90%). For this Primer, the word "T1D" refers to autoimmune T1DM unless otherwise stated. Autoantibodies commonly arise for several years or months before the beginning of symptoms in T1DM (Kumar et al.). Although not regarded to be harmful, these antibodies can act as indicators of the emergence of immunology. Targeting insulin, the 265 kDa glutamic acid decarboxylase-associated proteins related to insulinomas and the zinc transporters 8 (ZNT8) are examples of distinctive autoimmunity linked to T1DM. People with certain HLA as well which means they have a higher risk of having T1DM and more than one antibody. Typically, insulin or GAD65 are among the initial "cell-targeting autoantibodies" to manifest throughout the early years of life. Uncertainty surrounds the cause of this first-appearing cell-targeting autoantibody, although it is being investigated in a number of studies involving children who have been monitored since birth.

A growing international crisis, type 1 diabetes is becoming more prevalent everywhere. Type 1 diabetes has a lesser incidence than those with type 2 diabetes, but it has a much larger

yearly financial burden for the American healthcare system roughly $14.4 bn (Mobasseri et al.). Growing insulin prices and expensive comorbidities associated with type 1 diabetes may be to blame for this financial burden. The majority of type 1 diabetes deaths are still caused by such complications. According to the historic DCCT experiment, intense insulin therapy quadrupled the risk of serious hypoglycemia while delaying the onset of complications associated with diabetes. The preferred objective is to sustain nearly normal blood sugar levels because people with diabetes who have type 1 must use these treatments to survive (Janež et al.). Glucose monitoring is essential to obtaining this diabetic goal. 8.8% of adults globally have diabetes, based on data from the International Diabetes Federation14. Only 10-15% of people suffering from diabetes have a condition called type 1 diabetes (T1DM); the second kind of diabetes mellitus (T2DM) is the least prevalent type (Musselman et al.). T1DM, nevertheless, is the most prevalent kind of hyperglycemia among children although the cause of this variance is not entirely understood, it may be linked to external and behavioral variables, such as hygienic and childhood illnesses, as well as genetic vulnerability (for instance, the high incidence of HLA risk genes in the population). T1DM might not be officially recognized in countries with limited resources because there are still no diagnostic tools for blood or urine glucose levels (Genuth et al.). Evaluating cell-targeted autoimmune and T1DM across European countries indicated that diseases and immune responses differ between nations, suggesting that the causes of cell-targeted autoimmune may also differ. The discovery of autoimmunity as a biomarker of pre-symptomatic disease, especially those that target insulin or GAD65, could eventually lead to exclusive knowledge of the pathophysiology and demography of T1DM. In fact, most people with more than one islet-targeting autoimmunity may develop disease symptoms (Apaolaza et al.). But for the time being, the mainstay of epidemiological is going to continue to be T1DM statistics according to existing diagnostic criteria since screening for islet-targeting autoimmunity is very far from being developed.

Importance of Understanding Type 1 Diabetes

One of the best illustrations of how scientific research has saved lives and improved clinical treatment is the finding of insulin and its quick adoption into clinical practice. Diabetes with type 1 diabetes (T1D) was a consistently fatal condition before the invention of hormone that resulted in either a quick demise from ketoacidosis, also known as diabetes, or, without strict starving programmed adherence, serious malnutrition and mortality between months or 1-2 years (Leslie et al.). The tales of individuals saved by their discovery of glucagon from near death are exceedingly rare and remarkable. As a result of the finding of insulin, thousands of people with T1D and their offspring are still alive nowadays. Many factors are responsible for causing diabetes type 1 disease some of them are given below in Table 1.

Table 1. Factors responsible for causing diabetes type1

Immunologic Factors	Immune tolerance	Background	References
			(Butalia et al.)

		In literature it found out that patients having T1DM responsible for having deficit in quantitate problems in Tregs, which are responsible for causing rise in immune response ,which definitely lead to autoimmunity	
	Cellular immunity	In histologically slides, a chronic inflammation in region of islet is observed which result into participation of auto immunity.	(Daneman)
	Humoral immunity	Best marker in diagnosis of T1DM is synergistic expression of more than 1 autoantibodies	(Maahs et al.)
Genetic Predisposition	**Genetic factors:**	Genetic loci responsible to gene susceptibility for causing diabetes type 1 and autoimmunity.	(Paschou et al.)
	MHC	Addison's disease are more common disorder having up to 70% prevalence, and 50% prevalence in TIDM patients.	
	Insulin-VNTR	Insulin VNTR is Polymorphism of CLT4 and connected with T1DM and also connected with autoimmune disease.	
Environmental Triggers	**Viruses and vaccinations**	Viruses represent important triggers for T1DM pathogenesis and this was originally described by epidemiological observations	(Knip and Åkerblom)
	Diet and gut microbiota	Gut microbiota are responsible for causing various interactions, having new diagnostic and therapeutic plan for treating and preventing T1DM.	

Diagnostic Tests and Criteria for Type 1 Diabetes

The clinical manifestation of diabetes controlled by insulin beginning in the adolescent years and perhaps ketoacidosis due to diabetes has historically served as the foundation for determining the presence of T1D (Jensen et al.). Since type 1 diabetes (T1D) can be precisely defined by considering its clinical traits, type 2 diabetes heterogeneity and differentiation from one gene to atypical types of diabetes have received the majority of attention in discussions of diabetes due to the growing emphasis on precision medicine. Two significant shifts in our thinking have significantly changed our perspective. Before the condition or glucose manifests,

there is evidence of islet-directed autoimmunity at the beginning of type 1 diabetes (T1D). Age of start, genetics, pancreatic pathological conditions, metabolic processes, production of insulin, and eventually variances in sensitivity to treatments and consequences from diabetes all indicate that T1D likely develops from various paths to cell destruction (G. A. Gregory et al.). According to the current paradigm, those with genetic susceptibility to T1D experience the disease in three stages throughout time. Two or several islet-directed autoimmunity coexist with hyperglycemia in stage 1. Such autoantibodies serve as markers for the autoimmune process, which is thought to be triggered by an unknown event or set of events. Following a glucose or food challenge, dysglycemia indicative of insufficient insulin production coexists with the autoantibodies in stage 2. Symptoms are typically apparent and insulin medication is started at stage 3, which is when T1D is typically officially recognized. From ketoacidosis due to diabetes to mild hyperglycemia, the presentation can vary (Redondo et al.). Despite the loss of cell count at the time of clinical manifestation, functioning cells continue to be intact. While this concept of stages is useful, it should be highlighted that not everyone in stages 1 or 2 progresses to hyperglycemia necessitating insulin therapy. The model's reliance on measures taken from peripheral blood vessels (Insulin production, immune-mediated indicators, etc.) and clinical variables (age regarding onset, body mass index (B external insulin requirements, etc.) is an important drawback (Holt et al.) .There are no widely accepted, specific requirements for T1D assessment. Instead, the medical diagnosis still hinges on two key characteristics: (a) the absence of sugar and the demand for external therapy and (b) the existence of islet-directed autoimmunity. These requirements are somewhat reliable in people who acquire diabetes before reaching the age of 20, but they are considerably less precise in people who develop diabetes after the age of 20, underscoring the requirement for more information (such as a family history of diabetes score, further serological markers, or T1D subgroups) (McCoy et al.). Up to 20% of people with T1D may also have other inflammatory endocrinopathies such as inflammatory thyroid disorders, inflammatory insufficient production of adrenaline, celiac disorder, or a condition called atrophic gastritis, which should be taken into account.

Differentiation between Type 1 and Type 2 Diabetes.

T1DM and T2DM distinction clinically separating individuals who have T1DM from individuals with Type 2 diabetes. is not always easy. While T1DM is usually believed to have an early childhood onset, adulthood onset is possible; in these circumstances, T1DM is sometimes mistaken for T2DM. Adults frequently have moderate symptoms, making it difficult to categorize patients only based on hyperglycemia (J. M. Gregory et al.). Adults as well as kids with T1DM typically have BMI distributions that are similar to those of the rest of the population. As a result, 20 to 40 percent of kids with T1DM are overweight, though they're seldom as obese as the majority of kids with T2DM. Compared to kids and adolescents with T2DM, the mean body mass index (BMI) among kids and younger adults with T1DM appears to be higher (Ooi et al.). While a person's family history may be a clue as to whether they have T1DM, T1DM patients have three times more T2DM in their families than the general

population does. Teenagers who are obese and have a clinical profile indicative of type 2 diabetes may also have autoimmune. According to this research, T1DM is categorized as an autoimmune condition irrespective of adiposity or insulin resistance, while T2DM necessitates a diagnosis of insulin resistance as well.

The link between COVID-19 and Type 1 Diabetes

After identifying over 118,000 instances worldwide in 114 different nations, WHO announced the COVID-19 epidemic on the 11th of March, 2020. Acute Airways Syndrome with Severity The coronavirus variant responsible for COVID-19 is called Coronavirus 2 (SARSCoV-2) (Nassar et al.). The RNA virus is a member of the previously merged corona family and is characterized by respiratory symptoms and an elevated mortality rate while symptomatic persons are susceptible to the illness, virus infection can happen either right away through interaction with infected people or through indirect means through contaminated things in the surroundings (Shrestha et al.). It also delays the proper response to emergency situations since a significant reduction is reported in emergency department access mainly because of fear of infection Therefore, we conducted this systematic review to summarize the prevalence, clinical findings, and outcomes of COVID-19 in patients with T1DM, based on the findings of available evidence (Pranata et al.). Individuals with COVID-19 may present with a variety of medical symptoms, from a complete lack of indications or a minor illness to a fatal illness with multiple organ failure. People who suffer from chronic conditions like Type 1 Diabetes Mellitus (T1DM) are worried as a result of this. On the other hand, research indicates that COVID-19 indirectly poses concerns for T1DM patients on several fronts; in some nations, it may make it more difficult for them to access sufficient medical care. For T1DM patients, a lack of medication, outdated equipment, or inadequate treatment can lead to poor glycemic control and additional issues.

Treatment Options for Type 1 DiabetesCurrent therapy for T1DM:

Currently, the insulin that is exogenous and dietary intake are matched, and everyday activities like exercise and sleep are also taken into account. Technology related to diabetes, particularly techniques for administering insulin and monitoring blood sugar levels, has achieved remarkable advancements (Atkinson and Eisenbarth). T1D clinical treatment is also developing to embrace mobile technologies (smartphones, wearables, telemedicine, etc.) and to place more attention on behavioral and psychosocial factors, the socioeconomic drivers of health, and wellness accessibility and affordability. The objective is to get close to glucose levels while preventing hypoglycemia and enabling routine daily activities. The glucose objective for people with T1D is currently a blood sugar level (A1C) of 7.0 or lower, having this target customized for years of age, multiple medical conditions, and lifestyle. Importantly, a significant, lifelong burden of T1D treatment today is hypoglycemia, a significant side effect of stringent glycemic control. Combining basal insulin with bolus insulin in response to food or calorie intake forms the basis of T1D insulin therapy. Syringes, pens, smart pens, catheters having insulin pumps or

insulin delivery devices and, less frequently, inhalation devices can be used to administer insulin (Suryasa, Rodríguez-Gámez and Koldoris). The intestinal absorption pattern of administered insulin can be significantly extended or increased compared to native diabetes proteins in a neutrality buffer by altering the amino acid arrangement of diabetes or by adding an attachment to the insulin protein. Additionally, the use of insulin diluents can be utilized to either delay uptake or speed absorption. The marketplace has lately seen the introduction of basic insulin compositions with action times as long as seven days because of the critical function that basal glucose plays in limiting the production of glucose by the liver (Zhang et al.). The incidence of serious hypoglycemia decreases, which is a benefit of a longer-acting formulation. Potential futures include glucose-responsive insulin, which is based on literature to determine the structure and function of the pancreas. Medical treatment has been substantially enhanced by these extraordinary developments in insulin compositions and insulin methods of administration. Many T1D patients, however, claim that the use of CGM has made an even bigger and more noticeable effect on their daily activities. The ability to walk insulin profiles using moments in a specified glycemic vary, GMI calculated using insulin and correlating with A1C, change in glucose level or coefficients of variations, and the quantity of time that someone is in the hypoglycemia range are all glycemic metrics that are made possible by CGM and its packed blood sugar data sets (Perkins, Sherr and Mathieu). The results of this analysis change how the patient and provider regulate glucose, connect with A1C, and give people with T1D knowledge they may use to organize their daily activities. A device such as a sensor or an electrode that detects an electrical byproduct (such as hydrogen peroxide), which is the result of the interaction involving intercellular hyperglycemia and an insulin analyzer is the present-day foundation of the quickly developing CGM technologies. Additionally, all available CGM methods assess interstitial fructose, which, even though it is in balance with blood glucose levels, can lag or deviate from this, particularly when blood insulin is changing quickly (Mathieu, Martens and Vangoitsenhoven). Temporary CGM, whereby a sensor is in place constantly but glucose level is only captured when the instrument has been set across the electrode, and actual time CGM, in that interstitial fluid sugar, is tracked and delivered to the capturing device constantly, are both of the primary types of CGM used today. Both methods make use of a subcutaneously positioned sensor that needs to be changed every 3–14 days; an implanted sensor with a 6-month replacement cycle is also an option.

Insulin Therapy–Blood Glucose Monitoring

Continuous glucose monitoring's efficiency in helping persons with type 1 diabetes mellitus maintain glycemic control: In conventional self-monitoring of blood glucose (SMBG), a finger-prick capillary blood sample is taken, and blood glucose levels are measured with a glucometer. SMBG has a few drawbacks: Because of its reliance on the user and inability to detect nocturnal and asymptomatic hypoglycemia, as well as its vulnerability to user error from contaminated fingers, this method is unable to detect or predict the impending onset of hypoglycemia. Utilizing continuous glucose monitoring (CGM) can help overcome these

restrictions (Han, Gu and Yu). A small device that is implanted through the skin and used with CGM continuously monitors a person's interstitial glucose levels. A combination of glucose patterns, retrospective data, and information produced in real-time, CGM may notify and identify glycemic variations as well as anticipate approaching hypoglycemia. Professional CGM (P-CGM), real-time CGM (RT-CGM), and intermittent-scanning CGM (isCGM) are the three distinct kinds of CGM devices. Every system performs slightly differently. HbA1c is still the most reliable measure for evaluating glycemic control and serves as a proxy for the risk of developing long-term diabetic problems (Furthner et al.). Medical professionals who have an interest in managing diabetes and present and future studies may find what they learn from this review useful. Currently, CGM research is crucial to the development of an artificial pancreas, where a CGM sensor can autonomously control the administration of insulin.

Long-term Complications of Type 1 Diabetes

The significant morbidity and mortality in T1D are caused by diabetes-related complications, nephropathy, retinopathy, neuropathy and macro vascular cardiovascular disease and peripheral artery disease (Furthner et al.). Although the length and intensity of hyperglycemia are what cause diabetes problems in T1D, the molecular mechanisms by which too much glucose causes a particular organ to malfunction are still poorly understood and probably unique to the organ system in question. Complications linked to diabetes tend to be multifaceted and include cellular processes like advanced byproducts of glycation, lipid metabolism, inflammatory cytokines that have multiple growth hormones and cell damage. They may also be caused by a genetic predisposition to sugar exposure, epigenetic modifications brought on by high blood sugar levels, connected dyslipidemia, and/or connected hyperglycemia (Melendez-Ramirez, Richards and Cefalu). With fewer cases of nephropathy, neuropathy, and retinopathy as well as better cardiovascular outcomes, long-term outcomes in people with T1D have significantly improved; it is now more typical for people with T1D to live substantially longer than fifty years. The condition known as hypo, on the other hand, is a significant side effect of stringent glucose management and a significant, permanent problem for those with T1D. Additionally, those with T1D who received aggressive diabetic therapy put on more weight. Although the idea of metabolism memory has been challenged by some, it appears plausible that initial glycemic management has long-term advantages that may last for over a decade and may be mediated by epigenetic pathways (Papatheodorou et al.). The obvious clinical implication is that the objective should be to achieve glucose level control as safely as possible starting right away after the first signs of diabetes. The treatment of T1D-related disorders such as nephropathy retinopathy, and coronary artery disease is getting better thanks to ACE inhibitors, and angiotensin receptor blockers, which slow the decline in glomerular filtration rate. Nevertheless, some people have incapacitating or fatal consequences such as neurotoxicity or end-stage kidney disease (Vestergaard, Rejnmark and Mosekilde). Even though tight glycemic control greatly decreases microvascular complications, familial susceptibility, remaining secretion of insulin, the activity of particular the glycolytic enzymes, the generation of

advanced end products of glycation, and the extent of renin-angiotensin-aldosterone structure stimulation may also play a role.

Strategies for Preventing Complications of Type 1 Diabetes

Many clinical trials have been undertaken or are still being conducted with the goal of halting or delaying the onset of T1DM. Trials for prevention have unfortunately had very little effectiveness (Kilpatrick, Rigby and Atkin). Early studies with the immunosuppressant medication showed enhanced preservation of insulin production among patient populations when therapy was initiated within six months of T1DM detection and supported the significance of resistant destruction in the condition, but short treatments were only feasible due to the drug's known side effects (Melendez-Ramirez, Richards and Cefalu). The best course of action would involve first-line prevention, which in many situations would additionally offer conclusive answers regarding whether a suspected environmental risk could indeed play a significant role in the formation of T1DM. There have not yet been many significant primary prevention studies. The multiple risk-associated HLA-DR4 subcategories could not be distinguished, however imputed of risk-defining HLA alleles using SNPs in the area allowed the Immune Chip array to be used in a combined study of both HLA polymorphisms and nonHLA SNPs with high sensitivity and specificity. Thus, panels of HLA and non-HLA area SNPs combined in specially prepared arrays may be utilized, for example, to screen newborns for follow-up investigations.

Lifestyle Management and Support for Controlling T1DM

Awareness is necessary for managing diabetes. Understand the daily factors that cause your blood sugar to climb and fall as well as how to manage them. Figure 1 depicted life style management and support for controlling diabetes.
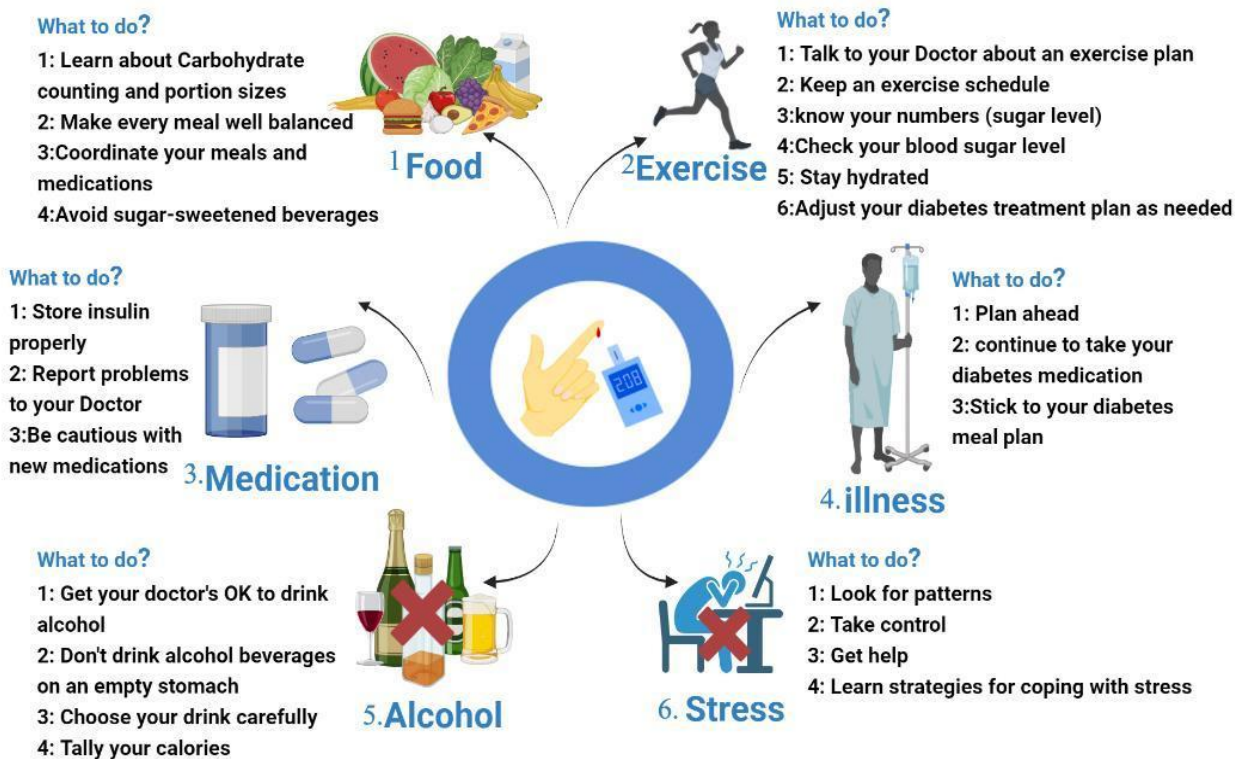
Figure 1. Life style modifications to control diabetes

Future Outlook and Promising Directions

The primary three categories of predicted novel therapeutics at the beginning of the 21st century after the discovery of insulin are: (a) exogenous insulin replacement; (b) cell-based insulin delivery from new sources of insulin-producing cells; and (c) protection of endogenous cells by immunomodulation. A closed-loop system that combines a glucose sensor with an autonomously adjusted insulin delivery device, which is frequently loosely referred to as an "artificial pancreas," is particularly successful in treating T1D in children, adults, and pregnant women. Future developments in sensor technology might involve assessing blood glucose rather than interstitial glucose, or using optical or vascular techniques to measure glucose in other body regions (such as the eye or skin). Even when using modified insulin analogs, insulin absorbed through the skin penetration through the circulatory system is considerably greater than the physiologic production of insulin, necessitating changes in the administration of insulin. Future therapeutic approaches might include implants that also provide glucagon. Ideas to overcome T1D could be utilized by enhancing identification by targeted delivery to β cell–targeted autoimmunity. Over the next decade, it truly will be a competition between these three clinically viable therapeutic options for T1D. In summary, since insulin's discovery, there has been much progress in understanding the pathogenesis of T1D and in using insulin to improve the lives of

individuals with T1D. Hopefully, the opportunities discussed here will be realized, leading to the prevention of T1D and its associated burdens.

Conclusion

      Individuals with type 1 diabetes and the professionals who care for them have experienced tantalizing optimism throughout the past 50 years, followed by disappointment at the apparent impossibility of the cure on the horizon. Clinicians, researchers, and patients now have a greater understanding of the underlying complexity of type 1 diabetes and a greater sense of humility in the face of numerous trials that failed to achieve a long-lasting disease cure. Patients as well as healthcare providers should concentrate on promoting modified access to contemporary advancements in diabetes care, particularly for accessible synthetic insulin and technologies that can lessen the expense of dealing with this chronic disease, while researchers continue to untangle the complex pathogenesis of the illness. Important research must also go on to find ways to delay the onset of disease and maintain or restore -cell functioning. These strategies have the potential to significantly enhance illness outcomes for people who already have it while reducing or removing disease consequences. In order to improve the management of diabetes, new low-cost, low-burden medicines must continue to be developed.

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Students' Motivations for Extracurricular Participation By Aoun Hakim

Introduction

High school is a stressful time for students, as they are at the threshold of embarking into a more independent, professional part of their life, that could determine the course of their future. In this time of uncertainty and familial/societal pressure, many students are expected to choose their potential fields of interest, and participate in activities that could enrich these interests. Little is known about the motivation of students choosing extracurricular activities – whether these are chosen in accordance with actual long term interest or driven by pressure to get a college admission advantage - in today's world where extracurriculars are becoming increasingly important in college admission decisions (CollegeBoard). While research has been done relating participation in activities to future career interests (Keenan), we have not found any sources that discern the motivation for participation in extracurriculars. In this project we will be exploring high schoolers' motivations for doing these extracurricular activities, and how different factors such as gender, ethnicity, and future plans influence their activities.

Method

We conducted a qualitative survey of high school students in Cary and Morrisville NC. The surveys were posted on multiple students from different schools' Instagram pages, as well as emailed to students at random, and responses are anonymous. In the survey there were questions about students' extracurriculars, their demographics, their fields of interest, their future plans, their motivations, and their possession of counselor assistance. We then analyzed the results of the survey in order to determine what students' primary motivations are for their extracurriculars, and how different factors influence their participation in these activities.

Goals/Hypothesis

1. Students are motivated by college admission odds to select extracurricular activities
2. Students are influenced by counselor advice to select extracurriculars.
3. Collect demographics including number of high school students enrolling in extracurriculars, type of extracurriculars. Analyze influence of demographics on extracurricular participation.

Results

From the data collected, We've made many observations which can give insight into the minds of high schoolers. In our survey population, 87.5% of students plan to attend a 4 year university (Fig 5). This definitely has an impact on students' choice of extracurricular, as those students who are undecided in their future plans have an average of about 3 extracurriculars, while the majority of students have an average of 4-5. Disregarding choice of future plan, most students, 65.5%, participate in extracurriculars simply for enjoyment, while only 24.7% participate to improve their college applications (Fig 3). Furthermore, there is no significant

difference in average number of extracurriculars between those who participate for enjoyment and those who participate for college applications. The most common planned career fields are Health/Medicine, Tech/Computer Science, and Natural Sciences (Fig 2). However, there is no significant difference in the type of extracurricular between students planning for different career fields. There is, however, a difference between students who have decided their career field and those undecided, with undecided participating in, on average, a lower number of extracurriculars, similar to those with undecided college plans. Demographics such as race and gender do seem to have an impact on choice of extracurricular, as Asians and females are more likely to choose their extracurriculars to improve college applications. Asians are also more likely to have outside of school counseling to advise these decisions, a service only 26.4% of students use (Fig 4). These counselors also appear to have an impact on students' extracurricular choice, as those students with counselors typically participate in research, internships and competitions more than those without outside of school counselors.
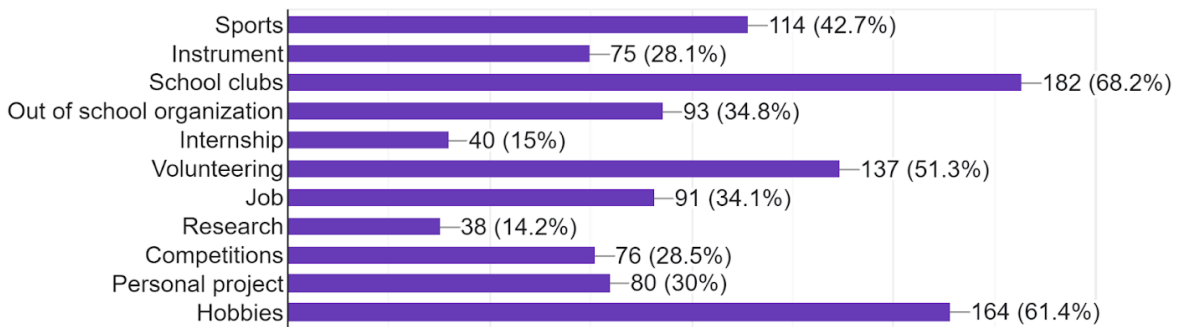
Fig 1: Distribution of extracurricular participation by activity

316
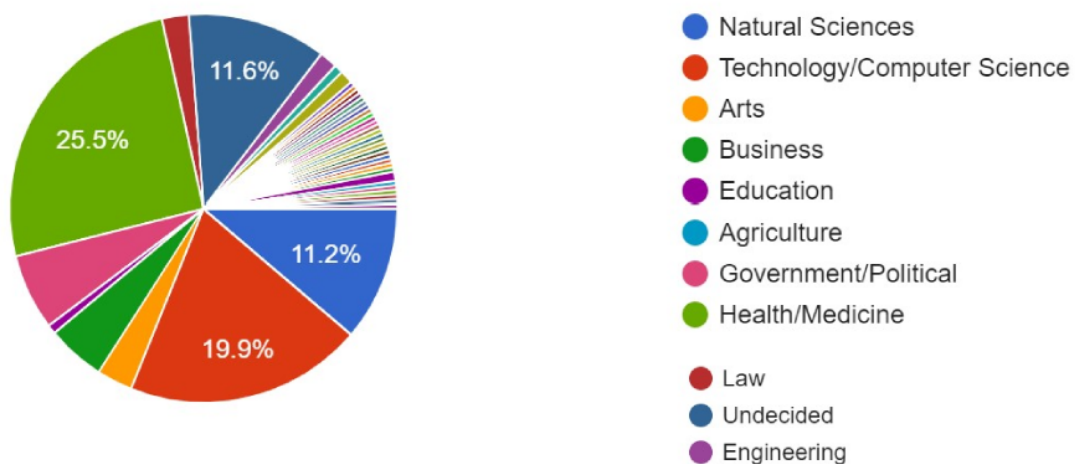
Fig 2: Distribution of the most common future plans

Legend:
- To improve college applications
- Because you enjoy them
- Because your parents want you to
- Counselor suggestion
- Personal pleasure, pleasure for others
- 9/11
- It's fun and the male the better
- Make money

1/3

65.9%

25.5%
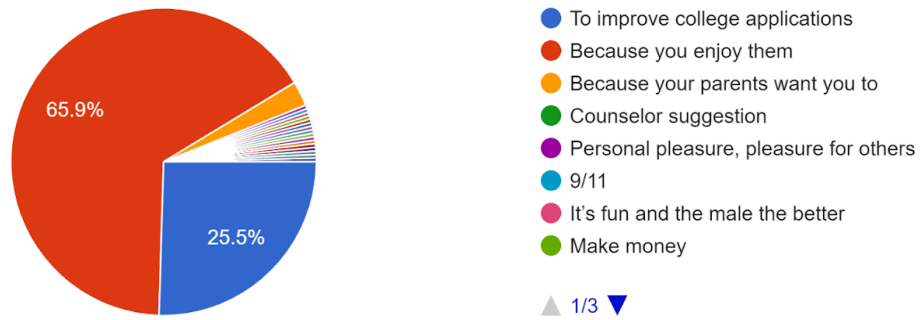
Fig 3: Distribution of reported motivation for extracurriculars

Do you currently have any counselors/assistance (other than parents and school counselors) to help with these decisions?
267 responses

Legend:
- Yes
- No

72.3%

27.7%
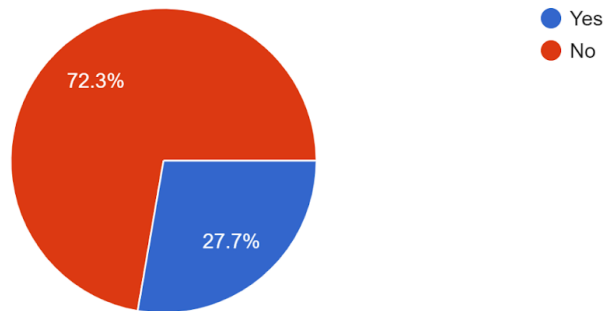
Fig 4: Distribution of students with (Yes) & without (No) counselor assistance

Legend:
- Get a job
- Join the military
- Attend a 2 year college/university
- Attend a 4 year college/university
- Undecided

85.8%

1/3
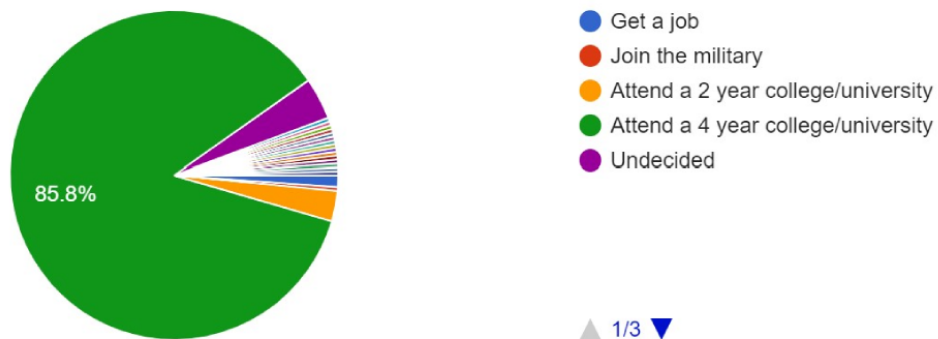
Fig 5: Distribution of students' post high school plans

Conclusions

The result of students planning to go to college participating in a higher average number of extracurriculars than those who are undecided fits in with our hypothesis, since it essentially implies that students participate in more extracurriculars in an attempt to boost their college applications. However, only 24.7% of students report college admissions as their main motivation for participation in these activities. Since the most common extracurriculars are school clubs, hobbies, and volunteering (Fig 1), all typically fun activities, it makes sense that most students participate for enjoyment. However, this result was surprising, as, to an objective observer, it would appear most Wake County students are very focused on getting admission into a competitive college. It was also surprising that the students who participate in extracurriculars for enjoyment have about the same average number of activities as the ones participating for college admissions. Perhaps this means that the college admissions process doesn't actually make students do more, rather, it makes them do things they don't enjoy that they feel are meaningful and will help them.

Females are more likely to choose extracurriculars to improve college applications. This may be because females are more focused on the future, because they typically mature earlier (Laureys), or because they want to ensure a safe future for themselves, with financial independence being a big factor in that (BofA Securities).

Asian students are also more likely to choose extracurricular activities to boost their college applications. This may be because of the pressure put on them by their parents - who frequently see their kids as extensions of themselves and thus attempt to fulfill unmet dreams through them (Capretto) - and their peers, or conformation to the stereotype that "Asians should be smart".

The students who utilize out-of-school counseling in order to assist with college admissions typically participate in different extracurriculars, meaning these counselors really do have an impact on students' choice of activity. They influence the student to participate in more academic extracurriculars rather than fun ones, likely in the hopes that it will help their chances of admission at more competitive colleges.

There were some unserious responses, as expected of high school students, such as those seen in Fig 3.

Full Findings (not included in finished work)

- Most students plan to attend a 4 year university - 87.5%
- School clubs, hobbies, volunteering are most common extracurriculars
- Most people(65.5%) do these extracurriculars because they enjoy them, but 24.7% do them for college applications
- Health/medicine, tech/computer science, natural sciences, and undecided are most common planned fields
- 73.6% of students don't have a counselor to assist them (other than school counselor)

- Some students are already focused on a specific career and working towards it.
- Some responses didn't take it seriously and made jokes
- Asians seem to be more likely to have outside of school counseling
- Asians and females seem to be more likely to pick extracurriculars to improve college applications
- There is no significant difference in the number of extracurriculars for those who participate to improve college apps and those who do them for enjoyment .
- Those who have a counselor to assist with decisions typically participate in research, internships, and competitions more than those who don't
- Since these results were taken from wake county, a more competitive area, they're probably skewed towards students having higher participation in extracuriculars than would be the normal for high schoolers
- Undecided future career fields typically have less extracurriculars than those decided
- The type of career field doesn't seem to have much impact on the extracurriculars
- Those with undecided future plans seem to typically have less extracurriculars, but there isn't enough data to draw a conclusion

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A Review on Hydroelectric Turbine Performance with Emphasis on Fish Survival Rates
By Mia Rafael

Abstract

Hydropower offers a cleaner alternative to traditional fossil fuel sources of energy. It provides power to the grid immediately because it utilizes consistent water flow, a reliable source of energy. However, fish mortality is an unintended consequence of hydropower leading to declining fish populations, a loss of biodiversity, and a disruption to the balance of marine ecosystems. Additionally, it can lead to economic impacts on the fishing industry. The aim of this research paper is to examine various turbine designs and compare their characteristics, cost, efficiency, and survival rates of fish in order to find sustainable and eco-friendly alternatives to traditional energy sources. Out of the various turbine designs, the Kaplan, Pelton, Bulb, Archimedes Screw, and Lucid Spherical turbines were prominent options based on the categories that were compared. Despite the fact that one design isn't ideal for every application site, the turbines have different strengths that can be considered when choosing a reasonable turbine to be implemented.

Introduction

Hydropower is the world's largest source of renewable energy generation with a total of 4,202 TWh generated in 2021 (International Energy Agency, 2022). Hydropower does not contribute to air pollution and toxic waste, making it an attractive option when considering the environmental impact of power generation (US Department of Energy, 2013). Hydropower generates electricity when flowing water spins a turbine to generate electricity for domestic, commercial, and industrial uses. However, the prioritization of clean and carbon-free energy production may lead to overlooking the impacts that hydropower plants can have on migrating fish populations. In this paper, I will be surveying the latest developments in turbine design by exploring and comparing designs in terms of environmental benefits, benefits to the fish population and costs in terms of productivity, installation and other tradeoffs.

Developer Considerations and Fish Injuries

While outlining a hydropower project, developers perform a feasibility study in which they determine the civil and mechanical components of the project to implement at the site (International Finance Corporation, 2015). The focus during this phase is to ensure design quality that will optimize the output of electricity, as well as analyzing cost estimates and financial options (International Finance Corporation, 2015). Because developers aim to maximize energy efficiency and production, they may utilize high rotation speeds, higher blade counts, and increased water pressure that can have damaging effects on fish that attempt to migrate through the power plant (Long, 2021).

Mechanical Injuries

Common mechanical injuries include those resulting from blade strikes, fish being trapped and grinded against a surface, as well as from experiencing friction caused from the

blade (Koukouvinis, 2023). Length of the fish, strike angle, strike speed, and the thickness of the blade and the operation of the turbine can affect the inflicted injuries, which can include "imbalance, ribs broken, gill cover broken, internal hemorrhage and death" (Meng, 2022). However, fish weighing less than 20g are less likely to come into contact with blades (Meng, 2022). Therefore, turbines may have different effects on fish populations based on the design, operational decisions, as well as the size of the fish. For example, in the Columbia River and the Snake River, Chinook salmon populations have been reduced due to the construction of major dams that generate electricity from the rivers (Rechisky, 2013). This species was labeled endangered under the Endangered Species Act in 1992 (Rechisky, 2013). As a result, billions of dollars were spent following the damage to the species to improve survival and migration rates (Rechisky, 2013). Following the investments, fish that migrate through the eight dam passage of the Columbia and Snake Rivers have a survival rate of 50% (Rechisky, 2013). Instances like that of the Columbia and Snake River demonstrate that the implementation of hydropower projects can lead to the potential of fish species drastically decreasing and being classified as endangered while stressing the marine environment. Therefore, designs of hydro plants and turbines must simultaneously aim to produce the maximum amount of energy while having negligible impacts on migratory fish.

Pressure Changes

Water pressure changes throughout the hydropower plant inside the penstock (where it gradually increases), near the runner (where it drops quickly) and in other instances during the journey through the plant (Koukouvinis, 2023). The penstock is modeled below, where fish may experience pressure changes before entering the turbine (Fig. 1).
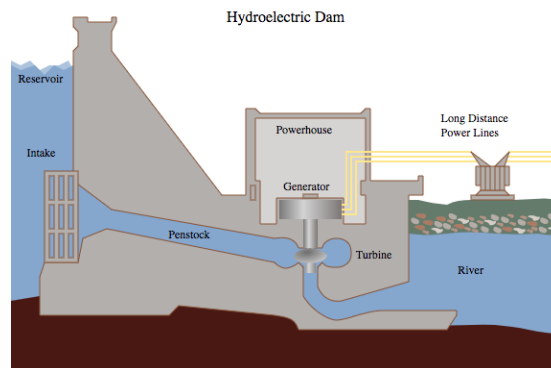
Fig. 1: Model of hydroelectric dam and the flow of water (Tennessee Valley Authority, 2005).

Rapid changes in pressure can affect the fish' gas bladder, which can negatively impact their coordination. Moreover, depressurization can lead to barotrauma and injuries that relate to it (Koukouvinis, 2023). It becomes particularly severe to fish at the depressurization rate of 90 kPa/s (Koukouvinis 2023).The barotrauma caused by depressurization can lead to exophthalmia, internal hemorrhaging, gas emboli, and a ruptured swim bladder (Koukouvinis, 2023).

Cavitation also results in rapid decompression and micro-jets can pierce tissues of the fish and emit shockwaves (Koukouvinis, 2023). Cavitation experimental studies have concluded a range of mortality from 0 to 60% when fish are exposed to cavitating conditions (Koukouvinis 2023).

Shear Stress

Shear stress refers to fluid layers moving at different velocities (Koukouvinis, 2023). A contribution to shear stress injuries can be attributed to jets of water in the hydropower operating system and the fish's positioning around the axis of the jet (Koukouvinis, 2023). High shear stress can result in injuries such as descaling, tissue tears, bruising, and (in critical cases) decapitation (Koukouvinis, 2023).

Additional Methods to Reduce Fish Mortality

Because of the damage that turbines cause on fish health and safety, developers have introduced modifications to hydroelectric dams in order to make them more ecologically friendly. Fish ladders are sloped passes that allow fish to pass upstream, and they are designed so that fish are inclined to use the ladder instead of taking passage through the turbine (Northwest Power and Conservation Council, 2016) (Fig. 2). The Bonneville Dam at the Columbia River was opened in 1938, and over 1 million fish were counted using the fish ladder in the first season after the ladder was built (Andrews, 2008). Despite the fact that the original plans for the fish ladder were set to cost around $670,000, the finalized fish ladder project cost more than $7 million due to additions that were made (Northwest Power and Conservation Council). Its high cost is a tradeoff that comes with combatting the environmental effects of the Bonneville Dam.

Fig. 2: A fish ladder constructed at Bonneville Dam in Oregon (Graham, 2006).

Additionally, the decline in some fish populations due to increasing mortality rates resulted in agencies taking measures to keep the fish populations steady and allowing them to reproduce, such as a method of trucking fish upriver (Weldon, 2011). Trapping and trucking fish cuts the cost of installation of fishways (Office of Technology Assessment). However, this system of transportation can be stressful for populations of fish such as salmon (FishBio). They are more susceptible to disease, and their ability to swim can become impaired (FishBio).

Fish elevators have also been used to trap fish in a compartment and be able to elevate them to a higher location, surpassing the dam altogether (Northwest Power and Conservation Council, 2016) (Fig. 3). For example, the Safe Harbor lift system was implemented at the Safe Harbor Dam on the Susquehanna River in 1997 with a cost of $17 million (National Hydropower Association). During its first year of operation, it lifted over 200,000 fish past the dam, indicating high success rates (National Hydropower Association). While these implementations are not directly a part of the hydroelectric dam in terms of functioning, they are additions that can be implemented in order to reduce mortality in areas where it is common.

Fig. 3: Image of fish elevator transporting fish to higher waters (Cooper, 2012).

Turbine Designs

Safer turbine designs can also be implemented to reduce the harmful impacts on fish populations while maintaining energy production and efficiency. Currently, there are two major types of turbines: impulse and reaction turbines (Office of Energy Efficiency and Renewable Energy, n.d.). Impulse turbines make use of kinetic energy of flowing water to rotate the runner, whereas reaction turbines utilize both kinetic energy and water pressure to spin the turbine (Kumar, 2022). However, there are exceptions to both types of turbines; some designs feature both impulse and reaction aspects, while other designs may use neither.

Archimedes Screw

The use of an Archimedes screw turbine for low head hydropower plants could be a cost effective and fish friendly alternative to traditional turbines (Purece & Corlan, 2021). Because the pressure that is utilized during operation is due to the weight of water, it is neither considered as an impulse turbine nor a reaction turbine (YoosefDoost, 2020). The use of potential energy is demonstrated below, which creates the motion to rotate the turbine and generate electricity (Fig. 4). Additionally, its shape and operational methods allow for debris and other matter to pass through without affecting the overall functioning of the turbine (Purece & Corlan, 2021). Its ability to be safe for passage of abiotic material without deteriorating the turbine's function correlates to the higher rates of fish survival.The Archimedes screw acts as a gentler option for passing fish than traditional impulse or reaction turbines.
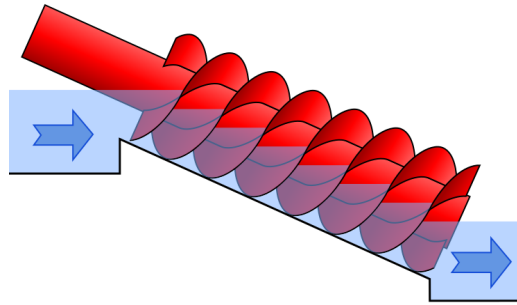
Fig. 4: Visual representation of potential energy of water as it moves through the turbine (Jahobr, 2020).

Furthermore, the Archimedes Screw turbine was designed to have slower rotational speeds than traditional turbines; thus, fish passing experience lower pressure changes which correlates to the reduced amount of barotrauma that occurs (Wolter et al., 2022). However, because the turbine can only be operated in one direction with the current, fish are limited to only downstream migration unless an alternate solution is implemented by investors, such as fish ladders or trucking. Ultimately, the Archimedes Screw design yields successful survival rates and provides a sustainable alternative to traditional hydroelectric turbines.

Alden

The use of Alden turbines, which have fewer blades that are specially engineered and are operated at slower speeds, could contribute to further integration of hydroelectric technology that lowers ecological effects (Perkins, 2013). It was designed so that the shape of the blades are able to "meet criteria for pressure change rates, shear rates and minimum pressures," by using semi-circular entrances that work to decrease strike damage to fish (Perkins, 2013).

Lucid Spherical

The Lucid Spherical turbine is a design which utilizes in-pipe technology as well as blades that create an 180 degree arc (Oladosu, 2018). It captures the energy of the flowing water and provides a predictable base load energy (C & Krishna, 2016). Its low installation costs and the ability to generate energy within a week of installation allows for project returns to be high (C & Krishna, 2016). As water moves through the turbine it enforces rotational energy on the turbine due to its excess head pressure, head being the vertical difference of the heights of the points of water intake and discharge (C & Krishna, 2016). Lastly, the Lucid Spherical design features a vertical in-pipe turbine generator and it removes pressure from the water flow and generates electrical energy simultaneously (Purdue ECT Team, 2016). Because of its spherical design, the diameter of the turbine decreases above and below the turbine centerline; as a result, there is a reduced blade speed in those areas and a lower strike velocity that correlates to the decreased mortality rate (Jacobson, 2012). In addition to its low strike rate, it also has the ability to harvest head pressure along the pipe, and in doing so it reduces power throughout the hydroelectric plant (Nallode, 2016). This may work to reduce barotrauma injury in fish that migrate through the dam.

Pelton

The Pelton design is an impulse turbine that utilizes a water pressure jet and strikes to the turbine tangentially to enable rotation (Anupoju, 2018). A nozzle is implemented to accelerate the water in order for it to reach high speeds and rotate the wheel (Anupoju, 2018). They also can be incorporated at high head sites and flow rates tend to be smaller (The Hydro and Wind Company, 2015). The Pelton turbine's use of higher rotational speeds as well as pressure changes put fish at more risk of injury and mortality during their passage through the turbine (Loew). The jet that shoots the force of water is used to rotate the runner (Fig. 5).
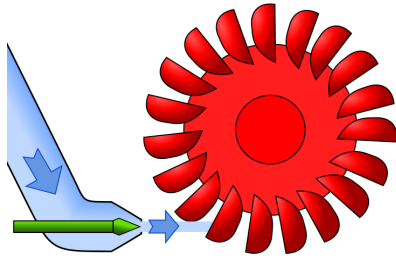
Fig. 5: Model of Pelton turbine runner and the flow of water to rotate the turbine (Jahobr, 2020).
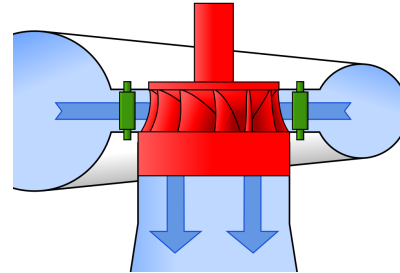
Fig. 6: Model of Francis turbine and the flow of water through the runner (Jahobr, 2020).

Francis

The Francis design uses both impulse as well as reaction forces of flowing water; therefore, it is classified as a mixed flow turbine because of its dual use (Rahman, 2010). Because both kinetic and potential energy is utilized in the process, Francis turbines typically run into issues with head applications (Rahman, 2010). Guide vanes are utilized to regulate the flow of water and "controlling the power output of a turbine" based on the pressure loaded onto the turbine (Rahman, 2010) (Fig. 6). Like the Pelton turbine, the Francis also uses higher rotational speeds, and changes in pressure that put fish at risk (Loew). The flow of water is portrayed as well as the runner which rotates on a horizontal axis (Fig. 6).

Cross Flow

The Cross Flow turbine is an impulse turbine in which a nozzle is used to direct water tangentially toward the runner (Yi, 2018). The use of the nozzle in the process converts the potential energy of the water into kinetic energy so it is able to rotate the runner and create electricity (Patel, 2016). The water then passes the first stage, crosses to the second stage, where it moves over the runner again, earning its name of the Cross Flow turbine (Yi, 2018). It is popular for low head applications as well as lower water flow rates. The Cross Flow turbine typically spins at slower speeds less than 160 rpm, allowing for a higher rate of fish survival (Pokhrel, 2017). They also have wider gap blades, giving fish a large space to travel through, and a lower chance of blade strike (Pokhrel, 2017). Water flows through the turbine and it crosses the runner twice (Fig. 7).
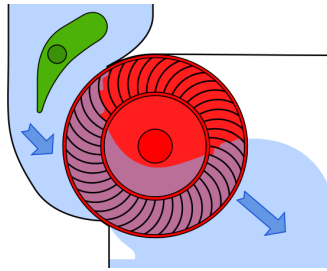
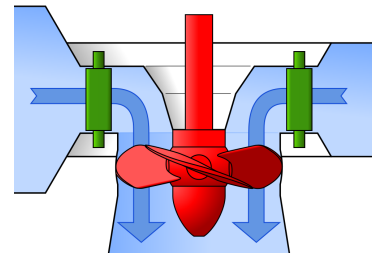Fig. 7: Pathway of water flow through the Cross Flow turbine runner (Jahobr, 2020).

Fig. 8: Water flow through a Kaplan turbine featuring the design of the runner (Jahobr, 2020).

Kaplan

The Kaplan design features a reaction turbine that utilizes a propeller, which is rotated by water flow along its rotational axis (Elprocus, 2013). It can be applied with a higher water flow rate as well as lower head rates for the highest efficiency (Elprocus, 2013). The turbine maintains efficiency by having adjustable blades that change location for various water supply flows and conditions (Elprocus, 2013). Water flows horizontally and then vertically down through the Kaplan runner, which rotates the turbine (Fig. 8). It includes fewer blades than other turbine designs and works at low head sites (Elprocus, 2013). However, it requires a high flow rate. which puts migrating fish at higher risk, and its installation costs are relatively high (Elprocus, 2013).

Bulb

The Bulb turbine is noted to be a reaction turbine, due to its reliance on a system of pressure as well as a continuous body of water (Savree, 2023). Like many other designs, the process begins with water entering the penstock, a pressurized conductor of water. The water makes its way to the wicket gate, where it is directed to flow tangentially across the runner blades, like that of a Kaplan turbine (Savree, 2023). The Bulb turbine is a variation of Kaplan turbine, so the process of electricity generation is similar. However, Bulb turbines facilitate water flow differently from the Kaplan turbine in that water enters and exits the turbine with little change in direction (HTE Engineering, 2016). Water flows horizontally through a bulb turbine to rotate the runner (Fig. 9). Moreover, the Bulb turbine is a horizontally mounted turbine, and due to this, water velocity is slower through the turbine; therefore, fish experience less extreme pressure changes in comparison to other turbines (Abernethy, 2003).
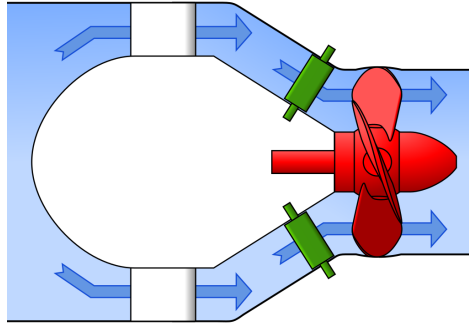
Fig. 9: Visual of water flow through the bulb turbine (Jahobr, 2020).

Methods

        I conducted a literature review of turbine designs and their impact on fish populations over the past 20 years, taking into account newer designs. From this literature review, I was able to compare turbines according to marginal costs ($/MWh), capital costs ($/kW), survival rate percentage, efficiency percentage, maximum power, and head applications. I compared fish-friendly alternative designs to Pelton turbines (with high heads from 601-1000 meters), Francis turbines (with a water head from 36-600 meters), and Kaplan turbines (head from 5-35 meters) (Difference Between Pelton, Francis and Kaplan Turbines, 2020) in regards to head applications.

        For the overall cost of the turbine, I used the metrics $/kW and $/MWh to compare models. To compare the cost of the rate of energy produced, economic comparisons will take the form of USD/kW, or the capital cost. Also, the marginal cost, including operational costs were compared using USD/MWh. These metrics were a useful comparison tool for development decisions regarding cost.

        Additionally, I compared the efficiency as a percentage and the maximum power generation of each design in MW. These metrics were considered in order to reflect how well each turbine performs in terms of energy potential and generation.

        In order to compare fish health and safety regarding turbine designs, turbine passage survival (the proportion of fish that do not survive the effects of the dam) was used as the main metric (Harrison, 2018). Because the survival rate may fluctuate depending on the power output for each separate turbine application, the average survival rate was used to compare each turbine. This ensured that the data accurately measured the damage inflicted on fish populations by passage through the turbines. Long-term post-passage survival rates were used to measure the amount of chronic damage inflicted on the fish, measuring a week after its passage through the dam (Harrison, 2018). Long term post passage survival rates refers to the difference in survival rates of fish that survived the passage through the hydroelectric plant and the survival rate of a control group that experienced downstream migration outside of the plant (Harrison, 2018). This metric can be utilized to gain a representation of the mortality rate of fish that pass through the dam through comparison of those who survive the turbine and those who survive migration without passing through the dam.

Results

Measuring the efficiency of various turbines is vital in the comparison process in order to determine what percent of the input is being utilized to contribute to the output of electrical flow (CK-12 Foundation, 2012). The maximum power of each turbine measures the amount of power that the turbine can generate. A statistic of maximum power and efficiency of each turbine was used for comparison (Table. 1).

Turbine	Maximum Power (MW) ▲	Efficiency
Archimedes	0.5	74.27%
Bulb	50	91.17%
Cross Flow	100	88%
Alden	120	93.64%
Kaplan	300	94%
Deriaz	350	90%
Lucid Spherical	350	80%
Pelton	500	90%
Francis	800	95%

Table 1: Table of maximum power in megawatts as well as efficiency for each compared turbine.

Efficiency

The Francis design has the highest efficiency at 95%. Its high efficiency is due to the utilization of both reaction and impulse force technology to generate energy (Rahman, 2010). The Pelton turbine's high head application allows for the potential energy of the water to be increased in comparison to other turbines. Its efficiency rate of 90% makes it a strong candidate to be implemented in areas that are in need of high electricity generation (Diepeveen, 2011). However, the Archimedes Screw design has an extremely low capacity for power generation, so its production of energy would be lower than that of the Francis design. This makes it a weaker candidate for areas in need of more reliable source with higher outputs.

Maximum Power Output

The Francis turbine has the highest maximum power (Fig. 10, Hammer, 2016), followed by the Pelton design (Diepeveen, 2011), leading with the highest range for power capacity of all of the turbines combined. The Lucid Spherical has a decent maximum power while having an efficiency rate that is not as high as the others (Litostroj Power Group, 2018). The Kaplan turbine follows in terms of maximum power, with a higher efficiency than the Pelton and Lucid Spherical (Diepeveen, 2011), then the Alden with lower maximum power and higher efficiency (Alden Research Laboratory, 2012). Lastly we have the Cross Flow (Donev, n.d.) and the Bulb turbine (Litostroj Power Group, 2018) both with lower maximum power potentials and fair efficiency rates. The Archimedes Screw turbine had the least capacity for power out of all of the turbines compared and also has a low efficiency rate (The Hydro and Wind Company, 2017).

The maximum power output is an important metric because it represents the highest value in the range of power that each turbine is able to reach.
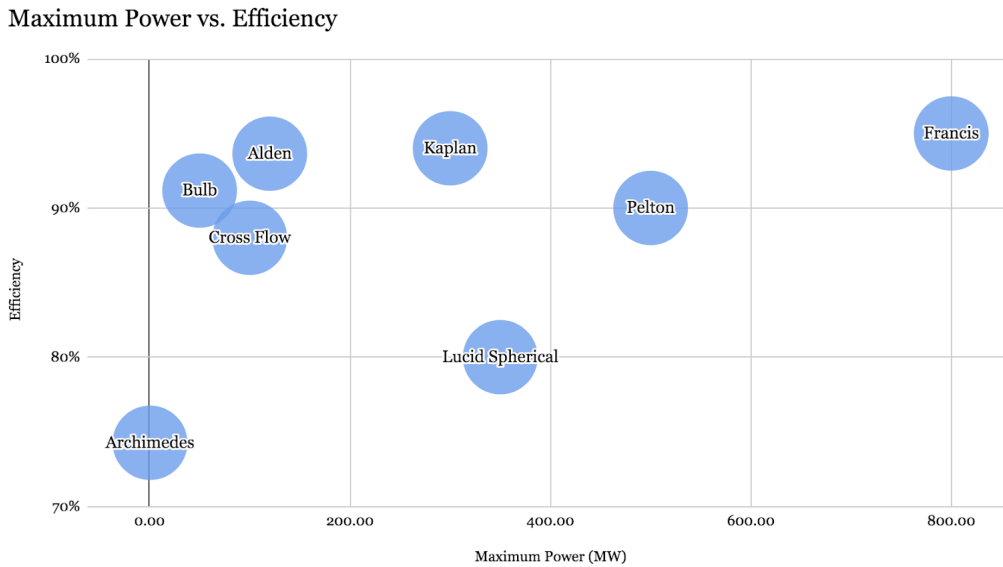

Fig. 10: Visual of efficiency in comparison to maximum power for compared turbines.

While the efficiency rates help investors decide which turbine design to implement at a site for hydropower development, the turbine's impact on fish populations is critical in order to take into account the effects that the dam will have on freshwater ecosystems. The energy metrics of each turbine reflect the characteristics of electricity generation of the turbine, and they help developers decide which turbine will suit the needs of a particular area in terms of energy production.

Turbine	Survival Rate	Minimum Head (m)	Maximum Head (m)	Maximum Power (MW)	Head Application
Pelton	78.70%	50	1000	500	High
Francis	93.10%	40	600	800	Medium
Cross Flow	91.40%	1.75	200	100	Medium
Alden	98.00%	10	40	120	Medium
Kaplan	89.00%	2	35	300	Low
Bulb	98.00%	0.5	30	50	Low
Archimedes	98.30%	1	15	0.5	Low
Lucid Spherical	98.00%	1.5	6	350	Low

Table 2: Table of survival rates, head minimum and maximum applications, maximum power output, and head application height classifications of each turbine.

Table 2 displays the survival rate of each turbine in comparison to the maximum power that the turbine can generate. The Francis turbine has a survival rate of 93.1% (Dedual, 2007), which creates a fair balance for both electricity generation as well as its impact on fish populations. The Pelton turbine, which had a high efficiency rate as well as a high maximum power, had a survival rate of 78.7% (Radinger, 2022), demonstrating the tradeoff that may be

faced by turbines whose design is to maximize the electricity output without regard to the environmental effects caused by the design. Also, the Archimedes Screw design has a high survival rate of 98.3% (New England Hydropower Company, n.d.), but its maximum power output is 0.5 MW (The Hydro and Wind Company, 2017) making this a turbine is impractical for powering large cities or areas in which electricity generation has a high demand. However, this design could be useful in areas where smaller towns need to be supplied and there is an abundance of wildlife in the area.

Cost

Cost of the production of energy is vital in determining the type of turbine suitable for each hydroelectric project. During the feasibility study for the development of hydropower plants, developers evaluate cost estimates, which informs whether or not to proceed with the project (International Finance Corporation, 2015). They act as the basis for the final decision about whether or not to implement the hydropower project (International Finance Corporation, 2015). Therefore, being able to maintain a sustainable economic cost is critical for the long-term use of hydroelectric power and being able to rely on clean energy.

Capital costs are the initial investment costs of construction and assets, such as land and equipment that are necessary for the production of a project (Gerardi). Capital costs and the cost of land combined make up the fixed cost of electricity generation, which do not vary with the amount of energy output that is produced (Blumsack, 2022). These costs include the necessary equipment to produce the electricity (Electric Power Research Institute, 2011).
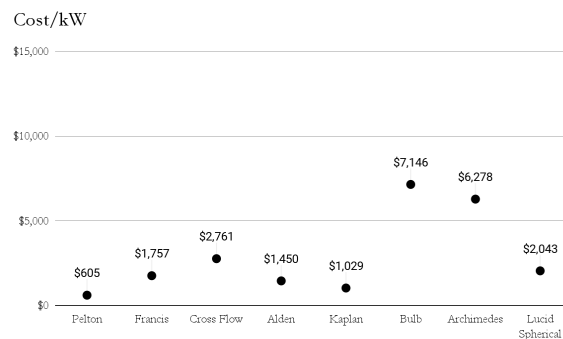
Fig. 11: Plot of cost analysis per kW of energy for turbines.

The cheapest cost of energy is generated by the Pelton turbine design, which produces energy at the rate of $605/kW (Ogayar, 2009) (Fig. 11). Because Pelton turbines typically operate in areas with high head heights and they rotate at high speeds as well, it presents the potential for the operating speed and the generator speed to be the same and can result in reducing the drive system cost (The Hydro and Wind Company, 2015). Its low cost/kW as well as its high maximum power application make it a considerable candidate for areas that need substantial power output at a relatively low cost. Additionally, the Kaplan turbine has a capital

cost of 1029/kW, making it a reasonable option for installation (Theron & Theron, 2017). Furthermore, the Electric Power Research Institute performed a research project in which they analyzed the design specifications of an Alden turbine and power plant in hopes that their findings will aid in the creation and implementation of the project (Electric Power Research Institute, 2023). In their findings, they reported the preliminary turbine cost to be $1450/kW, including turbine, generator, unit controls, limited balance of plant equipment, commissioning, and field installation (Electric Power Research Institute, 2023). This number can aid to be a projection as well as a tool in planning for the development and expansion of clean hydropower energy production. Because the survival rate of the Alden turbine is 98%, it provides a safe option for the passing wildlife as well as an economically beneficial option in cases of downstream fish passage (Office of Energy Efficiency and Renewable Energy, 2014).

The Francis turbine has a capital cost of $1756.80/kW (Zhang, 2012) , less than the capital cost of the Lucid Spherical turbine at $2043/kW (Aziz, 2021) and the Cross Flow turbine at $2761/kW (Picone, 2023). Typically, developers aim for capital costs that range from $2,000 to $6000 per kilowatt for small hydropower plants (Uria-Martinez, 2015). Outside of this range, the Archimedes Screw design has a higher capital cost at $6,278/kW (Lashofer, 2012). Additionally, application of the Bulb turbine may result in costs of energy that are comparatively higher. For example, the John Overton Lock and Dam, which features a Bulb turbine, has a cost of $7164/kW (Oladosu, 2021). Bulb turbines require specific air circulation and cooling within the bulb which may contribute to the higher costs than other turbine options (HTE Engineering, 2016). Because the capital costs of the Archimedes Screw and the Bulb turbine are so high, they may be passed over for more economic options.

The marginal cost is the change in total production cost in order to produce an additional unit of energy (Clarine). Analyzing the cost per MWh for each of the turbines takes into account the costs of operation as well as the costs of production of energy, resulting in the marginal cost (Blumsack, 2022). In other words, the marginal cost is the operating cost required to generate each unit of energy, in this case MWh (Blumsack, 2022). Investors would likely be concerned with capital costs of the project, whereas those who fund operational costs over periods of time would be interested in a project's marginal cost.

Turbine	Marginal Cost ▼	Capital Cost
Cross Flow	$171.19	$2,760.88
Kaplan	$142.72	$1,029.00
Lucid Spherical	$101.27	$2,042.93
Archimedes	$50	$6,278.44

Table 3: Table of capital costs ($/kW) in comparison to marginal costs ($/MWh).

Of the marginal costs collected, the lowest marginal cost is the Archimedes Screw turbine at around $50/MWh (Wasserman, 2013) (Table 3). Next, the Lucid Spherical turbine has

a marginal cost of around $101.27/MWh (Hydro Review, 2015). Lastly, the Kaplan turbine operates at $142.72/MWh (Ceran, 2020), and the Cross Flow has the highest marginal cost at $171.19/MWh (Picone, 2023). This metric is a measurement that can be taken into consideration by developers in order to account for the cost of operations for the various turbine designs. For example, the Archimedes Screw has a lower operating cost, so long term applications of it could be beneficial over a turbine with a higher marginal cost. On the other hand, the Cross Flow turbine has relatively high marginal costs, so developers on a less flexible budget may shy away from this option.

Survival Rates

The survival rate is measured by the percentage of fish that enter the hydroelectric power plant and exit alive. The general trend of the data gathered is that as the maximum head decreases, the survival rate of the fish that passed through the turbine increases.
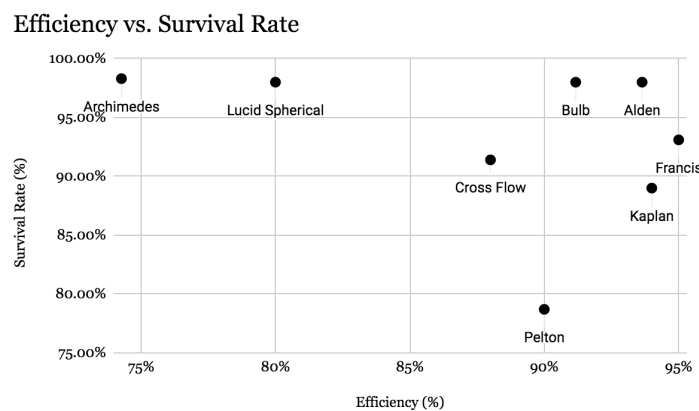
Fig. 12: Plot graph of each turbine's survival rate in comparison to their efficiency - both metrics used as percentages.

By comparing the turbine's efficiency to its average survival rate, we get a metric of performance compared to the turbine's environmental effects. The Alden turbine has an ecological and efficient balance with a survival rate of 98% (Office of Energy Efficiency and Renewable Energy, 2014) and an efficiency rate of 93.64% (Perkins, 2013) (Fig. 12). It can be used as a viable option when implementing a turbine that is both efficient and safe for passing fish populations. On the other hand, the Pelton turbine is an example of a turbine that has a decent efficiency rate at 90% (Diepeveen, 2011) while having a lower survival rate of 78.7% (Radinger, 2022). This example classifies the Pelton turbine as one that is more advantageous in terms of energy efficiency, but faces drawbacks when it comes to fish populations. The Archimedes Screw is a contrasting option in that it is extremely fish friendly with a survival rate of 98% (New England Hydropower Company, n.d.), but has a lower efficiency rate of 74.27% (Thakur, 2022). While this turbine is safer for fish populations, it takes more water flow to produce a substantial amount of energy. Where it thrives in ecological benefits, it lacks in its ability to efficiently produce energy.

Survival Rate vs. Cost/kW
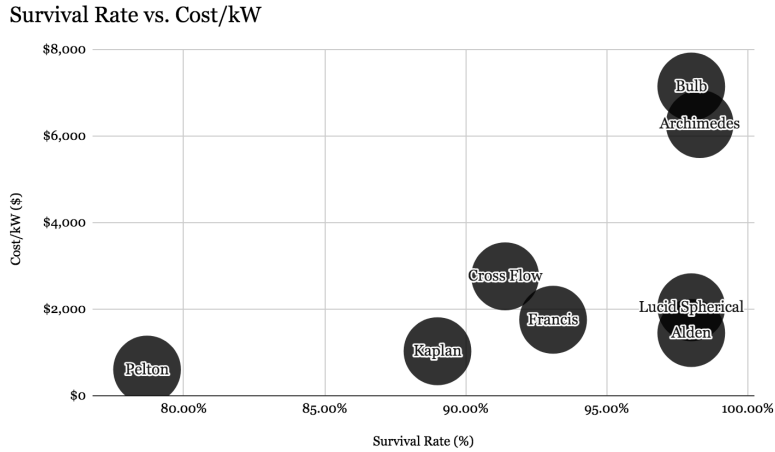
Fig. 13: Visual of capital cost in comparison to each turbine's survival rate.

I compare the capital costs of each turbine with the survival rate of each (Fig. 13). This comparison gives an idea of how the turbine affects fish populations and how the capital cost will appeal to developers. The Alden turbine performs the best in terms of both its capital rate and the survival rates (Fig. 13). Its low capital cost of $1450 (Electric Power Research Institute, 2023) and its high survival rate of 98% (Office of Energy Efficiency and Renewable Energy, 2014) make it a viable candidate for a cost effective and fish friendly option. However, the Bulb turbine, which has a capital cost of $7146 (Oladosu, 2021) and has a high survival rate of 98% (Quaranta, 2020) may not seem the most economically practical in the eyes of developers, depending on the specific cost.

Survival Rate vs. Marginal Cost
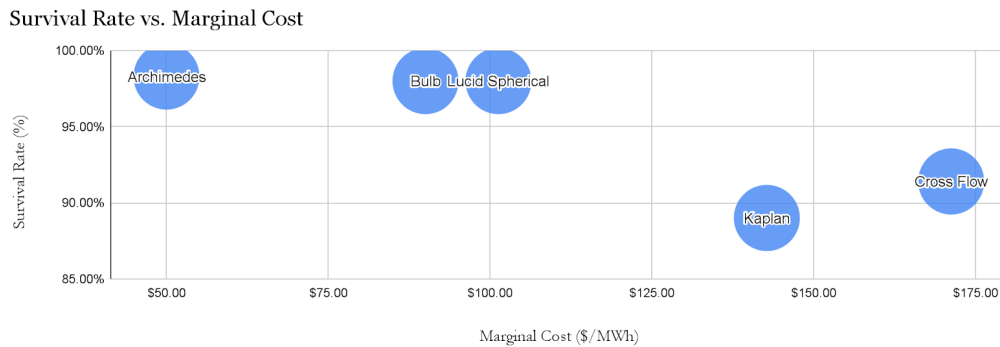
Fig. 14: Model of survival rate in comparison to the marginal cost. The survival rate is measured as a percentage and the marginal cost is represented as $/MWh.

The use of marginal cost takes into account the costs of operation of the turbine and how that metric can be compared to the survival rate of the turbine. Within the categories of marginal cost and survival rate, the most successful turbine design is the Archimedes Screw design, with a high survival rate of 98.3% (New England Hydropower Company, n.d.) and a low marginal cost

of around $50/MWh (Wasserman, 2013) (Fig. 14). It makes for a cheap cost of operation as well as a safe form of passage for the migrating fish. The Bulb turbine and the Lucid Spherical turbine are also turbines with high survival rates and relatively low marginal costs that make them a viable option. However, the Cross Flow turbine has the highest marginal cost of $171.19/MWh (Hydro Review, 2015) and a lower survival rate of 91.4% (Nasir, 2013). While it is not as low as the Kaplan turbine, the cost of the Cross Flow turbine may prevent it from being implemented in a widespread manner.

Discussion

Only prioritizing turbine output may result in unintended harm and destruction to fish populations. To ensure sustainability and the stability of freshwater ecosystems, it's crucial to take safety as well as the electrical output into account while implementing a turbine design. On the other hand, the application of a turbine that has high survival rates, but a low amount of maximum power can give the impression that the dam isn't being utilized to its full potential in terms of electricity generation.

Similarly, developers that prioritize low capital and marginal costs may contribute to the declining fish populations. Consumerist societies contribute to the mindset that costs are a more valuable metric than environmental effects, and as a result, ecological issues may be overlooked in the design and decision making process.

Head

The areas in which hydroelectric dams are built have a profound impact on the efficiency and electricity generation of the site. At high head sites, the potential energy of the water increases, and as a result, more pressure and water flow is utilized in order to generate more power (The Hydro and Wind Company, 2016). The increased pressure causes the rotational speed of the turbine to increase, which directly correlates to the amount of electricity that is generated from the power plant. Not only does the rotational speed impact the electricity generation, but it also impacts the safety of fish populations.

For example, the Pelton turbine, which has a maximum head of 1000 meters (Mavel, 2015), has a 78.7% survival rate (Radinger et al., 2022), which is low compared to the other designs that are at or above 90% (Table 2). Similarly, fish are at high risk for injury when attempting to make their passage through the dam, and frequently, they escape the turbine with tears in their fins, scale loss, and a variety of other injuries that affect their quality of life (Mueller, 2017). Because of the increased risk of fish harm that comes with higher head applications, investors of hydroelectric power plants focus their efforts on reducing the damage that high head turbines have on fish populations.

Considerable Options - Benefits and Drawbacks

Of the turbine designs compared, the ones with the least harmful effects on fish populations were the Lucid Spherical, Bulb, Archimedes Screw, and the Alden designs. Of the four options, the most efficient design is the Alden turbine, resulting in a smoother energy production process. Additionally, the Alden turbine can be utilized at higher head applications

than the Lucid Spherical, Archimedes Screw, and Bulb turbines. This provides a wider range of application sites than the other designs because the others are more limited in their head applications. The Alden turbine's capital cost is also less than those of the other turbines that perform at higher survival rates, making it more economically attractive than the others. However, the drawback of the Alden turbine is that its maximum power rate is less than that of the Lucid Spherical turbine. Yet, its efficiency and higher head applications may make up for this tradeoff.

Despite its lower survival rate, the Francis turbine provides a reasonable option for larger head sites. Its relatively high survival rate and comparatively low capital costs indicate that the design can both reduce negative impacts on fish populations as well as being an economical option for developers. It also has high maximum power potential as well as a high efficiency rate that indicate that it can be a strong producer of electricity to meet the consumer demand. While it doesn't reach as high of survival rates as the designs listed previously, it is an option that can be considered in areas that demand more energy, while having reasonable costs. Its potential for high head applications also make it a suitable candidate for areas in which the head is fairly large.

Conclusion and Main Goals

Hydropower is vital because it is a clean energy source that can be utilized without the use of fossil fuels. It can be used widely to provide electricity in order to meet the demands of consumers in the modern era. Despite the benefits hydropower provides, the consequences it has on fish populations is an unintended effect that leads to issues for the environment. This literature review was conducted in order to compare various statistics of turbine operations as well as the survival rates of each.

Overall, the turbine with the best maximum power and efficiency combination was the Francis turbine, making it a strong candidate for an area that will highly prioritize energy output over other metrics. Meanwhile, economically, the Pelton turbine had the lowest capital cost while the Kaplan turbine had the lowest marginal cost. Therefore, the Pelton turbine has a cheap cost of investment in comparison to the other turbines. Similarly, the Kaplan has a low marginal cost, so the cost of operation and the production of energy will be less over its time in use, a cost-effective option for long term use. Lastly, the Bulb turbine, the Archimedes Screw, and the Lucid Spherical designs had the best survival rate for migrating fish populations. These options could be utilized in areas in which there is a high priority in conserving wildlife and biodiversity.

By analyzing various designs of turbines, the efficiency and ecological impacts were determined and compared. In doing so, it was assessed that more sustainable turbines can be alternatives to common turbines that are implemented across the globe and may not be safe for fish populations. It is hoped that this research can aid in the knowledge and decision making process of governmental decision makers, industry practitioners, and members of the public while selecting hydroelectric turbine designs during future hydropower plant projects.

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Repositioning Type II Diabetes Drugs Using Machine Learning By Gang Joo Nam and Sanjay Ranka

Abstract

The urgent need for novel and affordable therapeutic approaches is highlighted by the rising incidence of Type II Diabetes (T2D) across the world. Drug discovery and development must once again receive attention as current strategies struggle to keep up with the rising demand. However, traditional drug discovery methods can require considerable time commitments and high-cost expenditures. Drug repurposing, which is an innovative application of already-approved medications, is an option that might be fast and inexpensive. This study applies this idea by concentrating on the repurposing of medications based on adverse effects that are similar to those of known anti-diabetic treatments. We investigated the similarity between well-known anti-diabetic drugs and other medications from various therapeutic fields using a comprehensive database of drug adverse effects. We examined patterns that connected the effectiveness of well-known diabetes medications with their adverse effects by utilizing machine learning approaches. We created a shortlist of potential repurposing candidates by identifying medications with comparable side effect profiles. Our findings showed that a number of potential pharmacological candidates had adverse effects that were quite similar to those of commonly prescribed diabetes drugs. A number of these medications fall within therapeutic categories that are not often connected to the management of diabetes, suggesting the broad potential of this strategy. The antidiabetic potential of chosen drug candidates was shown by literature study. This study highlights the possibility for drug repurposing for T2D, which could accelerate the process of discovering alternative diabetes drugs. We could more quickly and cheaply navigate the complicated landscape of drug development by making use of the existing pharmacological data. I think that further research in this respect will help us better address the growing healthcare burden that T2D poses.

Introduction

Type 2 diabetes mellitus (T2DM) is one of the global epidemics parallel to malaria, tuberculosis, AIDS etc. They all represent one of the most challenging and pressing public health concerns of the 21st century. However, one of the differences between most of the global epidemics and T2DM is that it does not originate from a pathogenic origin. Instead, while genetic factors might play a role [1], the rapidity of which it spread reflects the rapid socioeconomic changes to which humanity has been exposed over the past few years [2]. With its alarming increase over the past few decades, T2D affects hundreds of millions of individuals worldwide exerting a tremendous burden on healthcare systems, economies, and, most importantly, the lives of those afflicted [3]. As it is a chronic metabolic disorder, T2D is characterized by multiple descriptions. Known for insulin resistance, impaired glucose regulation, and progressive beta-cell dysfunction, the disease ultimately leads to hyperglycemia and the development of debilitating complications [4, 5].

Rising Global Burden of T2D

Over the past few decades, T2D has rapidly transformed from a localized health issue to a global pandemic. The WHO estimates that nearly 422 million adults lived with diabetes in 2014, and this number is estimated to be increased to 642 million in 2040 [6], imposing an overwhelming burden on local healthcare systems worldwide [7]. This phenomenon of increase in cases of patients with T2D is largely from an aging population, increasing urbanization, sedentary lifestyles, unhealthy diet patterns, all of which contribute to the rapid socioeconomic change inducing escalating rates of obesity and metabolic disturbances [8].

Notably, the consequences of T2D extend beyond its direct impact on individuals' health. For example, the economic implications of the disease are significantly inducing skyrocketing healthcare expenditures on diabetes-related medical care [9]. Also, premature mortality destabilizes productivity creating loss in multiple areas. Not only bounded in economical areas, T2D's burden is a substantial global issue which puts an accentuation on exerting pressure on governments, insurers, and healthcare providers so that they can seek innovative and economical solutions for diabetes management and prevention [10, 11].

The existing therapeutic arsenal for T2D includes various classes of insulin secretagogues, insulin sensitizers, glucose absorption inhibitors, and lifestyle modification aimed toward glycemic control [12]. While these approaches have provided significant advancements in diabetes management, they are often inappropriate in preventing disease progression and precluding long-term complications. Moreover, the pursuit of new and more effective drugs for T2D through traditional drug development faces many formidable challenges. These challenges include, but not limited to time-consuming and costly processes of drug discovery, preclinical testing, and clinical trials [13]. As a result, the need for innovative approaches to identify safe and effective therapies for T2D becomes cardinal.

Strategies of Finding Novel Drugs

Traditional drug discovery dates back to ancient civilizations, where humans relied on natural remedies derived from plants, animals, and minerals to treat various ailments. The empirical knowledge gained from these practices formed the basis for early pharmacology. In the Middle Ages, medicinal herbalism and alchemy played a crucial role in identifying therapeutic agents, while the Renaissance marked the transition to a more systematic approach. In the 19th and 20th centuries, technological advancements and a deeper understanding of biology paved the way for the era of synthetic drug development. This led to the discovery of drugs such as penicillin, insulin(which was synthesized using recombinant plasmid), and aspirin, transforming medical treatment paradigms. The traditional drug discovery process primarily focused on identifying small molecules, often through laborious and expensive high-throughput screenings.

As pharmaceutical research costs skyrocketed and the attrition rate of drug candidates remained high, drug repositioning gained momentum. Drug repositioning involves identifying new therapeutic uses for existing drugs that were originally developed for other indications. The

rationale behind repositioning lies in the exploration of known safety profiles and mechanisms of action of approved drugs, potentially accelerating the drug development timeline. Repositioning leverages the vast amount of existing pharmacological and clinical data to identify potential candidates for various diseases. The approach has led to notable success stories, such as sildenafil (Viagra) initially developed for angina, but later repurposed for erectile dysfunction. It offers several advantages, including reduced development costs, faster time to market, and potentially improved patient outcomes through broader treatment options.

The 21st century witnessed the emergence of cutting-edge technologies, particularly machine learning algorithms, that revolutionized the pharmaceutical industry. Machine learning employs computational models to analyze vast datasets and identify patterns or relationships that may not be apparent to traditional methods. This technology enables drug discovery researchers to harness large-scale genomic, proteomic, and clinical data to accelerate drug development. Machine learning algorithms are now being integrated into both traditional drug discovery and drug repositioning processes. In traditional drug discovery, machine learning assists in target identification, compound screening, and lead optimization. Algorithms can predict drug-target interactions, screen potential candidates for specific diseases, and prioritize compounds for synthesis and testing. In drug repositioning, machine learning algorithms analyze diverse datasets to identify potential drug-disease associations, predict off-target effects, and explore polypharmacology - the ability of a single drug to interact with multiple targets. These applications help researchers uncover new therapeutic uses for existing drugs and identify novel combinations for personalized medicine approaches.

The integration of traditional drug discovery, drug repositioning, and machine learning algorithms has opened new horizons in pharmaceutical research. These synergistic approaches offer the potential to streamline drug development pipelines, reduce costs, and improve treatment outcomes. While traditional drug discovery continues to be essential for developing novel chemical entities, drug repositioning offers a complementary avenue to explore existing drugs and expand their therapeutic applications. The combination of these approaches, empowered by machine learning algorithms, has the potential to transform drug development in the 21st century.
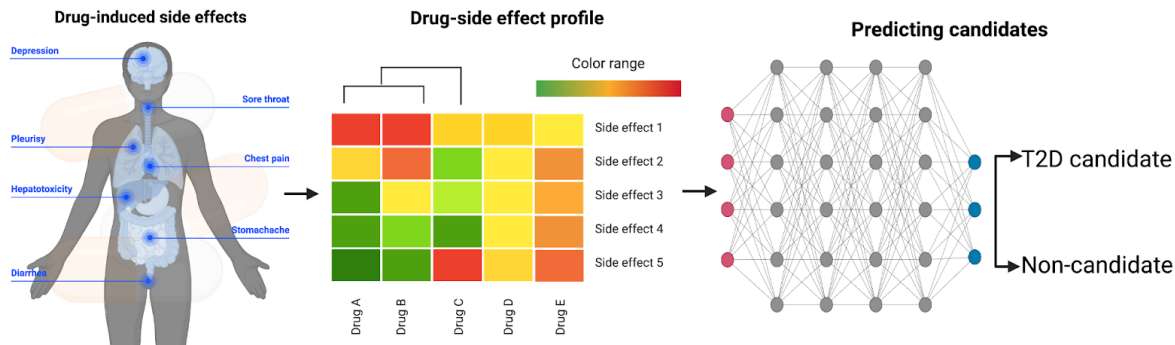
Method–Method Overview

Figure 1. Graphical summary of our method. Drug-side effect profile is constructed from public database and it is utilized in the prediction step. In the prediction step, a classifier is trained and tested to predict whether a given drug can potentially used as a T2D treatment.

In this study, we collected adverse event data for each drug to create an adverse event vector profile for each drug, which we then used to train a classifier to evaluate the likelihood of reintroducing the drug for type II diabetes. Figure 1 summarizes the procedure of this study.

Data Collection

For this work, drug indications and side effects are collected from Drugbank and SIDER databases. Data collected from Drugbank required the unification of the terminologies as the data describing the side effects is written in natural language. To unify the terminology of adverse event information in the SIDER database, the Unified Medical Language System (UMLS) and Medical Subject Headings (MeSH) were used to match each side effect to a single Concept Unique Identifier (CUI). However, data from the SIDER database did not need further modification as it contained CUI for each adverse reaction. Drug indications were matched in the same way, resulting in a total of 61,732 drug-symptom associations.

To find out which drugs are currently used for type II diabetes, I obtained information about the drugs from the Drugbank database. Drugbank is the world's largest database of drug information, which includes drug indication, chemical structure, target gene, and mechanism of action. We extracted drug indication information from this database and obtained 1,045 type II diabetes medications in total.

Data Preprocessing

To train a classifier from the collected drug data, we represented the drug data in the form of a vector. If a given drug has a certain side effect, the vector is 1, and if not, it is 0. Only the occurrence was considered, and other features such as frequency were excluded to keep the vector simple. Therefore, one binary vector is formed for each drug, and a total of 1,051 by 965 vectors are created for the entire data.

Training and Testing Classifier

To train and test the classifiers, we divided the total data into a train set and a test set in a ratio of 4:1. Next, we trained and tested a support vector machine, random forest, logistic regression, and multi-layer perceptron to compare the performance of various classifiers and select the best classifier.

Candidate Drug Selection and Finding Repurposable Drugs

The drug whose prediction score exceeded the threshold using the classifier selected in the above process was considered as a candidate drug. To propose a new drug for diabetes, we conducted a literature study on the candidate drug.

Result

Figure 2 and 3 shows the AUC score and F1 score of four different types of classifiers; random forest, support vector machine, logistic regression, and multi-layer perceptron. All the classifiers are trained and tested 100 times.

As shown in the figure 2 and 3, random forest classifier shows the best prediction performance among the four classifiers. Thus, only the random forest classifier is used for the further tasks.
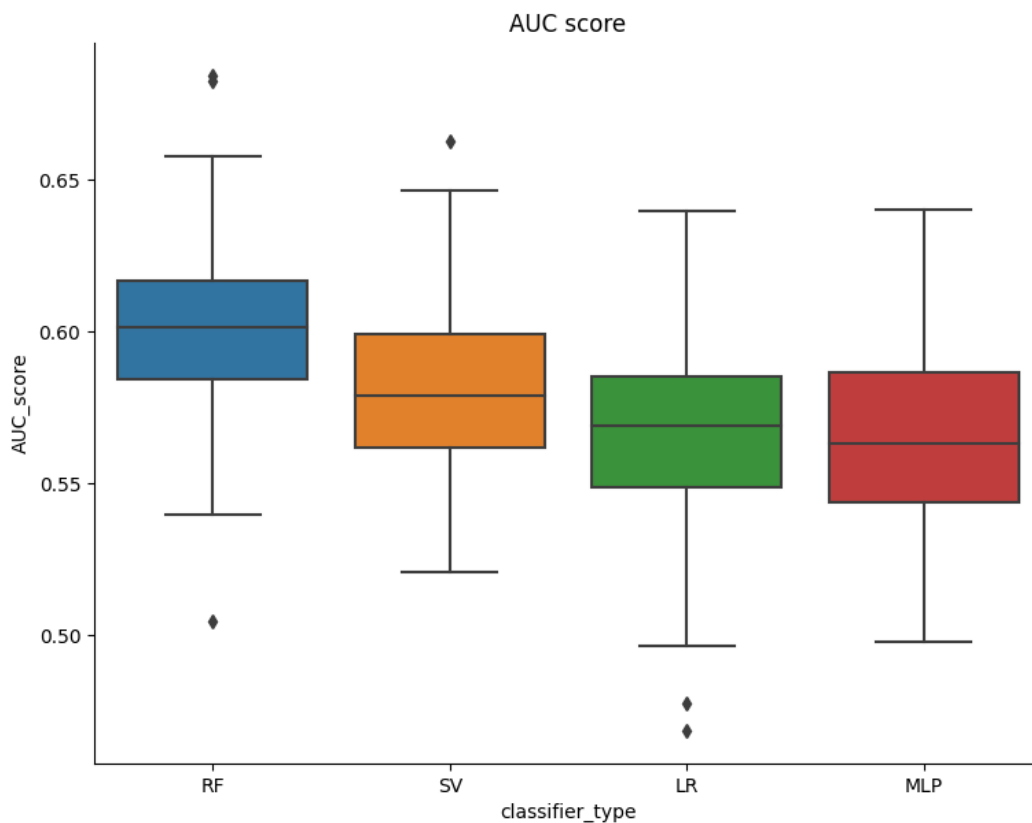

Figure 2. AUC score of four different classifiers. Random forest classifier shows the best performance, followed by support vector, logistic regression, and multi-layer perceptron.
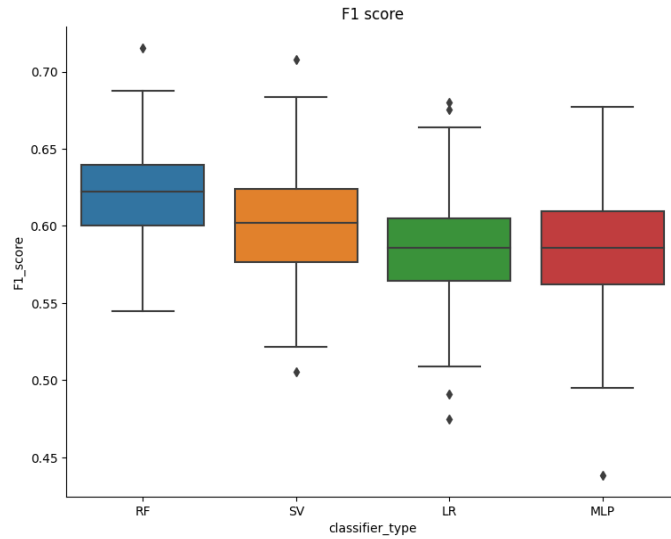
Figure 3. F1 score of four different classifiers. Random forest classifier shows the best performance, followed by support vector, multi-layer perceptron, and logistic regression.
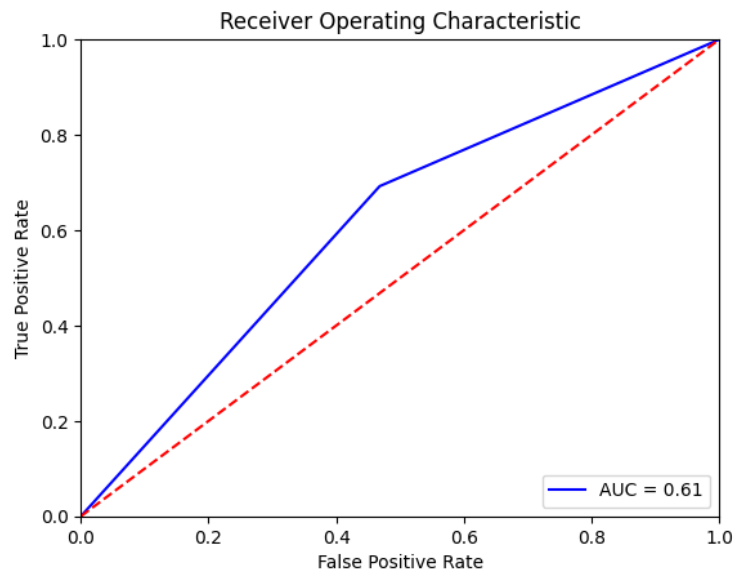

Figure 4. ROC curve of our model.

Figure 5 shows the precision-recall curve of the random forest classifier. The AUPRC score of our model is 0.62.
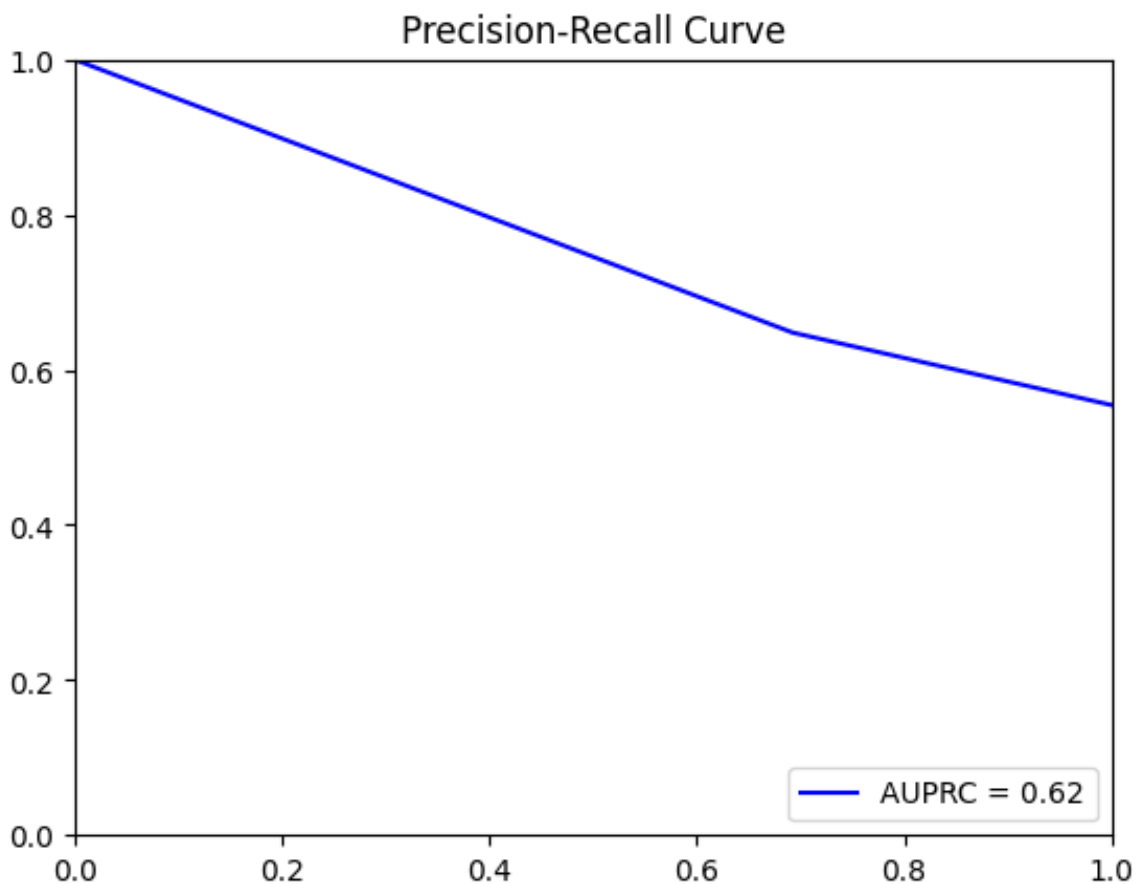
Figure 5. Precision-recall curve of our model.

The following is a list of drugs with high scores using the random forest classifier. The process from splitting the dataset to the model training and testing was repeated 100 times, and the number of times a score of 0.75 or higher was counted. After that, repurposable drugs were selected through literature study for each drug.

Fenofibrate is a peroxisome proliferator-activated receptor (PPAR)-α agonist which is used to treat hypercholesterolemia and hypertriglyceridemia [14]. Fenofibrate targets PPARα which is a primary target of metformin. As is well known, metformin is the most successful type 2 diabetes drug, and fenofibrate shares a target with it, so it has the potential to be used as a type 2 diabetes drug. Thus, fenofibrate has been studied as a treatment for type II diabetes through various studies such as the FIELD study, indicating that our model is good at predicting the probability of type II diabetes drugs [15].

Drug name	Count	Description
Technetium Tc-99m ciprofloxacin	4	radioimaging agent [19]

Naproxen	3	NSAID [19]
Hydrochlorothiazide	3	edema & hypertension [19]
Fenofibrate	3	PPAR alpha agonist [19]
Nafcillin	3	Antibiotics [19]

Table 1. Candidate drugs for type II diabetes and their descriptions. For those candidates, further literature study have been done to find the evidences for our work.

One of our other candidate drugs, naproxen, is a class of non-steroidal anti-inflammatory drugs (NSAIDs). Recently, various studies have explored the potential of NSAIDs as a treatment for type II diabetes [16-18]. In particular, [16] has suggested the possibility of naproxen. Therefore, in this study, we propose naproxen as a real candidate for type II diabetes.

Conclusion

In conclusion, the repositioning of drugs using machine learning for Type 2 Diabetes has emerged as a promising and innovative approach to address the growing burden of this chronic disease. Through the development and application of our algorithm, in conjunction with the comparison results with other algorithms, we have shed light on the potential of machine learning in revolutionizing drug discovery and treatment strategies. Our algorithm's success in predicting the efficacy of repurposed drugs for Type 2 Diabetes showcases the power of harnessing large-scale data and advanced computational techniques. By leveraging the vast amounts of available biomedical data, machine learning enables us to identify previously unexplored connections between drugs and diseases, thereby accelerating the drug development process and potentially leading to more efficient and cost-effective therapies. Furthermore, the comparison with other algorithms highlights the strengths and weaknesses of each approach. Such insights are invaluable in refining and enhancing machine learning methodologies for drug repositioning, ultimately aiding researchers and healthcare professionals in making informed decisions about potential treatment options.

However, it is essential to acknowledge the challenges that lie ahead. The integration of real-world patient data, ethical considerations, and regulatory hurdles are some of the critical aspects that must be addressed to ensure the safe and effective implementation of machine learning-based drug repositioning strategies. In the broader context of healthcare, our work exemplifies the transformative potential of artificial intelligence in revolutionizing patient care and improving health outcomes. As we continue to refine and validate these methodologies, collaboration between researchers, pharmaceutical companies, and regulatory bodies will be vital in driving the translation of these findings into tangible clinical applications.

Therefore, the combination of our novel algorithm and the comparison results with other algorithms signifies a remarkable step forward in the field of drug repositioning for Type 2 Diabetes. Through continued research and innovation, we have the potential to usher in a new era of personalized and data-driven medicine, providing hope for millions of individuals affected by this prevalent and complex condition. By embracing the power of machine learning and working together, we can collectively contribute to the advancement of medical science and bring us closer to a world where Type 2 Diabetes is better managed, and ultimately, one day, cured.

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The Definition of Hypoxia By Adayue Xia

Abstract

It is quite obvious that the environmental problem is a heated topic to be concerned with dates to at least Roman times, which is challenging to solve and associated with complex environmental issues and reasons. To be specific, the issue of hypoxic problems has drawn widespread attention in our country, which significantly plays a pivotal role in sustainable development. The relevant research has found that hypoxia, can be defined as a man-made environmental problem, a common phenomenon occurs in China severely, illustrated deficiency of oxygen in the ocean or tissues, and can be with two classical examples of the Changjiang River and Shizi Bay, located in the east Coast and South Coast of China.

Background of hypoxia

To begin with, as a general explanation, the term "hypoxia", or hypoxia water. (NSW Department of Industry), is illustrated as a depletion of oxygen, which is a normal environmental phenomenon due to several man-made issues such as deforestation and pollution of water. A huge number of experts have shown that the hypoxia standardization is defined as the concentration of dissolved oxygen (DO) less than 2 mg/L. To be specific, dissolved oxygen (DO) is the basic condition to the aquatic animals (Lai et al.), and hypoxia occurs when the oxygen in the water no longer supports aquatic organism, because the need for shrimps and fishes to live is between 2-5 mg/L approximately, and the amount of oxygen in the water per liter is lower than the minimum standard (Smith). In addition, it occurs when marine creatures consume more oxygen (microbial respiration, nitrification and sediment oxygen uptake) than the replacement of oxygen (photosynthesis, air-sea oxygen change) (Lai et al.). Although algae and aquatic plants will produce oxygen by photosynthesis, they will lower the oxygen level at night when they use them. Recent studies (NSW Department of Industry) have shown sufficient and apparent evidence that man-made activity is one of the major causes of the hypoxia, because with the pollution of human being, they will throw the trash such as branches, ash and other organic materials into the river, and the bacteria and fungus on those substances can consume additional oxygen in the river, lower its total oxygen quantity to some extent, and aquatic animals will then be stressed when there's lack of oxygen, which will seriously influence the whole ecosystem. Another factor of human cause of the hypoxia is the contamination which has deteriorated the quality of the environment, which have significantly affected the biological, physical and chemical process. (Chen et al.)

The Example of Hypoxia in Changjiang

As regards the general background of hypoxia, the examples of China in the Changjiang River can further explain the term "hypoxia" more deeply. Firstly, there are many metropolises around Changjiang River because of the developed economy. Those urban areas will generate a great deal of emissions such as carbon dioxide, a chemical material that gravely causes the

greenhouse effect. Relevant research has shown that the high temperature of surrounding areas could accelerate the metabolism and decomposition speed of the creatures, which will facilitate the hypoxia rate (Chen, Gong and Shiah). In addition, Changjiang River, as one of the biggest rivers in China, is also known as having one of the biggest fishing yields because of the high and abundant primary resource (adequate natural resources), and inhabitants discharge a substantial anthropogenic nutrient such as silver nitrate because of the pollutant in industry process. (Chen et al.) According to a scientific survey, professors illustrate this phenomenon of abundant silver nitrate and other salt such as phosphate salt appearing in Changjiang River will change the water structure and algae growth, which will accelerate their metabolism (Dai 2023, Zhao). The research has found that the general nutrient concentration in Changjiang River is increasing at a steady trend from 1984 to 2003, and dissolved inorganic nitrogen and phosphorus (DIN and DIP) is five times compared to the 1990s (Liu et al.). The harmful algal blooms will decrease the photosynthesis and cause the decomposition of the harmful biotoxins that kill the aquatic fishes. Besides, if the algae reproduction is too fast, covering the water surface will prevent the oxygen from dissolving in the water. indicates that the estuary absorbs around $8.9*10^{11}$ cubic meters of fresh water with a huge amount of organic substance from Chengjiang River (Lyu et al.). This serious phenomenon has shown the intensified eutrophication in the east coast of China. Due to the reputation as a prosperous agricultural region around the Chengjiang and its highly populated geographic area, the resource of the total dissolved oxygen in the ocean will be consumed rapidly by fish. Specifically, experts have found that the hypoxic area in the East China Sea has covered approximately 15000 square kilometers, which is comparable to two most oxygen-scarce areas in the world (Chen et al.). It not only threatens marine creatures such as local fishes, but also reduces marine biodiversity. With the lower PH level (Smith), it can also have a negative effect on the whole ecosystem, including the degradation and alteration of community structure and ecology in the east coast of China. Changjiang River is still suffering from hypoxia because of man-made pollution, which is linked to the urbanization, industrialization and agricultural modernization (Chen, Gong and Shiah). As one recent research has summarized the situation, "Ecosystem recovery requires the reduction of more environmental stress and the longer the human damage, the more difficult it is for the ecosystem to recover." (Dai et al.)

The Example of Hypoxia in Shizi Bay

However, the hypoxic phenomenon in the east coast of China is not an isolated event. Shizi Bay, which is in the upstream of the Pearl River in China, has suffered from hypoxia since 2000. The governments are taking measures to control the contamination emission in recent times, with significantly decreased amounts of ammonia (Lai et al.). Ammonia, a hazard as gas, which pollutes air and soil, has also accelerated the formation of nitrous oxide, which is a powerful greenhouse gas (Erisman). Besides, the intensified eutrophication causes the high level of Chemical Oxygen Demand (COD), which is a dominant oxygen depletion indicator (Lai et al.). Specifically, the high COD could lead to a strong water column respiration (WCR) (a major oxygen depletion) (Lai et al.). As a result, the total oxygen in water has decreased. Additionally,

Shizi Bay is on the upstream of the Pearl River, and with the fast economic development and urbanization of nearest cities such as Guangzhou and Dongwon, polluted waters have risen to $2.06*10^9$ tons per year (Lai et al.). The result is that the hypoxic rate in Shizi Bay in 2015 has hit to 1.52 mg/L, which is below the standard of 3 mg/L. Luckily, governments have taken measures by controlling the external pollutant in order to prevent the hypoxia exacerbating, and although ammonia level has decreased to some extent, hypoxia is still significantly experiencing an increasing trend. Because of the intensified eutrophication, the Chemical Oxygen Demand (COD) rate is still showing an increasing trend, which is also decreasing the oxygen level. As we can see from the data and survey, hypoxia is a severe problem in China, which has affected the environment and ecosystem significantly too (Lai et al.).

Conclusion

In conclusion, the definition of 'hypoxia' includes two phenomena in China, whose severity of hypoxia bears significant attention. As we can see from two cases in China, the hypoxia has been severely occurring in China, particularly in some areas adjacent to some bay and ocean, such as Shizi Bay and Chang jiang river. The increasing hypoxia has negatively burdened pressure on the ecosystem functioning, health and safety. Man-made damage to the environment is the stressor of the environment issue (Dai et al.). Due to the man-made disruption and lack of awareness of the importance of the environment, we should take joint efforts and proper actions to alleviate the problem by decreasing man-made pollutants and protect our environmental ecosystem in order to reduce the hypoxia phenomenon, which can ensure our sustainable development in the long term and the issue will give rise to the public activism to take actions on time.

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Analysis of Emissions of Electric, Petrol and Hybrid cars By Arav Agarwal

Abstract

The automotive sector is now a substantial source of greenhouse gas emissions, which have an adverse effect on the environment and the world at large. This research paper presents a comparative analysis of the emissions created by petrol cars, electric cars, and hybrid cars, and how these emissions can be reduced. It also looks into the legislation that is being developed by governments to combat climate change and cut CO2 emissions. The study emphasizes the huge environmental impact that gasoline-powered cars have and demonstrates how converting to electric or hybrid vehicles can have a positive influence on the world. The study also looks at how decarbonizing the grid, reusing batteries, utilizing better materials to create engines, and employing electric vehicles can all cut CO2 emissions.

Overall, the paper emphasizes how quickly greenhouse gas emissions must be reduced and climate change must be stopped. According to the study's findings, switching to electric and hybrid vehicles, along with the use of renewable energy sources and battery recycling, can assist to dramatically lower CO2 emissions and lessen the effects of climate change.

Keywords : Transportation sector, Greenhouse gas emissions, Electric vehicles, Hybrid vehicles, Clean energy sources, Carbon footprint and fossil fuels

Introduction

The transportation industry is a substantial contributor to the world greenhouse gas emissions, accounting for 14% of total emissions. (IPCC, 2018). One of the ways to reduce these emissions is by transitioning to electric, hybrid, and other alternative fuel vehicles. These vehicles have the potential to significantly reduce emissions from the transportation sector, particularly if they are powered by clean energy sources.

Electric vehicles (EVs) are powered solely by electricity and do not produce any emissions while in operation. On the other hand, hybrid vehicles have an internal combustion engine and an electric motor that enable them to run on both electricity and fuel. Hybrid vehicles can reduce emissions by using the electric motor during low power demands, such as when driving at low speeds or in stop-and-go traffic. (US Department of Energy)

Electric and hybrid vehicles have seen a rise in popularity in recent years, as governments and consumers seek to reduce their carbon footprint and dependence on fossil fuels. However this interest for electric and hybrid cars is only present in European markets. In Norway, for example, in 2020, 75% of cars were electric. Whereas in India, only 0.2% of cars are electric and 99.8% are internal combustion engine cars, i.e., not electric or hybrid. (International Energy Agency)

This research paper aims to conduct a comparative analysis of the emissions of electric, petrol, and hybrid vehicles. The study will take into account the emissions linked to the manufacture and use of these vehicles, as well as the impact of different sources on the emissions

of these vehicles. The study will also examine factors such as emissions produced in engine manufacturing and battery life. This paper also discusses the Paris Agreement and the impact it has had on the environment. Additionally, it discusses the environmental effects of internal combustion engine vehicles and viable alternatives.

The results will provide a comprehensive understanding of the emissions of electric, petrol, and hybrid vehicles and will help identify opportunities for reducing emissions from the transportation sector.

Methodology

This study compares emissions from petrol, electric, and hybrid vehicles. This paper will analyse the emissions produced and their sources, the emissions produced during battery and engine manufacturing, and whether there are any alternate technologies that offer the same benefits as electric, gasoline, or hybrid vehicles without the drawbacks.

Discussion–Emissions

Different Sources of emissions in the production and operation of vehicles
In this part of study we discuss emission from 3 different types of vehicles: 1) Petrol vehicles(ICE) 2) Electric vehicles(EV) 3) And lastly Plug in hybrids (PHEV).

When it comes to petrol emissions there are 2 main sources. Tailpipe & manufacturing emissions. Tailpipe emissions are mentioned later in the paper. When it comes to manufacturing emissions this consists of the emissions created in the transport of materials, emissions involved in the powering of the factory etc.

We are aware that an average electric car releases half as much greenhouse gases as an average European passenger car. (Hall and The International council of clean transport, 2018)Even the current market's most efficient internal combustion engine vehicle performs around 27% worse over the course of its lifetime than an electric vehicle powered by standard European power. (research group MOBI and Messagie) Despite this there are still many ways electric cars produce emissions. An area where a lot of emissions are produced is battery manufacturing. According to a study that happened in 2017 battery manufacturing produces 56 kg CO_2e/kWh (Hall and The International council of clean transport 3). This amount is lower than the results found by many other studies. For example one study by Authors Hanjiro Ambrose and Alissa Kendal (Ambrose and Kendal)stated that assuming a manufacturing grid similar to ones in east asia the amount produced could be anywhere between 194 to 494 kg CO_2e/kWh. This is primarily because of where the battery manufacturing occurs. If a 30 kWh battery is made in the European Union, its GHG emissions are lower. According to that report, BEVs will emit fewer life-cycle emissions when driven in any European nation than an equivalent diesel vehicle. (European Federation for Transport and Environment, 2017)

Another study mentioned in the same paper stated that similar batteries when produced in China gave emissions along the range of 96-127 kg CO_2e/kWh (Hao et al., n.d.) using the

Chinese grid to produce batteries. uncovers significant variations across battery chemistries. American-made batteries produce 65% fewer GHGs.

The reason for these huge differences has to do with their grid. If the primary source of electricity in a country comes from fossil fuels, AKA a carbonised grid. This adds on to the emissions produced in the manufacturing of these cars. Therefore countries where a large portion of their electricity comes from fossil fuels, like china where 80% of energy comes from fossil fuels, will have higher emissions than those with a smaller portion of energy from fossil fuels, like norway where 98% of energy comes from renewable sources of energy.

The efficiency of the electric drivetrain and the gasoline engine, the driving environment, and the source of the electricity needed to charge the batteries are only a few of the variables that will affect how much emissions are created by PHEVs. In general, PHEVs are designed to be more efficient than traditional petrol-powered cars, and can produce lower emissions under certain driving conditions.

When operating in electric mode, PHEVs produce no emissions at the point of use, as the electricity used to power the vehicle is typically generated from a power plant. (US department of Energy, n.d.) But if the electricity required to recharge the batteries is produced using fossil fuels like coal or natural gas,, it can result in significant emissions of greenhouse gasses, including carbon dioxide (CO2) (Hall, 2018). On the other hand, the emissions related to charging the batteries can be greatly reduced or even eliminated if the electricity is produced using renewable resources, such solar or wind energy.

In gasoline mode, PHEVs emit carbon dioxide (CO2), nitrogen oxides (NOx), and particulate matter (PM), which are identical to those of conventional gasoline-powered vehicles. (Ehrenberger & Konrad, 2022) The emissions produced in petrol mode will depend on the efficiency of the petrol engine and the driving conditions.

Different Gasses in the Emission of Vehicles

Gasses of several varieties are released by gasoline-powered automobiles. They release hydrofluorocarbons (HFCs), nitrous oxide (N2O), and methane (CH4) from leaking air conditioners. In 2023, the US Environmental Protection AgencyIn addition, there are emissions of carbon dioxide (CO2) from the tailpipe. Although these gases produce fewer emissions than CO2, they still have a significant impact since they have a higher global warming potential (GWP) than CO2.

An average passenger vehicle produces 4.6 metric tonnes of carbon dioxide each year(Environmental Protection Agency, 2023). This is based on the assumption that the typical gasoline car on the road today gets roughly 22.0 miles per gallon and travels about 11,500 miles annually. 8,887 grams of carbon dioxide are produced for every gallon of fuel used. (EPA)

A typical American passenger car with an internal combustion engine generates 0.016 grams of methane per mile, or 0.0000353 pounds of methane gas each mile, according to the EPA, while averaging 23.4 miles per gallon in fuel efficiency. (Environmental Protection Agency, 2023). For passenger cars made in 2009 or after, the EPA estimates nitrous oxide

emissions from ICE vehicles burning regular petrol at 0.0036 grams per mile or 7.94 X 10-6 pounds per mile. (Environmental Protection Agency, 2023)

Electric vehicles (EVs) don't emit any exhaust. A fuel cell car running on hydrogen will only emit water vapor. (US department of energy AFDC (FCEV's), n.d.). Carbon dioxide (CO2), nitrogen oxides (NOx), and particulate matter (PM) are all emissions from PHEVs operating in gasoline mode.

Policy on Emissions–Paris Climate Agreement

Because of the imminent threat posed by climate change, countries have established a variety of regulations to limit their nation's emissions of greenhouse gases. The countries which need to rarity the highest percentage of GHG emissions are China(20%), USA(17.8%), Russia(7.53%), India(4.1%) and Japan(3.79%) respectively.

As a result, the UN established the Paris Climate Agreement. The Paris Climate Agreement, also known as the United Nations Framework Convention on Climate Change (UNFCCC), was signed in 2015 by more than 190 countries in an effort to reduce greenhouse gas emissions and mitigate the effects of climate change. n.d. (United Nations Climate Change). The agreement establishes a framework for countries to act in order to keep global warming well below 2 degrees Celsius and to explore steps to keep it to 1.5 degrees Celsius.

Several objectives and targets for lowering greenhouse gas emissions are outlined in the Paris Climate Agreement, including:
- Increasing nations' capacity to adapt to the effects of climate change
- Making financial flows adhere to a course that will result in minimal greenhouse gas emissions and development that is climate-resilient
- Facilitating the transition to renewable energy sources
- Enhancing the removal of greenhouse gases from the atmosphere

According to the Paris climate agreement by 2030, at least 20% of all road transport vehicles must be powered by electricity, although currently electric vehicles only have a 1% global market share (International Energy Agency, 2021). According to IEA modelling, sales of electric cars, such as fuel cell, plug-in hybrid, and battery-electric vehicles, must account for 35% of global sales by 2030.

Although many people are disappointed with the Paris climate agreement as according to the New York times prior to this week's United Nations climate meeting, data from the independent research group Climate Action Tracker reveals that none of the world's four largest emitters—China, United States, European Union, and India—have reduced their emissions sufficiently to meet the Paris Agreement's goals. (Popovich, 2022)

India's present policies and activities, according to the Climate Action Tracker, are "insufficient" in comparison to its fair share contribution. This is due to the fact that India's second NDC (Nationally Determined Contribution) strengthened its targets on paper, but will not drive real world emission reductions beyond its current level of climate action. Significant improvements are needed for India's climate policies and actions to be in line with the 1.5°C temperature target in 2030. Global warming would exceed 2°C and potentially even approach 3°C if other countries adopted India's strategy.

According to the Climate Action Tracker, if current policies continue, India's emissions in 2030 will be between 4.1 and 4.3 GtCO2e (Climate Action Tracker, 2022). This estimate exceeds our prediction from the previous year by 219–234 MtCO2e. This significant change in carbon emissions is mostly attributable to the fact that the Indian economy has begun to recover from its COVID-19 lows, which has led to a surge in energy demand, particularly in the industrial sector. (Climate Action Tracker, 2022)

China's economy was originally shut down by the COVID-19 epidemic in 2020, with carbon-intensive industries like chemicals, iron and steel, food and beverage production, cement and concrete, and forest goods suffering the most (Climate Action Tracker, 2022). However, with an upswing in heavy industry and construction activities, the economy quickly rebounded.

The nation expects an additional 30 GW of coal-fired power plant installation by year's end, bringing the total to 1140 GW, and an additional 180 GW by 2030 (from levels in 2020), which will result in an increase in power consumption in China of 5% to 6% in 2022 (CEC, 2021).

In fact the interesting thing is that the most powerful and biggest countries in the world are not able to meet it while smaller, more underdeveloped countries are countries such as Nigeria, Ethiopia, Morocco, Gambia and Kenya as well as Costa Rica and Nepal.

Indian Policies to encourage adoption of electric cars

In order to encourage the use of electric cars (EVs) and the growth of the electric vehicle industry, the Indian government has created a variety of laws and incentives. Some examples of these policies include:

1. FAME India (Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles in India): This program offers financial assistance for the purchase and usage of EVs, including electric two-wheelers, electric three-wheelers, and electric buses. The program also supports R&D for EVs and associated parts, as well as the development of charging infrastructure and technologies.

2. National Electric Mobility Mission Plan (NEMMP) 2020: This plan aims to accelerate the deployment of electric vehicles in India and make EVs a viable alternative to petrol-powered vehicles. The plan includes targets for the number of EVs to be deployed in different sectors, as well as incentives for the purchase and use of EVs.

3. GST (Goods and Services Tax) rate reduction: The GST rate for EVs has been reduced to 5%, compared to 28% for petrol-powered vehicles, in order to make EVs more affordable for consumers.
4. Income tax benefits: The Indian government has introduced income tax benefits for individuals and businesses that purchase EVs, in order to encourage the adoption of these vehicles.
5. State-level incentives: Some states in India have implemented their own policies and incentives to promote the adoption of EVs, including subsidies and tax breaks for EV buyers and support for charging infrastructure development.

Overall, the Indian government has taken a number of steps to promote the adoption of EVs and encourage the development of the electric vehicle industry in the country. These efforts are part of a broader push to reduce greenhouse gas emissions and address the challenges of climate change. A very good example of this is the Norwegian government, which offers tax benefits for electric vehicles and a 25% levy on cars that run on fossil fuels (Norsk elbilforening, n.d.). Because of this 86% of cars are electric in norway. (Carlier, 2022)

Impact of Petrol Cars on Climate Change

As mentioned before petrol cars have many ways in which they impact climate change. Including tailpipe and manufacturing emissions. Which include carbon dioxide (CO2), nitrogen oxides (NOx), and particulate matter (PM).These emissions contribute to the warming of the Earth's atmosphere and are a major driver of climate change.

The Intergovernmental Panel on Climate Change (IPCC) claims that road transportation is a considerable contributor to the transportation sector's overall greenhouse gas emissions. In actuality, after the energy industry, road transportation is the second largest global producer of CO2 emissions.

Electric Vehicles as Substitute for Petrol Cars

Electric vehicles (EVs) are increasingly being seen as a substitute for traditional petrol-powered cars, as they offer a number of advantages over these vehicles in terms of their environmental impact and operating costs. Some of the key advantages of EVs including Zero emissions at point of use, Reduced operating costs, Better Performance and Range Increase over the years.

Zero Emissions at the Point of Use : EVs produce zero emissions at the point of use, as they are powered solely by electricity. This makes them a cleaner and more sustainable alternative to petrol-powered cars (Environmental Protection Agency, 2023). One type of tech they use for this is called Regenerative Braking. EVs often employ regenerative braking systems that capture and store energy during braking, increasing energy efficiency and reducing wear on traditional friction brakes. (Tires Plus, 2022)

Reduced operational expenses since electric vehicles (EVs) often have lower operating costs than gasoline-powered vehicles because they need less maintenance and have cheaper fuel.

In addition, many governments offer financial incentives and tax breaks for the purchase and use of EVs(Like Norway), which can further reduce their operating costs. A reason why they have reduced costs is because they have fewer moving parts compared to internal combustion engine (ICE) vehicles, resulting in lower maintenance requirements and costs. Their Performance is also exceptional, EVs can offer quick acceleration and smooth, quiet operation, as well as a smooth and comfortable ride. (Wallbox, n.d.)

Range: With several models now capable of traveling more than 300 miles on a single charge, the range of EVs has dramatically increased in recent years. It is crucial to remember that the size of the battery, the weather outdoors, and the age of the vehicle are just a few of the factors that will affect the range of an EV.

Overall, EVs offer a number of advantages over traditional petrol-powered cars, including reduced emissions and operating costs, quiet operation, and improved performance and range. Because of these aspects, EVs are becoming a more appealing solution for customers and legislators who want to cut greenhouse gas emissions and combat the effects of climate change.

Although Ev's do have the disadvantage of emissions produced in battery manufacturing, luckily studies show that debt related to life cycle emissions from battery manufacture is swiftly repaid. The increased emissions produced during the manufacturing process of an electric vehicle are offset after only two years of driving compared to an average conventional vehicle (Hall, 2018); The repayment duration is shortened to around 1.5 years if the car is powered by renewable energy. The electricity utilized in their manufacturing accounts for around half of the pollutants that batteries produce. According to estimates, roughly 25% of an electric car's lifetime emissions are attributable to battery production, which is comparable to the output of the typical internal combustion engine vehicle. However, there has been a 10-fold variation in recent estimates of emissions from battery manufacture, underscoring the need for more research in this area.

Hybrid cars as a substitute

Hybrid vehicles are a type of vehicle that combines an electric drivetrain with a traditional petrol-powered engine. These vehicles can switch between electric and petrol modes depending on the driving conditions, and are designed to be more efficient than traditional petrol-powered cars.

Hybrid vehicles are often seen as a substitute for traditional petrol-powered cars, as they offer many of the same benefits as electric vehicles (EVs) in terms of fuel efficiency and emissions. However, it's crucial to remember that hybrid cars cannot fully replace electric vehicles, as they still rely on a traditional petrol-powered engine and do produce emissions. They may not be a direct substitute of Ev's but they do serve as an alternative for people who want to do the environmentally right thing but may have very few charging stations in their country. (Acko, 2023)

Some of the key advantages of hybrid vehicles compared to traditional petrol-powered cars include:

- Improved fuel efficiency: Generally speaking, hybrid automobiles are more fuel efficient than conventional gasoline-powered vehicles, as they can switch between electric and petrol modes depending on the driving conditions. This can result in significant fuel savings for drivers. (Tyagi, 2023)
- Reduced emissions: Hybrid vehicles produce lower emissions than traditional petrol-powered cars, as they rely on the electric drivetrain for a portion of their power. The efficiency of the petrol engine as well as the source of the electricity needed to charge the batteries will both affect how much pollution hybrid vehicles emit. (Ghosh, n.d.)
- Reduced operating costs: Due to their increased fuel efficiency and lowered maintenance needs, hybrid vehicles often have lower operating expenses than conventional petrol-powered cars. (Tyagi, 2023)

Overall, hybrid vehicles offer many of the same advantages as EVs in terms of fuel efficiency and emissions, and can be an attractive alternative for consumers looking to reduce their environmental impact and operating costs. However, it is important to consider the full lifecycle emissions of hybrid vehicles, including both direct emissions from the vehicle during operation and indirect emissions from the production of the vehicle.

Battery Life

These emissions are significant even if the environmental advantages of electric cars throughout their whole lives surpass those of battery manufacture.

Manufacturing of batteries depends on countries' grids, in different countries different amounts of carbon emissions are produced.

As mentioned before a study that happened in 2017 says that battery manufacturing produces 56 kg CO2e/kWh. Which is lower than what other studies state. This is primarily because of where the battery manufacturing occurs. (Romare & Dahllöf, 2017) This is Because the 30 kWh battery is made in the European Union, its GHG emissions are lower. This is because the grid is mostly decarbonized in the European union. According to a 2017 research by Romare & Dahllöf, manufacturing energy accounts for at least 50% of the emissions produced by batteries over their entire life cycle, with battery production emissions ranging from 150 to 200 kg CO2e/kWh. This assumes that the battery was made in Asia.(Romare & Dahllöf, 2017)

There are many ways to mitigate the risk :
- Grid decarbonization : Batteries would be cleaner if more renewable energy was used and more efficient power plants were built, as the electricity required in the manufacturing process accounts for nearly half of the emissions related to battery manufacture. By 2030, it's projected that in most markets where fossil fuel burning is still prevalent, the carbon intensity of electricity will have decreased by more than 30%. 6 By 2030, emissions from battery manufacture will have decreased by roughly 17% as a result of the global power grids being decarbonized by an average of about 30%. The greenhouse gas emissions

linked to the manufacturing of metals like aluminum will also be decreased by lowering grid emissions. (Hall, 2018)

- Recycling batteries : With the growth of the market for electric vehicles, battery recycling will become simpler. The materials used in the production of batteries are responsible for around half of the greenhouse gas emissions, and recycled resources often have a smaller carbon footprint than equivalent raw materials. Recycling aluminum reduces greenhouse gas emissions by around 95% in comparison to producing aluminum from natural sources. (Hall, 2018)

Engine Manufacturing

The emissions created during the manufacturing of electric vehicle (EV) engines will depend on a variety of factors, including the materials used, the energy source used to power the manufacturing process, and the efficiency of the manufacturing process itself.

Generally, the production of EV engines is associated with the emission of greenhouse gasses, including carbon dioxide ($CO2$), together with additional air pollutants. These emissions may be produced throughout the manufacturing process when fossil fuels are employed, as well as during the extraction, shipping, and processing of the raw materials used to make EV engines.

The emissions created during the production of EV engines are typically significantly higher than the emissions produced by the vehicles during their lifetime.intensive battery manufacturing means that building a new EV can produce around 80% more emissions than building a comparable gas-powered car (MIT climate Portal, 2022). However, it is important to consider the full lifecycle emissions of EVs, including both the emissions from manufacturing and the emissions produced during the operation of the vehicle. This can give us a more thorough grasp of how EVs affect the environment.

To reduce the emissions associated with the production of EV engines, it is important to adopt more efficient manufacturing processes and use renewable energy sources to power the manufacturing process. In addition, using materials with a lower environmental impact and recycling materials can also help to reduce the emissions associated with the production of EV engines.

Sustainable Alternative solutions

There are a number of sustainable alternative solutions that can be used to power electric vehicles (EVs), including:

Renewable energy: One of the most sustainable alternatives to fossil fuels is renewable energy. This includes renewable energy sources like solar, wind, and hydroelectric power that don't emit greenhouse gases. By using renewable energy to power EVs, it is possible to significantly reduce the environmental impact of transportation.

Biofuels: Biofuels are fuels that are produced from renewable plant materials or waste products. Some common biofuels include ethanol, biodiesel, and biogas. Biofuels can be used to power EVs, and have the advantage of being renewable and having a lower carbon footprint than

fossil fuels.

Hydrogen fuel cells: Using hydrogen gas as a fuel, Electricity is produced by a chemical reaction in hydrogen fuel cells. Hydrogen fuel cells are an environmentally friendly and long-lasting replacement for fossil fuels because the only waste product of this process is water. It is crucial to remember that greenhouse gases are released during the generation of hydrogen fuel, and that many locations lack the infrastructure needed for hydrogen fuel cell vehicles.

Overall, there are a number of sustainable alternative solutions that can be used to power EVs, including renewable energy, biofuels, and hydrogen fuel cells. By adopting these alternatives, it is possible to significantly reduce the environmental impact of transportation and transition to a future that is more sustainable.

Conclusion

This study's objective was to compare the greenhouse gas emissions created by Petrol cars, Electric cars and hybrids. The study also then looks at the factors that lead to emissions in Electric cars and hybrids and the possible ways of reducing it. In today's world this topic holds a lot of importance as climate change has become a very prevalent issue. Majority of all developed countries are far away from meeting the Paris agreement,for example the UK, USA, India and the EU. According to the scientific american most of these countries are roughly 7 years off the target, and reducing CO2 emissions which could have substantial negative effects on the planet. Due to this it is important that people make the switch from petrol to electric or hybrid vehicles as it can help reduce CO2 emissions significantly. Another alternative to buying an electric car could just be to stop using private transport and rely more on public transport like metro, buses etc. Most people are under the impression that electric vehicles don't have any emission and that purchasing them will in turn produce no CO2. This study looks into what emissions are produced by vehicles from different sources and how electric cars and hybrids can be used as a substitute. It has also looked into how we can make changes to engineer manufacturing and battery manufacturing in order to reduce CO2 emissions such as grid decarbonisation and reusing batteries. The paper also discusses how purchasing an electric vehicle is actually inefficient if it is not utilised for at least two years because it takes that many years to make up for emissions emitted during manufacturing.

There are few common criticisms of electric cars, often the criticism is that the Battery lifespan is very short. This is because lithium-ion battery packs lose a little portion of their overall capacity with each charge cycle. These incremental reductions in the battery pack's maximum capacity gradually reduce an EV's overall driving range (McAleer, 2022). The cost of replacing the battery can be significant and so it is not efficient to buy an electric car, but what this argument fails to take into account is how battery technology has advanced significantly over the years. Over time technology will adapt and batteries will become more efficient and till then a way to reduce the cost of batteries could be to recycle batteries.In this field a way to make batteries more efficient would be by researching more into battery chemistry, improving electrode materials and enhancing thermal management. All the other common criticisms have to

do with how there are limited charging stations and limited options, but fail to take into account that as more people start buying electric cars this infrastructure will also develop. In America and Countries part of the European union this is already happening thanks to companies like Tesla and Efacec.

The study's findings make it abundantly evident that electric automobiles emit much fewer emissions than gasoline-powered vehicles. This can be accomplished by promoting the use of renewable energy to power these vehicles and by making investments in the construction of new infrastructure, such as charging stations. To make electric vehicles more accessible and effective, e top priority should be given to the research and development of new battery technology. By switching to electric or hybrid vehicles, we can drastically lower our carbon footprint and contribute to the fight against climate change.

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Social Media Superstar Firms' Content Management and Distribution: A Critical Stakeholder Analysis By Peifeier Wang (Michelle)

Abstract

Following the dawn of the internet, the evolution of social networks facilitated new models of communication. As social networks matured, a few leading companies emerged as dominant players with massive user bases and began to seek profitability. Previous works in this field focused either on these companies' potential exploitation of end users or on the technical development of the platforms themselves. This article aims to discuss the optimal relationship between companies and different stakeholders on social media platforms. What does it look like to ensure a social media platform can enable a good user experience, publish legal and ethical content, and remain profitable? First, this article recounts the shifting power dynamics in the evolution of social media networks over time. It then analyzes two pivotal dimensions of responsible information curation -- symmetric and diverse information as well as accurate and proportional information -- from the users', firms', and the United States government's perspectives. Finally, solutions are proposed to balance user experience, legality and ethics, and profitability, to address what this author believes is an urgent, global-scale challenge. This infectious spread of undesirable content drives deep, widespread harmful information. This article addresses collective user dissatisfaction, considering perspectives on behalf of different stakeholders and urging social media platforms to change.

Introduction

For the purposes of this article, social media is defined as any digital platform (website, app, etc.) that connects users and facilitates online interaction. Social media platforms evolved, the author proposes, in three important stages: First, on completely decentralized platforms; Second, on partially user-facilitated platforms; Third, on 100%-company controlled platforms.

Many state that the first social media platform was SixDegrees, founded in 1995 (Britannica "SixDegrees.com: American Company"). However, this author argues that the modality of social networking was first seen in the 1970s on Usenet.

Usenet was a completely self-regulated social networking website, with its most prominent feature being Newsgroup. Usenet gained popularity quickly, forming more than 120,000 newsgroups before the year 2010. (Duke Today) Despite its success amongst users, as seen in Figure 1 (Savolainen) due to its anonymous user accounts, hard-to-track NPS file protocol, and internet protocol, Usenet became a petri dish for pornography and pirated content (See appendix A) (Daniels).

Although the government tried to regulate Usenet, fines and restricting local servers were not effective due to the lack of a single owner or operating entity. In addition, the decentralized power dynamics of Usenet made it difficult or impossible to identify individual lawbreakers or policy violators. Eventually, Usenet's database was acquired by Google in 2001 and subsequently archived (Google).

This problem of untraceable content was eventually mitigated by the invention of a more centralized content-sharing model, P2P (peer-to-peer), by the social media platform BitTorrent in the 1990s. (Taprial and Kanwar) A tracker acted as an intermediary forof information transfer, recording pieces of information about the host, sender and tracker (as shown in figure 1). Under the stress of governmental regulations, the power dynamics controlling the platform were more centralized, making it easier to regulate. (See appendix B)
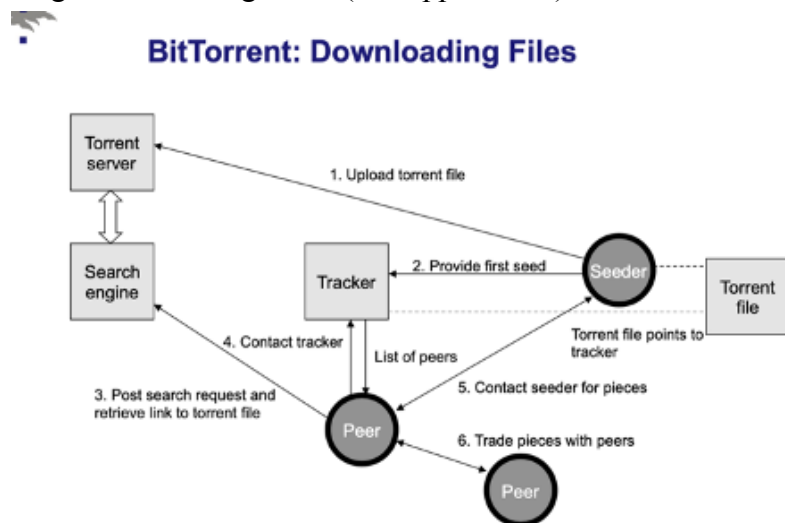

Figure 1: The model of downloading file on BitTorrent

Other forms of power-centralized platforms include message boards, where different regulated servers control different platform domains. However, from the author's point of view these governmental standards on behalf of content transfer are not unified across countries. Transferred content regulation remains an issue in parts of the world today.

A fascinating trend is clear in retrospect. Social networks began as freely available, essentially anonymous virtual gathering forums. However, the freedom that this decentralized model endowed was abused. So government regulation, in the author's opinion, encouraged clear ownership over and control of social networks. The centralization of power solves the long-standing issue of determining content legality through the content auditing system, but also contributes to the loss of anonymity. This influx of users to these social media platforms (Facebook, MySpace, Twitter, and the like), led platform companies to monetize their user bases.

Currently, to access most mainstream social platforms, people must pay an "entrance fee" with their data and time. By signing up, users unconsciously -- unless they read the fine print in onboarding agreement -- permit social media companies to use and process their data for content recommendation and selective ad displays – directly monetizing user attention.

In this author's opinion, users, although they may not realize it, therefore have critical leverage over today's corporate social media giants. Without satisfactory user experience, profit is impossible. But users often don't realize the degree to which their data and posted content is

shared with other users and advertisers. Privacy regulations and policies are confusing or ignored. Government regulators may have a hard time keeping up with the pace of innovation at leading tech firms. Algorithms that determine what content users see are incredibly complex, personalized, and change often. So users become a golden commodity, in a deluge of content. Creating a situation fraught with legal and ethical challenges regarding user privacy, information distribution, and responsible commercialization.

Key Issues – information asymmetry

Social media platforms gradually became an integral part of our daily lives, becoming the primary source of information for billions of people. The analysis below focuses on two dimensions of responsible information curation -- symmetric and diverse information as well as accurate and proportional information -- from multiple stakeholders' perspectives.

Symmetric and diverse information

Despite the large user base of social media platforms, its content often does not represent diverse, nuanced perspectives. This section considers a) how and why non-diverse and asymmetric information is presented to users and b) how that inaccurate and disproportionate information is created and further propagated.

This article defines symmetric information, in the context of social media, as an exact match between what social media companies' intend for their users to receive and what those users actually consume. Diverse information should be delivered from diverse sources, representing diverse opinions. The various mission statements of social media platforms proclaim and aspire to an inclusive atmosphere of equality. Such as Facebook's mission statement "to give people the power to share and make the world more open and connected", emphasizing on the social attribute, while reducing the power hierarchy between different users. However, this is not true. According to the SMC's ("Social Media Council") proposal in the United Nations General Assembly 2018, the recommendation algorithms deciding what content users see create platforms that are neither symmetric nor diverse. (Docquir)

Most social media platforms' recommendation algorithms show popularity bias, favoring content with high initial popularity.(Ciampaglia et al.) See Figure 2 (Gleeson et al.) below, detailing the spread of memes, in which the x axis represents the increment of time and the y axis represents popularity, measured by counting the number of times a particular piece of content is interacted with (read, liked, shared, etc.). This research model analyzes Facebook, Twitter and YouTube. The three graphs below compare the 'virality' of two memes – or how quickly those memes were shared across Facebook, Twitter, and YouTube. The red line represents one meme -- the blue line represents the other. Figure (a) on the top left displays an exponential growth in popularity a short time after both memes are posted. Due to the slight difference in initial popularity between the two memes, in figure (b), the popularity of the meme depicted by the red line grows more quickly. This popularity disparity became more evident in figure (c), after the timeline is extended.

Another critical factor in the 'popularity bias' driving content people see on social media platforms is the popularity of the original 'creator.' The Matthew effect (Kümpel), describes a positive feedback cycle in which popular users, with larger audiences, have more interaction on their posts, and get more popular, whether or not their information matches the intended content standards (beyond clear policy violations) for that particular platform. That makes it especially difficult for unpopular creators' content to be seen. This creates and solidifies the hierarchy of popularity between users, breaking from the idea of equality that the firms promote, and ignoring the value of diverse perspectives. Every iteration of content produced therefore accelerates popularity bias.
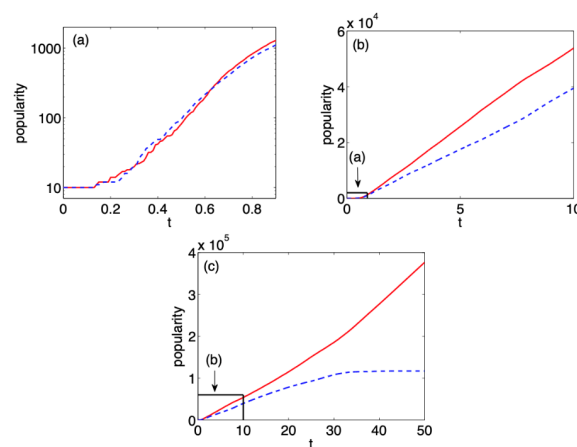
Figure 2: The popularity of two alike memes on social media through a 50h timeframe
Please note that figure (a) is logarithmic.

Current recommendation algorithms are successful, in large part, because of the power of advertisers on social media platforms. If users are interacting with content, advertisers are happy, often regardless of the quality or broader context of that content.

Content advertisers are charged by the platform companies based on the volume of exposure or interaction in an advertisement. Therefore, content advertisement is reliant on the recommendation engine. The more time users spend on the platform, the more opportunity for ad views, and higher social media platform earnings. So, to achieve short-term profit maximization, social media companies tend to optimize recommendation engines for best user attention, which, for better or worse, popularity-biased algorithms do very effectively—at the expense of symmetric information. This attempt to increase the accuracy of the recommendation engine is achieved by the adoption of a popularity-biased model as mentioned above. Secondly, the intrinsic profit model of sponsored content advertising also enhances the Matthew effect. For sponsored content advertising, firms ask certain trend leaders to promote their products by

embedding advertisement content in their personal posts, such as Instagram sponsored-content or Facebook newsfeed posts. The sponsored content advertising creates a direct relationship between creators or influencers' advertising firms' profits. Profits are also often indirectly linked to users' value judgments of the sponsored content. Research in the International Journal of Advertising suggests that participants from ages 19-29 see sponsored or native ads on Facebook as favorable (Youn and Kim). This conclusion is supported by multiple comparative studies between content and native advertising, suggesting that effective native advertising can induce positive user response, increasing user adherence to the platform. Sponsored content relies heavily on influencers or trend-leaders, so platforms have even more incentive to surface influencers' content irrespective of its value or context.

Externally, the unique social media market further enhances the reliance on popularity in the monetization model. The limited potential user-base of the current social media superstar platforms results in the emphasis on user retention rate as a method to sustain their long-term development. Thus, social media platforms further develop their modularity by recommending popular content to users to capture their interest, luring them to endure the boring ads and keep flipping, further enhancing the Matthew effect.

All told, there is a very real risk that social media content is, and will be, guided by a few trend leaders, so diverse voices will be silenced, causing a spread of homogenous information and jeopardizing the promise of symmetric and diverse information.

This model does not match the equality ideology that platforms guided users to believe that their voices are equally heard, causing information asymmetry to form. The threat of information asymmetry is severe as it is a violation of early documents such as the Communications Act of 1934 (47 U.S.C. §230), and the Communications Decency Act of 1996. (Gallo and Cho)

Ironically, the information asymmetry and homogeneity caused by the popularity bias may also decrease user satisfaction over time – putting social media platforms at risk of losing the very users their revenue depends on. This is demonstrated in a study correlating the relationship between quality and popularity of transmissible units of information, "such as music tracks, videos, books, fashion products, or links to news articles", in cultural markets, such as social media. Figure 3 (Ciampaglia et al.) presents the correlation between α, the exploration cost, where a bigger value implies that users are more likely to consider one or more popular items; and β, the probability that an item is selected based on its popularity. <q>, suggests an item's intrinsic quality, the "probability that an item is selected by a user when not exposed to the popularity of the item". As the popularity bias (β) increases, regardless of exploration cost (α), the intrinsic value of content decreases (<q>). (Ciampaglia et al.). This suggests that a more popularity-biased model promotes ill-quality content. The popularity-biased recommendation model not only decreases user satisfaction but is also detrimental to the platform's ecosystem, disincentivizing the production of quality content. While this prevailing theory has been demonstrated in several contexts, other more recent studies challenge its accuracy. An MIT Technology Review published in 2021 suggests that social media firms are constantly improving

their algorithm, allowing the spread of high-quality content, more effectively enhancing user loyalty. (Zhang and Liu)
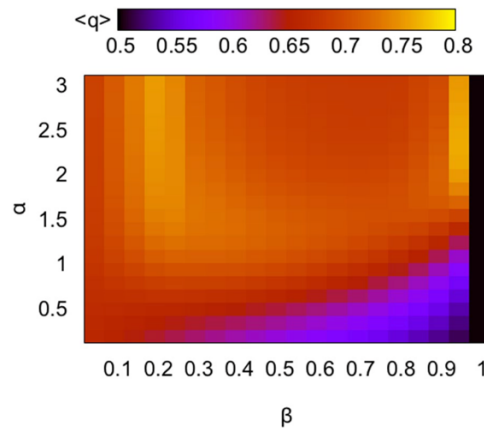

Figure 3: The relationship between popularity bias (β), exploration cost (α), and the intrinsic value of content (<q>)

Accurate and Proportional Information

I define accurate information as information that is factually correct, not being tailored and exaggerated. Proportional information represents multiple opinions regarding the same issue. Critically, those opinions are included proportionately in a post or article reflecting the most representative global understanding of the time. For example, while climate deniers' voices are loud, they represent only a fraction of scientific and popular discourse about climate change.

In the author's opinion, regional governmental regulations (as dictated by the Content Regulation in the Association for Progressive Communications (APC) only underlines the baseline for content regulation. However, social media firms reduce costs by regulating the content spread according to the bare minimum that legislation restrains while having no strict regulations on content accuracy in the auditing process.

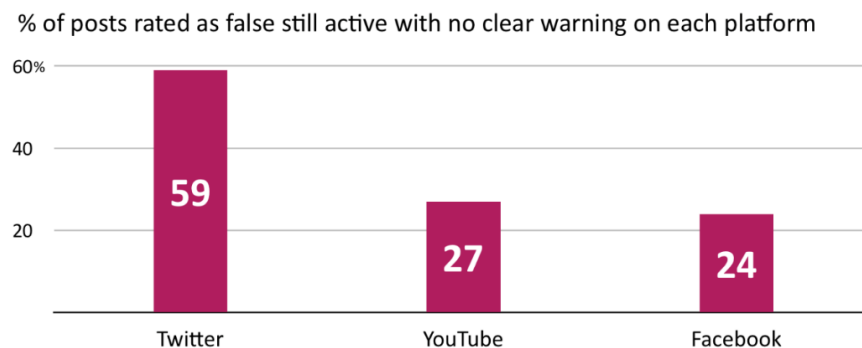## Figure 5: Percentage of active false posts with no direct warning label in our sample

% of posts rated as false still active with no clear warning on each platform

Figure 5 shows the percentage of posts in our sample rated as false that were still active and did not have a clear warning label at the end of March (Twitter: N = 43; YouTube: N= 6; Facebook: N = 33) out of the total number of posts on each platform in the sample (Twitter: N = 73; YouTube: N = 22; FB: N = 137).

378

Figure 4: The percentage of active false posts with no direct warning across different platforms

Misinformation spreads through the same mechanisms that promote non-diverse information: the recommendation algorithm feedback loop. At the initial stage of information production, content producers seem to favor misinformation. A study at Oxford (Figure 4) (Simon et al.) distinctly demonstrates the number of inaccurate posts on social media platforms without clear citations regarding the COVID-19 pandemic. (Simon et al.) The misinformation gains momentum and spreads from there. An MIT study indicates that on Twitter, "false news was 70% more likely to be retweeted than the truth" due to its novelty and emotional appeal (Vosoughi et al.) (Reynolds). The platforms' recommendation engines respond to the likes, comments, and other interaction on these inaccurate posts and will recommend them to even more people, causing a misinformation cascade. This author argues that the long-term effect of perpetuating misinformation on these platforms makes it unlikely that social media companies can be high-quality, accurate, proportional information distributors in the future.

Information Cocoon

A concept called the 'information cocoon' helps explain in further detail why misinformation spreads so quickly and widely on social media. The information cocoon is a psychological concept suggesting that our attention is limited to information passively recommended to people, making them unlikely to voluntarily search for new opinions. A study conducted using the Chinese social media platform Kuaishou (Figure 5(Deng)), with more than 320 million DAU (daily active users, data collected by the end of 2021), presents users' being trapped in the filtered information bubble. The different coloured lines in the data represent users forming different groups during different lengths of interaction, measured in weeks. For example, [4,8) represents users from group 8, with 4 active weeks. From the two figures on the left-hand side, it is clear that as the number of interaction weeks increases the diversity of videos viewed decreases across all user groups. While the two figures on the right-hand side suggest that as the number of interaction weeks increases, the number of video exposure and watches increases across the more homogenous content. This table uses a huge number of statistics, generated by a variety of users, and across a variety of video categories. Showcasing the formation and restriction of an information cocoon in social media.
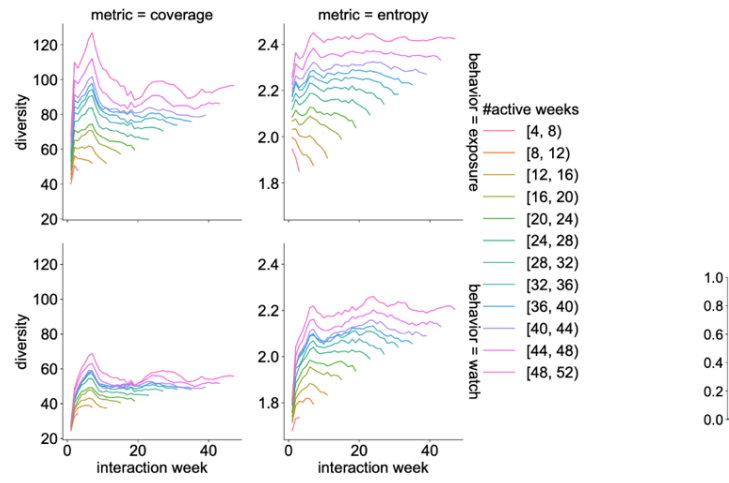
Figure 5: The video viewing diversity of users forming different groups during different lengths of interaction, measured in week on KuaiShou

This information cocoon cannot be easily broken according to the theory of confirmational bias, where supporting information is preferred over conflicting information (Jonas et al.). This abuse of social media platforms also restricts users from getting a real insight, instead leading them to blindly follow the herd mentality. (Duke Today) As the coverage for social media platforms is big, and the targeted age groups move increasingly younger, the information cocoon restricts the value-system's development of a younger generation. This author argues that in the long-term, the impacts of information cocoons will be negatively reflected in society. Thus, it is urgent to change.

Conclusion

Since the launching of the first social media, Usenet, 25 years ago, mindless negotiations between the different stakeholders including the users, controller, and government shaped the landscape. Ultimately, resulting in the general exposure-monetization model today. For this monetization model to persist, the companies compromise between user experience and platform profitability, while conforming to governmental regulations.

However, this long-lasting negotiation is far from finished. This author proposes the following solutions, regarding the two roles that users play in the data monetization cycle, as content publishers and content viewers.

Solutions–Users as Content Publishers

As content publishers, the social media environment should be symmetrical to what the companies' mission statement implies - all user's voices should be heard equitably.

To protect the broad benefit of accurate, proportional information, companies might weigh popularity less heavily in the recommendation algorithm by instead setting an initial exposure rate to the user's content. The author conducted a brief experiment on DouYin (TikTok China), a platform with about 600 million DAU (daily active users) by the end of 2020. (Choudhury) With a new account, the author posted two posts (photo collection and short video) accumulating about 300 views each in 48h. So, the author recommends the initial exposure to about 300-400 hundred people suggested by the recommendation engine, then recommends this content to the market of users and followers according to the initial feedback, while considering platforms' policies and ethical standards.

Users as Content Viewers

As content receivers, the recommendation of content should not be view-point biased, homogenous, or factually incorrect.

As a simple solution to combat disproportionate information could limit recommending content purely based on popularity or alignment with a users' 'information cocoon.' Such information could still be presented, but not consecutively and not repeatedly. Another approach could present the content landing page in a collage format rather than the one-at-a-time scrolling format so prevalent on platforms today. The formatting of the cover page in a collage format could encourage users to actively choose the topic that they are interested in instead of being to articles chosen by the recommendation engine -- effectively breaking the information cocoon. Furthermore, if possible, the platform could spend some computational power on analyzing the constituent of stances within a topic category, then recommend proportional content mimicking the composition of perspectives across the platform to users. However, the platform's culture might be biased. This can be solved by manual arbitrary content checks of the, while using technology to set boundaries on top of current platform regulations, to check for extremist content.

To ensure distribution of factually correct information, a similar system to the content regulation system could be considered. Current social media platforms are equipped with "inaccurate content reporting" functions, while firms such as Facebook and Insta have recently updated their misinformation community standards. However, these tacit mainly focus on mitigating the effect of misinformation made, neglecting the identification of misinformation. Thus, this author suggests the linkage with an information database, utilizing AI factual auditing system ,or a selective manual auditor, could be considered.(Deng; Transparency Center) Alternatively, regarding the massive content overflow of social media platforms, there could be factually correct content that could be certified, and given exposure benefits. It can be done by adding a labelling function to the content produced. Just like the blue checkmark on Twitter, the label is an authorization of the content produced but only applies to specific posts. The content

producer would need to indicate willingness to undergo screening when publishing the video, and the platform would check it accordingly. In addition, counterintuitively, as fake news often receives more attention, an automated check of abnormally popular content could help eliminate fake news. Nonetheless, it must be taken into consideration that the idea of being factually correct can be opinionated, making it hard to identify; factually correct information is wide-spread across all fields, making it hard to regulation; and our current knowledge structure varies with time, increasing the maintenance and updating costs of the factually correct information auditing system. These accumulative difficulties result in the issue of misinformation being underdressed across all social media platforms, prevalent even in online platforms.

Moreover, to enhance the user's experience, a user's recommended content could be updated even more frequently – adjusting the algorithm, potentially even daily, to account for users' changing biases.

Limitations

All the solutions proposed above are intended to improve consumer satisfaction. However, from a company's perspective, the costs and other potential drawbacks of those suggestions must be analyzed.

From an expenditure perspective, the trial-and-error and research and development costs of the suggestions need to be factored in. Especially since there is no guarantee that the modified model can generate sufficient content interaction to drive stable or ideally increased ad revenue. There are too many psychological factors determining the effectiveness of monetization of the model, where increased user satisfaction might not directly translate into more screen time or more profit. The colossal complexity and size of social media platforms enhance the risks analyzed above. Maintenance costs of the modified model should also be considered in the long term.

To propel the change in platform behavior, governmental support could also be adopted. Progressive regulation and a waiting period before policy implementation could be set may help smooth complex transitions – particularly if those mechanisms are combined with performance-based subsidies and a tax reduction scheme.

Outlooks into the Future

In conclusion, by considering the different stakeholder perspectives and nuances of current and proposed potential policy and technical changes, the author was able to explain the aspects of consideration in social media regulation and attempted to establish a clear boundary between reasonable and user abuse in content regulation. The author sincerely hopes that this passage can promote the development of social media regulations, making the rights of each stakeholder defined and ensured. The development of social media should be looked at utilizing a developing lens. Hopefully, in the future, social media can make more of a positive contribution to social welfare.

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The Plans and Mistakes of the Powerful: Charles de Gaulle and Europe by Michael Zhang

"All my life I have thought of France… like the princess of fairy stories… dedicated to an exalted… destiny…[to] *la grandeur*."[17]

The greatness of their plans often defines the politically powerful. Brought into power by political crisis, de Gaulle believed utterly in French grandeur, reflected in his European policy. Through obstinate negotiation, de Gaulle executed his plan to create a tariff-refund system for the Common Agriculture Policy, in the short term unilaterally benefitting France. However, the system could not resolve France's structural inequities long term. Indeed, these plans were inextricably tied to his greatest mistake. Despite his nationalistic ideology, de Gaulle compromised over the creation of the European Council, a decision forced by French farmers to secure the CAP. To have left at that moment would have reduced the role of the EEC and avoided the development of the anti-democratic institutions that today define its successor, the European Union. Because de Gaulle did not commit to his nationalistic ideology, the EEC could fundamentally reshape its executive branch's political structure. His mistakes would have an infinitely greater impact than his best-laid plans. This has proved true for the leaders of the Union itself, positing an iron law for history: our mistakes define us far more than our plans.

A common agricultural policy?

De Gaulle understood that the French economy could be harmed by the cheap import of manufactured goods from Germany and that the direct consequence of this would have been the industrialization and consolidation of agriculture. Understanding these issues not as a necessity but as "a matter of choice for society, and … of concern to all Frenchmen"[18], de Gaulle sought to represent agricultural interests in the gestating EEC. Only subsidies from Germany could finance a modernization program that supported the small scale and diversity of French agricultural goods.[19] Such a change would ultimately "create a better standard of living" for French farmers.[20] Therefore, when negotiating, de Gaulle pursued this policy with his typical stubbornness and brashness.[21]

In the initial discussions in 1961, de Gaulle repeated his threat that the common market "would not continue to develop" without resolving agriculture and even threatened to exit the bloc if a policy was not approved, making it clear both in private and public that it was a *sine non qua*, it was an essential condition. [22, 23] De Gaulle made further geopolitical threats, proposing a radical reconsideration of French political-military policy and shifting alliances

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[17] DeGaulle, *The Complete War Memoirs of Charles de Gaulle*. 1
[18] Alphandéry, Bitoun, and Dupont, *Les champs du départ*. 255
[19] Gaulle, *Memoirs of Hope*.
[20] Gaulle, *Major Addresses, Statements, and Press Conferences, May 19, 1958-January 31, 1964.*
[21] Gaulle, *Memoirs of Hope*. 159
[22] Gaulle, *Memoirs of Hope*. 159
[23] during a meeting with Konrad Adenauer, president of Germany on May 20 1961, Müller-Roschach, *Die Deutsche Europapolitik, 1949-1977*. 105

away from Germany toward the Soviet Union. [24] Forced by the deadline, the other nations began to negotiate, finally establishing on January 14, 1962. [25] Through these threats, one can see precisely how different Europe, without the CAP, might have been.

While pursuing the CAP, de Gaulle was explicit that only an economic union should be formed, not a supranational federation which would curb the power of the national government.[26] De Gaulle preferred a small Europe, with a France, which made independent economic and foreign policy decisions. This conflicted with contemporary proposals for a "genuine supranational executive" with a large degree of autonomy with a Parliament that possesses "real powers over a Community budget."[27] Upon hearing these proposals, De Gaulle left the negotiations in an attempt to protest the increasing power of its bureaucratic organization.[28]

The advantageous political landscape made such a move favorable - CAP was nearly finalized, and a weak government ruled Germany. To de Gaulle, he could "profit from the crisis" by "replacing the Commission with something fundamentally different". [29] Delighted, de Gaulle saw it as a chance to replace the European Commission with something completely different.[30] Key to this was strategic silence - "to keep negotiations moving and to avoid triggering counter demands and obstruction from its allies on economic issues, France must avoid conveying any inkling of its desire to destroy EC institutions."[31] De Gaulle hoped to secure CAP while destroying any hopes for further European integration. It was consistent with his Machiavellian ideology of using other countries while promoting French interests.

Indeed, the approval of the CAP is frequently cited as the "birth" of the EEC precisely because it created an internal market with common prices and a joint fund to enact price support and export remittance protected by tariffs. [32] In his rhetorical fashion, de Gaulle proudly congratulated himself for doing so much work in the fight for agriculture.[33] Indeed, de Gaulle had created the CAP and the foundation for the greater union.

French Farmers

Initially, de Gaulle's plan seemed to achieve its goal, and French farmers benefited enormously. CAP encouraged the increased production of essential agricultural commodities. Without foreign competition, European farmers could sell their products at a higher price domestically and, when exporting, could accept a lower price, which subsidies would top up.

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[24] Peyrefitte, *C'était de Gaulle. 2* pg 231-237; Volker Hentschel, *Ludwig Erhard* pg 541
[25] Hendriks, "Germany and the CAP."
[26] Gaulle, *Major Addresses, Statements, and Press Conferences, May 19, 1958-January 31, 1964*.
[27] Willis, *France, Germany, and the New Europe, 1945-1967*. 343
[28] Etienne Deschamps, Interview with Paul Collowald: the Hallstein Commission and the empty chair crisis.
[29] Peyrefitte, *C'était de Gaulle. 2*. 594 2620
[30] Peyrefitte, *C'était de Gaulle. 2*. 295, 296
[31] As outlined in a secret memorandum sent by Alain Peyrefitte detailing France's European policy. In *Le Général de Gaulle et la construction de l'Europe (1940-1966)*.
[32] Keeler, "De Gaulle and Europe's Common Agricultural Policy: The Logic and Legacies of Nationalistic Integration."
[33] Gaulle, *Memoirs of Hope*. 135

This benefitted France as she had the most extensive arable land and the most significant agriculture workers among the Six. She was most positioned to benefit from a policy that encouraged blatant overproduction, a fact that French farmers were quick to notice an 86% increase in production in the first year CAP was adopted. Decades later, this would create massive inventory bottlenecks of butter and wine, the notorious "wine lakes"[34] and "butter mountains." [35]

TABLE 3. FEOGA, GUARANTEE SECTION: CONTRIBUTIONS AND EXPENDITURE

Accounting year	1962/63		1963/64		1964/65		1965/66		1966/67		1967/68 1968/69
Proportion of total cost of guarantees financed by FEOGA	one sixth		one third		one half		six tenths		seven tenths		ten tenths
Assessment of national contributions	according to the 'key' (Article 200 §1 of Treaty)		90 per cent by the key; 10 per cent by net imports		80 per cent by the key; 20 per cent by net imports		according to agreed scale		according to agreed scale		90 per cent of all levies; balance to agreed scaleᵃ
	Contributions as per cent of total	Drawings as per cent of total	Contributions as per cent of total	Drawings as per cent of total	Contributionsᵇ as per cent of total	Drawings as per cent of total	Contributionsᵇ as per cent of total	Drawingsᵇ as per cent of total	Contributionsᵇ as per cent of total	Drawingsᵇ as per cent of total	
Germany (FR)	28·0	6·3	28·2	4·8	29·3	4·0	31·67	6·76	30·83	7·37	
France	28·0	86·0	25·6	85·3	24·3	67·0	32·58	59·96	29·26	41·62	
Italy	28·0	3·3	28·6	1·3	28·0	6·6	18·00	2·01	22·00	25·95	
Netherlands	7·9	3·4	9·3	7·8	9·7	21·0	9·58	26·84	9·74	20·23	
Belgium	7·9	} 1·1	7·9	} 0·7	8·5	} 1·4	7·95	4·40	7·95	4·80	
Luxemburg	0·2		0·2		0·2		0·22	0·03	0·22	0·03	
	100·0	100·0	100·0	100·0	100·0	100·0	100·00	100·00	100·00	100·00	

ᵃ Germany, 32·2; France, 32·0; Italy, 20·3; Netherlands, 8·2; Belgium, 8·1; Luxemburg, 0·2.
ᵇ Estimated.
Source: *News of the Common Agricultural Policy*, Agricultural Information Division, Brussels, *passim*.

[36]

In the short term, overproduction meant that French agricultural income rose by 50%, at a rate of 4% per year from 1965, outstripping the rest of her European peers. [37] However, from 1973 to 1980, it fell by 15%, while average non-farm incomes increased by 20%. As productivity increased, average income stagnated. [38]

[39]
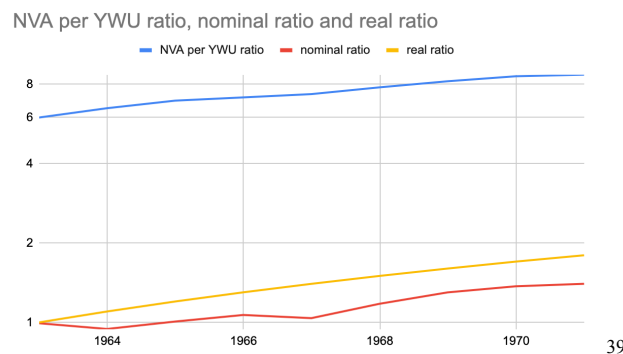
[34] Chrisafis, "Drowning in Europe's Wine Lake."
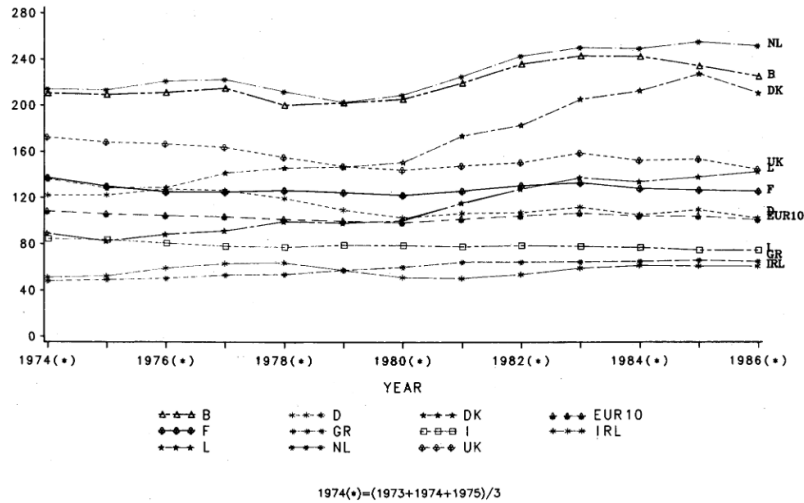[35] Castle, "EU's Butter Mountain Is Back."
[36] Butterwick, *Food, Farming, and the Common Market*.
[37] "GraphAgri 1981 : Annuaire de Graphiques Agricoles | Www.Bnsp.Insee.Fr."
[38] Fund, *The Common Agricultural Policy of the European Community*.
[39] "Agricultural Incomes in the Enlarged Community. Present Situation and Course of Development. Working Document. SEC (73) 900 Final, 7 March 1973."

FIGURE 19: THREE YEAR MOVING AVERAGE OF THE REAL NET VALUE ADDED AT FACTOR COST PER AWU
EUR 10 IN '1980' = 100.0

But the CAP disguised the underlying issue facing 20th-century agriculture - consolidation. While more significant, more productive farmers could purchase the machinery to overproduce and benefit, smaller farmers could only by taking on ruinous debts. The initial boost lasted as long as it did because older French farmers, discouraged by the government, sold their land, increasing the land sizes of smaller farms. Denis Bergmen concludes, "Gross farm income per farm in real terms has risen - mostly because the number of farms among which the cake was divided has fallen."[41]

NIVEAUX DU RBE MOYEN PAR UTAF ET PAR DÉPARTEMENT (optique livraisons) POUR L'ENSEMBLE DES EXPLOITATIONS EN «1986»

"1986" = moyenne des années 1985 à 1987 (en francs 87).
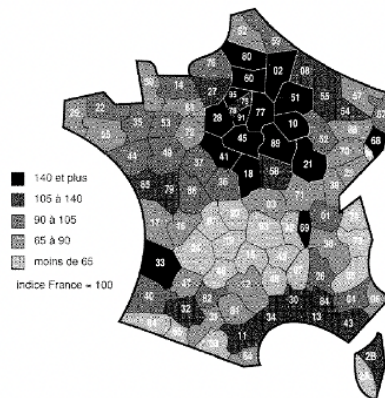
42

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[40] "Agricultural Income 1988."
[41] Bergmann, "French Agriculture."
[42] texte, *GraphAgri Régions 1986*.

To make things worse, French farmers struggled to outproduce the rest of their European peers and took on enormous debts. This is not a French problem; as noted below, low productivity and high leverage were shared concerns for the Six. A ratio below one suggests that the average citizen earned more than an average farmer. French income was highly correlated with the Six's average income; collectively, the Six's farmers earned less than the average population.

Table 5
Indicators of Vulnerability to CAP Liberalization (1986/87)

	FFI/Gross Output	Gross Farm Income/Gross Output	Liabilities/ Total Assets	Liabilities/ Gross Farm Income
EUR 12	25.7%	48.8%	15.3%	118.8%
South	41.9%	59.3%	2.4%	18.0%
Greece	51.5%	70.5%	4.5%	28.3%
Italy	44.3%	60.0%	1.5%	13.7%
Portugal	29.2%	51.2%	3.9%	31.5%
Spain	34.3%	51.6%	1.4%	10.6%
North	19.2%	44.5%	24.8%	178.0%
Belgium	33.0%	48.3%	25.9%	104.2%
Denmark	6.1%	38.0%	44.3%	375.8%
Germany	17.0%	42.4%	23.0%	184.5%
France	20.8%	46.7%	29.2%	183.7%
Ireland	25.5%	44.2%	5.9%	79.8%
Luxembourg	28.0%	48.7%	17.0%	120.2%
Netherlands	19.9%	42.5%	33.4%	234.8%
United Kingdom	13.7%	45.1%	13.5%	112.6%

Source: Computed from Commission of the EC [1990].

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Table 3
Structural Characteristics of Commercial in the EC (1986/87)

	Number of Commercial Farms (1,000)	Percent of all Farms	Average Size of Commercial Farms (ESU)	Average UAA per Farm (Ha)	AWU per Farm (1,000)	Number of Livestock Units per Farm	Input Intensity (ESU)	FFI/FWU (ECU)	Ratio of FFI/FWU to GNP/CAP	Ratio of FFI/FWU to GNP/WM	Fixed Capital per Farm (1,000 ECU)	Land Capital per Farm as Percent of Total Capital	Other Fixed Capital per Farm as Percent of Total Capital
EUR12*	3984	46.1	21.5	24.2	1.57	22.4	0.51	7741	0.67	0.39	120.3	60.9	39.1
South*	2483	40.3	11.3	14.9	1.52	7.3	0.42	6578	0.79	0.47	78.1	74.3	25.7
Greece	528	55.4	7.9	6.3	1.30	4.1	0.32	5009	1.23	0.72	48.9	81.2	18.8
Italy	1108	39.8	14.5	10.5	16.0	6.9	0.41	7637	0.68	0.41	109.5	72.3	27.7
Portugal	262	41.1	8.4	17.0	2.10	8.6	0.49	2670	0.86	0.50	45.8	74.8	25.2
Spain	585	32.7	9.4	30.1	1.29	10.2	0.50	7736	1.18	0.69	59.4	76.1	23.9
North*	1501	60.5	38.5	39.5	1.67	47.4	0.55	9452	0.71	0.43	190.0	51.8	48.2
Belgium	55	59.3	43.2	24.2	1.66	59.6	0.54	18361	1.50	0.92	130.0	38.7	61.3
Denmark	85	98.2	37.2	32.7	1.11	48.9	0.62	6035	0.39	0.23	219.2	21.8	78.2
Germany	374	53.1	33.6	27.9	1.68	43.1	0.61	8712	0.56	0.35	201.6	55.6	44.4
France	596	60.7	32.4	38.5	1.59	33.9	0.51	8112	0.60	0.35	119.4	46.3	53.7
Ireland	145	66.9	14.5	35.2	1.27	39.2	0.51	6020	0.92	0.50	141.7	77.0	23.0
Luxembourg	2	61.3	34.6	47.2	1.73	74.3	0.53	13092	0.69	0.42	195.8	36.1	63.9
Netherlands	95	72.1	70.9	21.4	1.91	79.1	0.56	19918	1.62	1.01	368.5	53.4	46.6
United Kingdom	147	56.5	77.7	98.4	2.54	95.1	0.56	11961	1.10	0.65	384.9	55.5	44.5

Legend: FFI-Farm Family Income, FWU-Family Work Uurt, GNP/WM-Gross National Product per Working Member of Population.
Note: *The weights used for the averages are the number of FADN farms.
Source: Computed from Commission of the EC [1990].

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EC Economic Integration for Agriculture

The CAP had failed. French agriculture had been modernized but largely consolidated. It had failed to improve the standard of living of French farmers relative to their peers. Despite its initial importance to the EEC, its proportion of expenditure has declined progressively. Responding to complaints of high prices and inefficiency, the last vestiges of De Gaulle's bargaining were erased through the MacSharry reform in 1992, which placed a greater emphasis

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[43] Sarris, "Implications of EC Economic Integration for Agriculture, Agricultural Trade, and Trade Policy."

on targeted payments. [44] De Gaulle's plan was unsuccessful. But what would its unintended consequences be?

CAP expenditure in total EU expenditure *(current prices)*

EU, OECD and US PSE

[45]
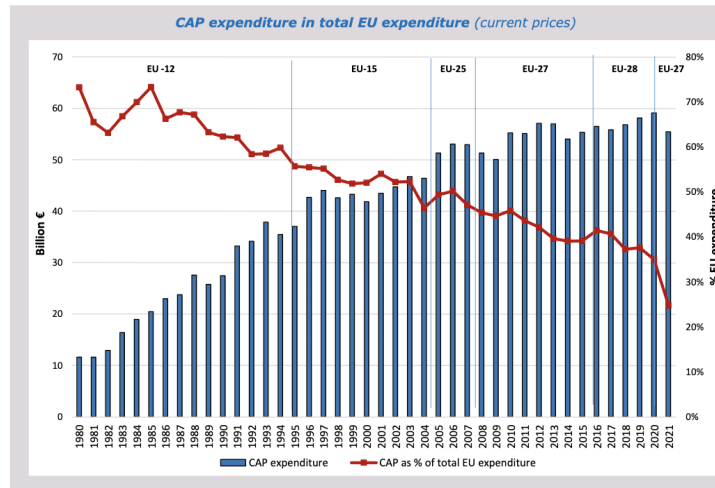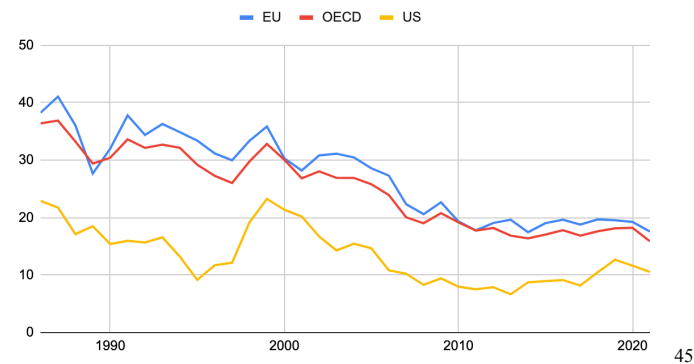
De Gaulle's Mistakes

Taken alone, the CAP, implemented in 1962, seemed to align fully with De Gaulle's ambitions. But in 1965, a crisis over its financing emerged, with de Gaulle boycotting the community meetings in response to increasing proposals for greater union. However, farmers were concerned about the prospect of losing CAP subsidies. In the presidential election of 1966, FNSEA, a large farmers' group, recommended that its five million members vote against de Gaulle. The rural vote swung to Jean Lecanuet, a centrist politician who was pro-European. [46] De Gaulle won in the second round, but by a small margin, which he attributed to opposition from farmers for his decision to jeopardize the EEC. [47] Faced with pressure from his base, De Gaulle

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[44] Cunha and Swinbank, "The 1992 MacSharry Reform."
[45] "Agricultural Policy - Agricultural Support - OECD Data."
[46] Averyt, *Agropolitics in the European Community*. 33
[47] *C'était de Gaulle - Tome II*. 612-613

negotiated with the EEC, compromising by allowing for the establishment of the European Council.[48] Ultimately, "[through the 1966 Luxembourg compromise] both in the rules on majority voting and in preserving the Commission's powers of initiative, the Five saved the nucleus of the supranational state."[49]

Rather than reversing the process of European integration," the establishment of the European Council "actually signifie[d] a wish to extend Community decision-making to new areas in response to changes in national policy objectives arising from the fundamental change in economic circumstances of the western European countries after 1965." [50]

Despite his plans, the consequence of the CAP was further integration. The current organization of the EU should be seen as an undemocratic consequence of de Gaulle's mistakes.

The European Union's Democratic Deficit

Dahl characterizes a democratic institution through its ability to fulfill two criteria: "the extent of permissible opposition" and "the breadth of the right to participate in public contestation." [51]With these criteria, Dahl created the famous Dahl box.
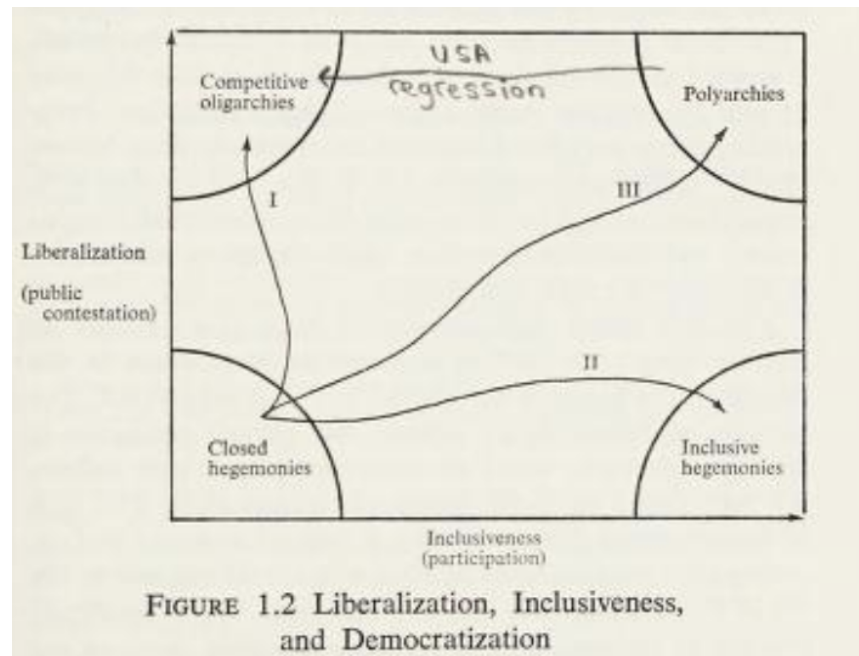

FIGURE 1.2 Liberalization, Inclusiveness, and Democratization

The EU fails in the first category as there is little space for organized opposition within the system, and instead, national governments and civil servants have dominated decision-making.[52] Despite attempts at reform of the European Parliament and the role of federal

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[48] Virieu, *La Fin D'une Agriculture; Bilan de La Ve Republique*.
[49] Willis, *France, Germany, and the New Europe, 1945-1967*. Pg 350
[50] FØRLAND, "Autonomy-Community-Suzerainty."
[51] Dahl, *Polyarchy; Participation and Opposition*.
[52] Mair, "Political Opposition and the European Union."

governments in the Council, the Union has a "low level of parliamentarization, especially regarding national policy formulation on European matters."
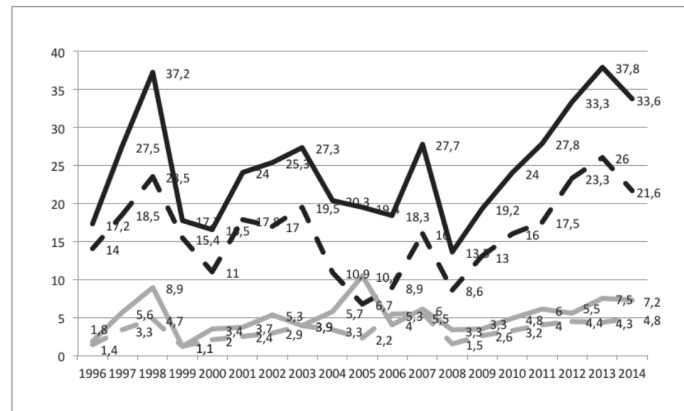
European integration has meant a decrease in the power of sovereign parliaments and an increase in the power of the European Commission. Consequently, this meant fewer mechanisms to regulate the power of the executive branch overall.

Figure 6. Percentage of acts adopted at first reading (1999-2014)[17]
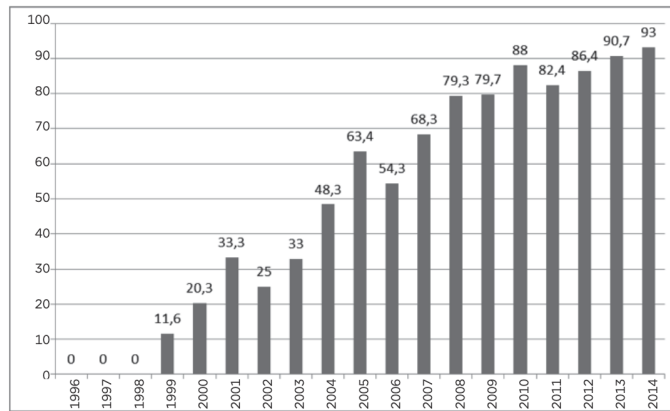
53

Figure 3. Size of the minority in the Council (1996-2014)[12]

Legend :

— All opp. and abs.
- - - 1 MS
— 2 MS
- - - More than 2 MS

54

[53] Dehousse et al., "L'Observatory of European Institutions."
[54] Dehousse et al.

# PublicVote: Publicization of Member State's votes in the Council	
Information	[Type= discrete] [Format=numeric] [Range= 1-2] [Missing=*]
Statistics [NW/ W]	[Valid=3325 /-] [Invalid=0 /-]
Notes	The variable is retrieved from either the "Monthly Summary of Council Acts" or the "Council Minutes".

Value	Label	Cases	Percentage
1	Vote made public	647	19.5%
2	Vote not made public	2678	80.5%

Warning: these figures indicate the number of cases found in the data file. They cannot be interpreted as summary statistics of the population of interest.

[55]

Despite the absence of public contestation, the EU does allow participation, making Europe an inclusive hegemony. The problem, however, is that it has little impact.[56] Consider the lack of democratic guardrails involved in the recent election of the Commission President.

In 2019, the President was supposed to be determined by the parliament. Political groups put forward lead candidates for Commission President ahead of the election. Voters would have a clear choice, with the candidate who was able to garner a majority in the European Parliament getting the job. MEPs were explicit that they would reject anyone nominated by the European Council who was not a *Spitzenkandidat* during the campaign.[57] When the time came, this was ignored. Von der Leyen, who did not participate in the elections, became president of the European Commission. Even in her native Germany, 56% of voters opposed her nomination. [58] In such a system, how does one's vote matter? How does one hold officials accountable?

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[55] Bendjaballah, Dehousse, and Michaud, "The European Union Legislative Output (1996-2014)."
[56] "Towards a Genuine European Executive Power: From Governance to Government."
[57] "Institutional War."
[58] "Most Germans Skeptical of Ursula von Der Leyen"; Oltermann, "'Not the Best Candidate.'"

QA17ab In your opinion, what are the reasons for which people vote in the European elections? Firstly? And then?
(%)

		It is their duty as citizens		They want to change things by voting in the European elections		They want to influence who becomes next President of the European Commission		They want to express their discontent		They want to support the (NATIONALITY) government		They want to express dissatisfaction with the (NATIONALITY) government	
		March 2023	Diff. March 2023 - Oct/Nov 2022	March 2023	Diff. March 2023 - Oct/Nov 2022	March 2023	Diff. March 2023 - Oct/Nov 2022	March 2023	Diff. March 2023 - Oct/Nov 2022	March 2023	Diff. March 2023 - Oct/Nov 2022	March 2023	Diff. March 2023 - Oct/Nov 2022
EU27		38	1	29	0	10	-1	21	-2	16	0	11	0
BE		49	4	28	-2	11	-1	25	-2	13	1	14	-1
BG		29	2	29	-2	9	-1	10	-4	10	-2	8	0
CZ		17	-7	32	1	7	-1	19	1	13	-3	10	2
DK		49	-4	26	-5	10	0	14	0	14	-5	4	1
DE		35	3	33	2	11	-2	20	-3	19	-1	10	1
EE		38	3	29	1	8	2	15	2	16	3	6	1
IE		42	-3	26	-1	10	0	16	-2	22	2	8	0
EL		33	-3	37	0	10	2	16	-7	23	4	13	-2
ES		41	-3	26	4	11	5	21	0	12	0	7	-2
FR		44	2	22	0	8	-1	31	-4	12	0	14	-1
HR		38	-2	29	1	13	3	23	-1	10	-3	15	-3
IT		39	0	31	-1	13	1	22	-4	21	-1	10	0
CY		52	3	34	15	4	-3	11	-2	17	1	4	-2
LV		51	5	38	4	6	0	17	5	21	2	11	2
LT		61	10	27	0	3	-2	8	-2	17	-1	4	-2
LU		51	13	25	-1	7	-3	23	6	14	-1	5	-1
HU		33	3	27	1	15	0	14	-1	17	-3	14	0
MT		34	7	23	-3	5	-10	12	-2	26	-2	10	-4
NL		45	3	48	5	7	-3	31	3	9	-1	10	0
AT		32	3	29	-2	20	-4	19	-1	21	1	14	0
PL		27	4	21	-3	12	-1	14	1	14	-1	13	-1
PT		41	-8	21	3	13	1	13	-2	28	3	8	1
RO		37	8	25	-2	11	0	20	-2	16	0	13	1
SI		37	2	22	-1	8	-1	15	0	17	2	7	-2
SK		27	7	29	-2	9	-1	19	-2	11	-2	10	-3
FI		35	-3	43	5	3	0	15	2	15	2	4	0
SE		37	-8	51	2	5	-1	22	5	9	-1	6	2

[59]

Consequently, through executive collusion, neoliberal policies such as the single market, common agriculture policy, and EMU were passed, even when these policies were to the right of the domestic status quo. This "policy drift" can happen as the executive branch is less pressured than the domestic government. [60]

De Gaulle's mistake led to the silent loss of democratic freedom. Reform is impossible in a system where the institutions that benefit are those with powers. Despite increases in voter discontent and Euroscepticism, the executive looks likely to continue unabashed. [61]

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[59] "EP Spring 2023 Survey: Democracy in Action - One Year before the European Elections - June 2023 - - Eurobarometer Survey."
[60] Scharpf, "Economic Integration, Democracy and the Welfare State."
[61] "A Federalist Rescue of Sovereignty as a Response to Populism and Euroscepticism on JSTOR."

Conclusion

  The powerful are often held on a pedestal and praised for their intellectual capabilities. By looking at Charles de Gaulle's European policy, it becomes clear that the powerful do not have complete control over the effects of policy. They must compete with other powerful actors to push their chosen domestic or international policy. Policies can be readily substituted even shortly after their implementation - as de Gaulle was forced to do, following the shifting of his political support. As we saw by looking at the impact on farmers, the effects of the policy are difficult to forecast - in fact, Europe is probably worse off thanks to the CAP. Few foresaw, for instance, the implementation of a neoliberal agenda through the European Economic Community as a likely outcome, yet we have seen this happen. We live, instead, in a world where the mistakes of the powerful define our lives.

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The Stolen Babies of the Spanish Civil War By Valentina Casas-Sayek

"Forget Your Baby"

The Spanish Civil War was a prelude to the Second World War. On July 17, 1936, Generals Emilio Mola and Francisco Franco orchestrated a military revolt against the Republican government to overthrow the country's elected representatives. The division in Spanish society and politics had developed over the previous decades. On one side were the Nationalists, comprised primarily by the Catholic Church, prominent military figures, landowners, and businessmen. They were supported by Fascist Italy and Nazi Germany.[1] On the other side were the leftists or "Republicans", comprised of urban workers, agricultural laborers, and some of the educated middle class. The Republicans were backed by the Soviet Union and the Mexican government.[2] The Spanish Civil War ended on March 28, 1939, with the Republicans' surrender. This surrender led to Franco ruling for the next 40 years until his death in 1975. Ruling as a tyrant, his despotic reign isolated Spain diplomatically and caused internal turmoil.

One of the greatest horrors during Franco's regime was the stealing of babies. Antonio Valleja-Nájera, a psychologist at Franco's service, formulated an idea similar to the Nazi Germany's concept of the creation of a superior race.[3] Instead of setting up something like Adolf Hitler's Lebensborn, a project designed for women to give birth to a superior race, he decided to steal children from families that could potentially pass the 'red gene' (the impure gene of republican parents and those who opposed Franco) along.[4] He used the people's trust against them. From the beginning, Spanish people were taught to trust people in uniforms and the Church. However, their faith was exploited by doctors, nurses, priests, nuns, government leaders, and bureaucrats. This tore families apart. People suspected of not supporting Franco's Nationalist forces or people who could not defend themselves were targeted. All parents whose children were stolen told the same story. Seconds after childbirth, targeted parents were informed that their child had died. They were told that their babies had already been baptized and buried, so parents were not allowed to see the bodies. What actually happened to these babies was that they were placed for adoption and 'redistributed' to 'better suited' parents. Only in the early 2000, almost 7 decades after the Spanish Civil War, did people start to speak up. As stolen babies' adoptive parents died, these people who were separated from their families began to learn the truth by finding inconsistencies in their birth records. This allowed even more people who were stolen from their parents soon after birth to discover their stories. The history of stolen babies during the Spanish Civil War demonstrates humanity's tendency to obscure the truth; the adoptive parents allowed their children to live a lie, and the government abused its power and continued covering up the past.

The most evident way the truth was obscured was when the adoptive parents of the stolen children hid the truth about their biological families from them. They only revealed the truth on their deathbeds, if at all. Two women, Ana Belén Pintado, a stolen baby, and Manoli Pagador, the mother of a stolen child, tell their similar, but distinctive stories. In October 2017, as Ana Belén Pintado cleared out her garage after her mother's death, she came across documents she had

never seen. These documents were her mother's decades-old medical records. Looking through these records, she found a note from her mother's doctor. It said that her mother, Petra Torres, was 31 and had been trying to have a family. However, X-rays revealed a uterine anomaly and blocked fallopian tubes.[5] This meant that Pintado's mother had been sterile – she could not have children. Until this day, Pintado always believed this was her biological family. Still, a few years before, there had been an odd incident after her father's death. The lawyer overseeing his estate found papers showing she was born with a different last name. However, before anyone could take a closer look or ask any questions, her mother took the papers and hid them.[6] No one brought them up again. As Pintado looked at her birth certificate, she realized that it had been tampered with. She said, "I knew this couldn't be my mother, and that's when I thought, I might be a stolen baby."[7] Although she did find her biological mother later and developed a meaningful relationship with her, this was not the case for most of the victims. Another victim, Manoli Pagador, a mother of a stolen baby who told her story to a BBC reporter, was not as lucky as Pintado. Even though she now has three daughters and many grandchildren, Pagador has never gotten over the loss of her first-born son almost 40 years ago.[8] In April 1971, she gave birth to her first child at O'Donnell Hospital in Madrid. She was 23 years old and had not been married for long. Pagador gave birth to a healthy boy, with zero complications. However, he was quickly taken for routine tests. "[Pagador] said, aren't you going to give him to me? No, [the nun] said, no, no, we need to take him down to see the doctor."[9] Then, nine hours after they took her son from her, a nun arrived and informed her that her baby had passed away. Yet, she never believed her son had died. She believed he had been stolen. "When they first told me he died, for me that was the worst thing on earth. My whole world collapsed. From that moment on, I no longer existed."[10] Her son is most likely alive, someplace in the world, living a life that is not truly his.

Pagador never questioned the hospital staff. She said, "Doctors, nuns? I couldn't accuse them of lying. This was Franco's Spain. A dictatorship. Even now we Spaniards tend not to question authority."[11] People are more inclined to believe in the Church and the doctors because they are in positions of power. Lies can easily affect and influence people's thoughts. The root of the problem lies in 'meta-cognitive myopia' (MM). MM refers to the phenomenon of people accurately processing complicated information, but not thinking about the history or legitimacy of where they got the information.[12] When someone is emotionally or psychologically significant to someone, it is easier to believe their lies.[13] Additionally, since the brain makes so many decisions, it naturally uses shortcuts to make some decisions. It watches for signals of authority, meaning people tend to believe those in positions of power.[14]The Spanish had always been taught to respect and believe authority. Therefore, once they started lying to them, they never imagined that it could happen. Why would the people they were supposed to trust lie to them?

Spain tried to obscure the truth by allowing the Spanish government and the people who worked closely with them to abuse their power. In a case against the late Sister Maria Gomez Valbuena, a severe and relentless nun who played a significant role in the stealing of children,

two witnesses stood up and spoke up against her. The first, I.M., was a janitor at the same hospital as her. "I cleaned her office, I saw everything," she said.[15] What surprised her the most about the nun was her behavior towards the unwed and poor mothers. She called them "heathens and subversives," sometimes to their faces.[16] I.M. also mentioned seeing many babies in the hospital that had been reported dead, alive and well a few hours earlier. In addition, she had heard many rumors that at least one deceased newborn was preserved in a refrigerator, but she did not know why. However, according to other victims, the body of an already deceased baby was refrigerated because it was used to show the parents their 'dead baby.'[17] I.M. remembered that there was also a blue notebook on Sister Maria's desk. Inside was a list of names. She recognized them as "prospective parents" who had visited the nun.[18] Every morning, they arrived at the clinic with a check. Sister Maria would interview them, and if they were lucky, they would leave with a baby. In another column in the notebook, there were numbers in pesetas. These amounts did not seem to be donations as some totals amounted to a week's wage or more.[19] Secondly, there was Maria Luisa Torres, the first victim to sue Sister Maria. She said she had the characteristics of Jekyll and Hyde.[20] "I was very scared, and she comforted me. I trusted her. She was spinning a web until she had me trapped."[21] In 1982, Torres was pregnant and alone. After seeing one of her advertisements offering help to pregnant women, she decided to contact the nun. "When I woke up after giving birth, she was a different person. She had two faces; she was cruel, haughty. She kept my baby. She threatened to take my other daughter for adultery. And while she was saying it, I could see her imagining that moment."[22] The people whom the victims thought would help them eventually stabbed them in the back. Doctors, nuns, and priests lied and acted as if they cared at the beginning, but they ended up showing their true colors, only using these people for their financial and political gain.

In April 2012, Dr. Eduardo Vela, 85, was charged with stealing babies. This case concerned Inés Madrigal who was abducted as a baby in 1969. The judges had indisputable evidence that proved that Vela was guilty of stealing babies from families and giving them to infertile mothers. He was found guilty of three crimes: abduction, fraud in pregnancy, and document forgery.[23] Even though Madrigal's lawyer continued to say that the statutes of limitations should not apply to this case since she had only learned she had been stolen, not adopted in 2010, Vela's lawyer continued to push the statutes of limitations.[24] Vela eventually won; he could not be convicted because too much time had passed since the crime had been committed. "We are really disappointed [by the outcome] – it's like being slapped in the face. We need to change the laws so there would be no statute of limitations for these crimes," said a mother of a stolen child supporting Madrigal.[25] Dr. Vela, an influential and respected person, was not convicted because of the influence of his job. Being in a position of power allowed him to get away with and deny his crimes.

In Spain, many people still want to hide the truth. Other cases, like this one, have been closed because of the statute of limitations or claims of not enough evidence. Reporters who try to investigate what happened tend to receive threats such as, 'drop the matter or face the consequences.'[26] Additionally, since the Church refuses to open its records, the judiciary cannot

help with the investigations. The judiciary claims it can only help once the Church opens its records.[27] They protect each other. "Where one begins, and the other ends is nearly indistinguishable. [The Church and Spanish Government] entered into a mutually beneficial alliance, that, in many ways, continues on even today."[28] These victims have "spent years talking to government officials and dealing with judges who have made every possible effort to ensure nothing more comes out of this scandal."[29] This is a something the victims who want to know the truth will continue to struggle with as government officials work against them to hide the reality of these crimes.

Other nations such as Argentina and Ireland, have also endured their version of stolen babies, but have taken actions to rectify their past wrongdoings. International regulations prohibit the illegal abduction or adoption of children. In 1980, the Hague Convention on Civil Aspects of International Child Abduction was signed by ninety-nine nations.[30] Its goal was to return stolen babies to their original parents and to address known cases of stolen children. Additionally, Argentina created a truth-and-reconciliation commission, something Spain refused to build. Instead, after Franco's death, they passed an amnesty law, to 'ease the country into democracy.' This law pardoned members of Franco's regime for most of their crimes. Not only did this regime create this law, but it also created the Pact of Forgetting to "avoid confronting the dark legacy of their dictatorship."[31]

Evidently, this history of stolen newborns highlights humanity's tendency to hide the truth. However, even before the Spanish Civil War and stolen babies, Spain was divided. The country might have more secrets hidden within its history that have not yet been uncovered. Continuing to seek answers could open old wounds. This could cause more destruction and another civil war. This brings up the question: does society gain more from learning the truth or from pretending it never happened? There is no easy answer to this question. If the Spanish people really want to know the truth, regardless of the harm that could come with it, a vast amount of political change will be needed. The government would have to revisit legislations, establish investigative bodies, and provide resources for the victims and their families. Only by facing the past, holding the guilty responsible, and removing unnecessary obstacles from the path of those who search for the truth, will justice, truth, and reconciliation be found.

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Which Has a Bigger Effect on History: The Plans of the Powerful or Their Mistakes?
By Huayi Qin

Though there are many Stages, and many Acts, of History, it has often been the case that those Rulers of Men have taken center stage. We fame their strategy – from Sitting Bull and Crazy Horse at Little Bighorn to the plotted propaganda of Augustus' Res Gestae (Goldsworthy, 2015); we often, likewise, decry their mistakes – not just the Maginot Line's porosity, or the Italians' defeat at Adwa, but also Gerald Ratner's after dinner speech, collapsing his jewelry empire in one loose-tongued quip (The Telegraph, 2021). Unpredictable history is entertaining history. Yet, to what extent do the intentions and designs of the powerful truly dictate historical outcomes? History is as much about the powerless as the powerful – and narratives of Great Historical Change cannot simply focus on the great Rulers of Men. The ruled, the colonized, the unknown: their stories, and ability to influence societies around them, must be recognized alongside the plots and ploys of the powerful. Yet, when analyzing the powerful, it is revealed that, whilst plans executed correctly can have a wondrous effect on History, the mistakes of history – and the woes they cause – can be equally as important.

Studying the impact of the plans and mistakes of the powerful on history is a critical part of under- standing historical progression. Powerbrokers, whether political, economic, social, possess the ability to shape and direct events, societies, and cultures through their decisions (Carlyle, 1841). Their strategic plans often represent the intent to progress towards a specific vision or goal, embodying deliberate, thoughtful efforts to produce certain outcomes. These can lead to monumental achievements and innovations or severe consequences and suffering, altering the course of history signifi- cantly. On the other hand, their mistakes, whether due to oversight, misjudgment, or even hubris, can inadvertently trigger unintended consequences, creating ripple effects that drastically reshape histori- cal trajectories. Was hubris not the downfall of the great Macbeth, being Aristotle's *hamartia*? And so it was the downfall of Cleon, and even Athens, in the 5th Century BCE: hubris borne from initial popularity, and initial success, led to oversight, and abuse of power, which ultimately came to cause ruin (Thucydides, c.399BCE). The stories of Cleon – like that of Demosthenes after him - were re- counted by Thucydides; and, from this, historians must always remember that the stories of the plans and the failures of the powerful are often tinted by the author recounting them. However, it is not just the case that history is dictated by powerful rulers alone (Krantz, 1998). How those being affected by the actions of the powerful react is clearly an essential part of determining how successful and im- pactful the powerful are – take for, example, the reaction of the Ndebele in newly-formed Southern Rhodesia to their colonization in 1893: by 1896, they were revolting, seeking to throw off their new yoke (Mlambo, 2014). Rhodes' mistake was not the colonization, but in the methods, and ferocity, in which it was effected – stoking continued rebellion and little acquiescence. The Ndebele of the 1896- 7 *umvukela* pushed British rule and rulers to the edge, and wrung from their hands of the colonizers new status and respect for the colonized (Ranger, 1967). There is a message of history,

here, too: though success may be won, the method through which success was won may render future rule more unstable.

The concept of 'the Powerful' need also be clarified. Power manifests itself in diverse ways, and it can be classified into two overarching categories: institutional power and structural power. Institutional power is derived from the authority held by individuals within the framework of established institutions (Nye, 1990). These individuals wield influence by virtue of the power vested in their states or armies within specific institutional settings. For instance, organizations like the United Nations and historical alliances (take the alliance of the British with the Itsekiri of the Niger Delta, for example, who combined to overcome nearby kingdoms of the Urhobo and Ijaw across the 1880s) confer institutional power to those who hold prominent positions within them (Falola, 2012; Dike, 1956). On the other hand, structural power emanates from possessing military might or commanding a formidable economy (Nye, 2004) Historical examples abound, with figures like Genghis Khan, Attila the Hun and Tsoede of the Nupe – all of whom epitomized structural power through use of strong armies over extensive territories. Throughout the annals of Chinese history, various rulers exemplified structural power, establishing dominance through military prowess and management of vast re- sources (Gascoigne, 2014). When discussing the plans and mistakes of the powerful, historians must clarify what type of power is being discussed, and should acknowledge how this affects the plans and mistakes of the powerful.

The mistakes of the powerful have also been impactful on the course of human history. Mistakes can be characterized as the unintended consequences, misjudgments, errors and failures of those power- ful players in history. These mistakes stem from flawed reasoning, inadequate information, hubris, miscalculations, or unforeseen circumstances. One of the most telling examples lies in the reign of the Qin Dynasty's first emperor, Qin Shi Huang, who had initial success in unifying China in 221 BC (Burbank and Cooper, 2010). Later complacency, however, led to several mistakes that ultimately resulted in the dynasty's downfall (Pancella, 2003). His decision to employ brutal tactics to suppress dissent, such as book-burning and burying scholars alive, undermined his rule. Additionally, his ob- session with seeking immortality instead of addressing the needs of his people led to further resent- ment. Thus, the Qin Dynasty collapsed in 206 BC, a mere 15 years after its establishment, demon- strating the considerable impact of a leader's mistakes. The same stories were true in certain episodes of late British colonial rule in Africa: the brutality of the British reaction to the Kikuyu Mau Mau rebels in the late 1950s prompted fresh waves of nationalist sentiment which galvanized the (as they now considered themselves) Kenyan population into finally removing British rule in 1963 (Reid, 2020). Indeed, it was episodes such as this which stimulated the transition of sub-nationalist, ethnic identities into (even if only temporarily) more nationalist identities – turning Kikuyu into Kenyan, Shona into Zimbabwean (Tordoff, 2002). It was then a mistake of these African 'state builders' and early independent statesmen that they failed to maintain a national identity – and the tragedies of early post-colonial years were the consequences of an unraveling of the national, and re-emergence of the ethnic (Chakrabarty, 2008; Reid, 2017). This was epitomized in episodes of

national unravelling such as the Rwandan genocide (1994), the Gukurahundi (1983) and the Benin War (1967-70). In- deed, it can be argued, whilst these were failure for the new 'state,' they were episodes in the perpe- trators' new plans for success – unfortunately, being the expunging of neighboring ethnicities. This, therefore, reveals a fundamental point to understand: 'mistakes' and 'plans' for success were not mutually exclusive: the mistakes of the state were the successes of its individual actors. Traditional mis- takes are, therefore, often easy to see; but mistakes born from success, or mistakes for one being part of the plans for another, are often equally as significant – yet not always as obvious.

The mistakes of the powerful can also play a pivotal role in fostering progress and learning. The 2008 financial crisis, resulting from the errors and misjudgments of powerful individuals in the world of finance, led to a global economic recession with profound implications for millions of individuals. The lessons learned from this prompted numerous reforms and regulations intended to pre- vent a similar catastrophe in the future (Tooze, 2019). Similarly, the mistakes of powerful leaders in history have served as critical lessons for future leaders, informing their decisions and actions and shaping the direction of their societies. In the United States, the Vietnam War (1955-1975) led to 'Vietnam syndrome' in American foreign policy (Simons, 1997). This political aversion to overseas military involvements after Vietnam influenced American foreign policy until the 1990s. Historians must examine how the powerful have learned from their mistakes or been influenced by the mistakes of others when considering the impact of the powerful on history.

However, to characterize the past as simply the story of powerful rulers ignores the significant contributions played by the powerless. The decline of empires throughout history have largely stemmed from united forces coming together to defeat dominant empires (Taylor, 2008). The fall of the Ro- man Empire was driven by the Goths and barbarian kingdoms, for example: unity in identity – in ways that, though preceding the nation state (a largely 19th century concept), demonstrate the early power of unity in identity, and a shared language and shared history. Indeed, this commonality of his- tory has galvanized various powerless communities across history; an elucidating example of this is the growth of cross-ethnic collaboration in countries such as South Africa and Uganda in the run up to, respectively, the end of apartheid and independence. These communities of the ruled toiled away in youth movements, in unofficial newspapers, and in the communes and clubs of urban cities and rural villages, to find avenues and identities that could combine to bring independence. Histories written at the time – for example, Ranger on Southern Rhodesia – overlooked the role of the ruled, and focused on either the success or failure of the rulers. Yet, as we have moved through Marxism to postmodernism to postcolonialism, History and historians are appreciating, finally, the fact that, in History, whilst the powerful can 'effect' History, it is often the case that the powerless drive it. The agency of individual rulers can also be challenged on the grounds that there are several other external forces that impact how history unfolds. Technological inventions, disease and geography have all had a profound impact on history (Diamond, 2016). When the Spanish discovered the 'New World' in 1492, their success in establishing colonies and conquering local

populations can be at- tributed, in part, to the diseases which they brought with them, such as smallpox and measles, which the indigenous peoples had not yet been exposed to (McNeil, 1976). Similarly, the dominance of European empires such as the Portuguese in the early modern period, and the British in the 19th century can be attributed to the technological advantages that these empires had over the local territories they sought to conquer (Ferguson, 2003). Whilst 16 million guns flooded Africa in the 1800s, it remained the British (and French, German, Dutch and Portuguese) who wielded the technological power to conquer and rule (Reid, 2020). More generally, island nations have generally suffered fewer inva- sions and have had greater political stability which has meant that their rulers been able to deliver their plans and impact history more substantially (Marshall, 2015). This is true of both Britain and Japan in the 19th century. Therefore, although European rulers had great ambitions to expand their empires, they were only able to do so, and have a lasting impact on history, due to the favorability of external factors such as technology, disease and geography.

The question posed, therefore, simplifies the actors, agents and authors of History. The actors of His- tory are as much the Chilembwes as the Caesars; the agents are as much the chiefs as the consuls; and the authors are as much those from the New World as those traditionalists from the Old. This is vital to remember. Yet, in isolating the focus onto the powerful, it remains to be seen that both their plans and mistakes have had prodigious impacts on the course of History. History is not simply the product of individual action, nor state coordination. History is dictated by how these rulers interact with those around them, the context within which they find themselves, and how external forces shape what the powerful are able to achieve.

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A Multi-Factor Analysis on the Effects on Global Poverty By Adriano Saettone

Introduction

Poverty is a persistent social and economic problem that affects millions of people around the world. Despite efforts to reduce poverty levels, many individuals continue to struggle with basic needs such as food, shelter, and healthcare. Understanding the factors that contribute to poverty is essential for designing effective policies to tackle socioeconomic inequality.

Poverty is significant because it has profound consequences for individuals, communities, and societies. It leads to lower living standards, fewer opportunities for economic mobility and political instability. This research paper aims to use econometric methods to identify and analyse the key factors that affect poverty. By examining a range of economic and social factors, we seek to provide insights into the root causes of poverty.

Theoretical Foundations–Linear regressions

Linear regression models study the strength of the relationship between two or more variables by fitting a linear equation to a set of plotted data. To determine the line of best fit or the regression line, we perform ordinary least squares (OLS) by minimizing the error of the predicted values from the actual data. These can be simple linear regressions or multivariate linear regressions, which are regression models that have 2 or more independent variables. In this research, we apply multivariate linear regression using independent variables such as energy power consumption per capita, immunization to DPT, enrolment to primary school and GNI per capita forecast poverty. Poverty is defined by the headcount ratio of individuals in any country who earn less than $2.15 a day.

Once this equation is fitted to the model, the strength of the relationship between the actual data and the data predicted by the linear equation is shown by the R^2 value. The R^2 value or the coefficient of determination illustrates how well a model fits the data; The closer the R^2 value is to 1, greater the predictive ability of the model. For example, a value of 0.79 for the R^2 indicates that 79% of the variance in Y is explained by X, while the rest is caused by other factors that are not considered by the model.

Calculating Regression Lines

The equation for the regression line can be expressed as $\hat{y} = b_0 + b_1x_1 + b_2x_2 + \ldots + b_px_p$ where b_0 is the constant, b_i is the slope, x is the data for each independent variable and $\hat{y}$ is the estimated value of y. We want to minimize the error between the y and ŷ, this way we get the line that best fits the model. We do this by forming the equation:

$$y = b_0 + b_1x_1 + b_2x_2 + \ldots + b_px_p \ .$$

Then get the ordinary least squares function:

$$\sum(y - b_0 + b_1x_1 + b_2x_2 + \ldots + b_px_p)^2$$

To minimize the errors, we want to find the minimum point in the equation above. This is the point at which the gradient of the graph of the residuals is zero, or when the first derivative of the OLS function is equal to 0. Since we have many unknowns, we must take partial derivatives with respect to each independent variable and then solve:

$$\partial/\partial b_1 \sum(y - b_0 + b_1x_1 + b_2x_2 + \ldots + b_px_p)^2$$

$$\partial/\partial b_0 \sum(y - b_0 + b_1x_1 + b_2x_2 + \ldots + b_px_p)^2$$

$$\partial/\partial b_p \sum(y - b_0 + b_1x_1 + b_2x_2 + \ldots + b_px_p)^2$$

This way, we end up with a system of linear equations. In this case this system has 4 equations with 4 unknowns.

Calculating the Coefficient of Determination

The coefficient of determination, or R^2 value, shows how well the regression line predicts the actual value and the strength of the relationship between these variables. R^2 determines the goodness of fit and measures how much the variability in y that can be explained by the variability in x. If $R^2 = 0.99$, it means that 99% of the variance in Y is explained by X, which shows a very strong correlation. And if $R^2 = 0.2$, this means that 20% of the variance in y is explained by x and therefore these 2 variables a weak correlation.

This value can be calculated by subtracting the sum of $(y - \bar{y})^2$ divided by the sum of $(y - \bar{y})^2$, the distance from the estimated values to the mean values squared, from 1. Or,

$$1 - \sum (y_i - \hat{y})^2 / \sum(y - \bar{y})^2$$

where $\hat{y}$ is the value of Y predicted by the model.

World Bank Data

The data compiled for this research paper has been collected by the World Bank from 1985 until 2014. In my research, we determine the factors that affect global poverty include number of patent applications, immunization to DPT, monetary sector credit to private sector, and enrollment in primary school.

Dependent Variable: Poverty headcount Ratio at $2.15 a day

In our research, we used the poverty headcount ratio at $2.15 a day as an indicator for poverty. This measure is based on the idea that people who earn a lower income than $2.15 face significant difficulties meeting their basic needs, such as food, shelter, healthcare, and education. The poverty headcount ratio also makes comparisons between countries and over time possible.

Factor 1: Patent Applications, Residents

Patent applications are worldwide applications for patents. These give the owner exclusive rights to an invention that provides a new way of doing something or that provides a solution to a problem. This indicator is made up of the sum of patent application filed through the patent cooperation treaty procedure and national patent offices.

Patent applications provide insights into a country's legislation system and innovation within an economy. A higher quantity of patent applications can indicate increased levels of research and development and higher innovation. Both higher research and development and innovation offer greater income generating opportunities since these can give birth to new jobs and increase productivity resulting in higher living standards.

Factor 2: Immunization to DPT

DPT immunization refers to vaccination against diphtheria, pertussis, and tetanus. DPT immunization is a key measure of a population's access to healthcare, as it indicates the extent to which individuals are protected from these life-threatening illnesses. Countries with high DPT immunization rates are more likely to have well-established healthcare systems that provide easy access to high-quality medical services. Contrastingly, countries with low DPT immunization rates may have inadequate healthcare infrastructure, limited access to vaccines, or barriers to accessing healthcare services.

Access to healthcare can greatly impact an individual's development and a country's poverty rate. If people do not have sufficient access to healthcare, they may be unable to treat diseases, or prevent other conditions from developing resulting in lower living standards. In particular, with the lack of access to healthcare during childhood, diseases can affect an individual's ability to learn and succeed due to poor cognitive development. Adults who experienced developmental delays as children can be limited in economic activities, reducing their earning potential, and creating a cycle of poverty and disadvantage.

Factor 3: Monetary Sector Credit to Private Sector

Monetary sector credit to private sector refers to the value of financial resources provided to the private sector that establish a claim of repayment.

This indicator provides insights into people's access to financial resources. Greater access to financial resources may mean households can invest in income-generating activities, education, or healthcare. It can promote entrepreneurship and job creation since access to finance will enable people to receive funding for their businesses. Moreover, greater access to financial services can increase productivity as it enables firms to buy capital goods. Finally, access to financial services can result in poverty alleviation. Microfinance and microcredit services can help low-income households to expand their businesses, manage risk and improve their living standards.

Factor 4: Enrollment in Primary School

Enrolment in primary school refers to the number of children of primary school age who are enrolled in primary education programs. Primary education is considered a fundamental human right and a crucial component of sustainable development. High enrollment rates in primary schools can indicate that a country has a well-established education system with adequate infrastructure, resources, and policies to provide access to education for all children. It can also indicate that the country has achieved a certain level of economic development, as education is often linked to better economic outcomes and higher levels of human capital and production.

On the other hand, low enrolment rates in primary schools can indicate that a country has limited access to education due to factors such as poverty, gender discrimination, or limited infrastructure. Lack of access to primary education can perpetuate poverty and limit economic opportunities, as education is often linked to better employment prospects and higher earning potential. Also, children from poor families are less likely to attend school due to factors such as limited financial resources, lack of transportation, or the need to work to support their families. By ensuring that all children have access to primary education, countries can help reduce poverty and promote social inclusion.

Results

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.973884034
R Square	0.948450111
Adjusted R Square	0.940202129
Standard Error	2.216403833
Observations	30

ANOVA

	df	SS	MS	F	Significance F
Regression	4	2259.563518	564.8908795	114.991775	1.02787E-15
Residual	25	122.8111488	4.912445951		
Total	29	2382.374667			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%	Lower 95.0%	Upper 95.0%
Intercept	103.9550116	34.0147269	3.056176576	0.005273667	33.90037017	174.009653	33.90037017	174.009653
Patent applications, resider	-1.69824E-05	2.63558E-06	-6.443524513	9.53178E-07	-2.24105E-05	-1.15543E-05	-2.24105E-05	-1.15543E-05
Immunization, DPT (% of ch	-0.381848571	0.083042616	-4.598224232	0.000105572	-0.55287804	-0.210819101	-0.55287804	-0.210819101
Monetary Sector credit to p	0.230423966	0.119110269	1.934543245	0.064439885	-0.014888225	0.475736158	-0.014888225	0.475736158
School enrollment, primary	-0.505790799	0.345561691	-1.46367729	0.155743346	-1.217488424	0.205906826	-1.217488424	0.205906826

Figure 1. (Results of Multivariate linear regression in excel)

Data Analysis–R-Squared Value

The results from the multivariate regression that was carried out show that the variables in the model have a strong relationship, as shown by the R squared value of 0.948 meaning that 94.8% of the variance in Y can be predicted by X. This means that the independent variables are important factors to be considered when predicting poverty.

Patent Applications, Residents

The results demonstrated that as patent applications increase, poverty decreases, as shown by the correlation coefficient of -1.69824E-05. This is because patent applications reflect the level of innovation in an economy. Greater innovation means increased job opportunities and

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greater productivity, which serve as income generating activities that help people lift themselves out of poverty and increase their living standards.

Despite that the correlation coefficient for patent applications and poverty is negative, this number is very close to zero. This may indicate that the number of patent applications is not the primary contributor to reductions in poverty.

Immunization to DPT

The results showed that as immunization to DPT increases, poverty decreases as shown by the correlation coefficient of -0.38. People who have better access to healthcare can seek medical help and recover from illnesses more quickly. This means that each person's productive capacity increases, resulting in a higher earning potential. Furthermore, better access to healthcare will ensure adequate cognitive development in children, ensuring their capacity to earn a greater income than they would otherwise.

Monetary Sector Credit to Private Sector

The results contradicted the hypothesis that as monetary sector credit to private sector increases, poverty may decrease. This may be because more access to credit can contribute to poverty since it can lead to excessive debt. This means that it may result in low-income households taking on more debt than they can afford, resulting in a debt trap and a downward poverty spiral.

In the long run however, there is a greater opportunity for human capital development and more inclusive economic development. Individuals can now gain access to funding for starting businesses, education, and healthcare. So, people can enjoy a higher standard of living. Nevertheless, since the effects of these take a longer time to materialize than excessive indebtedness, the model may not show these in the short term.

School Enrollment

The results also show that as school enrollment increases, poverty decreases. Education can provide people with the skills and knowledge needed to increase their human capital. This can lead to greater economic mobility and help individuals lift themselves out of the poverty cycle. In addition, education can also promote greater social cohesion, tolerance, and engagement, which can lead to stronger communities and more effective poverty reduction efforts. Also, education can help future generations: educated parents are more likely to invest in their children's education and provide them with the resources they need to succeed. This may result in a positive cycle where more education leads to greater economic opportunities, reducing poverty.

Discussion–Multi-collinearity Test

To ensure that the model is accurate, we conduct a multicollinearity test for the independent variables. This was performed since having independent variables that correlate

with each other can distort the R-squared value of the regression, making the model seem more accurate than it is.

Multicollinearity Test				
	Patent applications, residents	Immunization, DPT	Monetary Sector credit to private secto	School enrollment, primary (% gross)
Patent applications, residents	1			
Immunization, DPT (% of children age	0.700539038	1		
Monetary Sector credit to private sect	0.322242723	0.685779227	1	
School enrollment, primary (% gross)	0.83116312	0.584768325	0.241633487	1

Figure 2. (Results of Multicollinearity Test)

The results of the multicollinearity test showed that school enrolment and patent application were the only two factors that were highly correlated, given that their VIF is 5.92. This doesn't necessarily mean that these two are connected to one another, but rather it is likely that the data illustrates a correlation simply because the numbers happened to be highly correlated, since patent application and school enrollment are not related to each other.

So, because only two variables are highly correlated and they are likely to be correlated simply by chance, there is no need to remove any variable from the regression to remove multicollinearity. This means that the model has not been distorted by multicollinearity and accurately represents the relationship between global poverty and all the different factors.

Heteroskedasticity Test

We also conducted a heteroskedasticity test to check the model's accuracy. One of the basic assumptions of linear regressions is that the error between the predicted Y value and the actual Y value stays the same throughout the model, so if the error changes throughout the model, specifically, if it increases, then the r-squared value of the regression may be distorting, misrepresenting the true strength of the relationship between the independent and dependent variables.

For this test, we calculate the squared residuals of the model and conducted a linear regression of these against the 4 different factors:

SUMMARY OUTPUT								
Regression Statistics								
Multiple R	0.282134925							
R Square	0.079600116							
Adjusted R Square	-0.067663866							
Standard Error	8.922204193							
Observations	30							
ANOVA								
	df	*SS*	*MS*	*F*	*Significance F*			
Regression	4	172.116089	43.02902224	0.540526712	0.707375734			
Residual	25	1990.143191	79.60572766					
Total	29	2162.25928						
	Coefficients	*Standard Error*	*t Stat*	*P-value*	*Lower 95%*	*Upper 95%*	*Lower 95.0%*	*Upper 95.0%*
Intercept	-79.22358443	136.927366	-0.578581088	0.568048246	-361.2307737	202.7836048	-361.2307737	202.7836048
Patent application	-1.21795E-05	1.06096E-05	-1.147969561	0.261847867	-3.40304E-05	9.67139E-06	-3.40304E-05	9.67139E-06
Immunization, DP	0.289330939	0.334290696	0.865507004	0.394990606	-0.399153637	0.977815514	-0.399153637	0.977815514
Monetary Sector c	0.067371366	0.47948218	0.140508592	0.889384151	-0.92014067	1.054883402	-0.92014067	1.054883402
School enrollment	0.67905509	1.391069588	0.488153214	0.629695542	-2.185906357	3.544016537	-2.185906357	3.544016537

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Figure 3. (Results of Heteroskedasticity Test)

Then, we multiplied the R-squared value by the number of observations to get the value for the chi-squared statistic, which was 2.39.

Then, using the chi-squared table we determined the critical value for this distribution curve at 0.1 significance with 3 degrees of freedom. This gave a critical value of 6.251.

Since 6.251 is greater than 2.39, there is evidence to accept the null hypothesis that there is homoskedasticity and reject the alternate hypothesis that there is heteroskedasticity in this model.

Conclusion

In our research, we concluded that patent applications, immunization to DPT and school enrollment all decreased poverty. This is because these create jobs, increase productivity, and improve human capital, resulting in a greater earning potential for individuals. We also concluded that, in theory, monetary sector credit to private sector could decrease poverty, however, it has likely led to overindebtness, thus increasing poverty.

The relationship between these 4 indicators and poverty was very strong as shown by the coefficient of determination of 0.9485, meaning that 94.85% of the variance in Poverty can be explained by monetary sector credit to private sector, school enrolment, immunization to DPT and patent applications.

Some factors showed greater effects in reducing poverty than others, reflected by their correlation coefficients. The greatest contributor to poverty reduction being school enrollment and the weakest being patent applications, while the model showed that monetary sector credit to private sector contributed to poverty.

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Patent applications, residents | Data (worldbank.org)

Poverty headcount ratio at $2.15 a day (2017 PPP) (% of population) | Data (worldbank.org)

Immunization, DPT (% of children ages 12-23 months) | Data (worldbank.org)

Monetary Sector credit to private sector (% GDP) | Data (worldbank.org)

School enrollment, primary (% gross) | Data (worldbank.org)

Closing the Circle: The Disruptive Nature of Androcentrism By Daria Hajimiri

Abstract

Instinct or construct? When talking about human behavior, particularly gendered behavior, many turn to this question—often concluding that it is instinctive. Centuries of imposed cultural norms and subjugation are replaced with an over-simplification of human behavior: women are naturally more emotional, more nurturing, and weaker. However, social change is limited by the assumption that gendered behavior is innate. Fixating on definitions will not change demeanor. It will not change that because of these assumptions, the female voice is often strangled. In this manner, existence and survival often become contingent on disrupting androcentric behavior and institutions. The subversion of the perceived convention of androcentrism illustrates that androcentric demeanor disrupts preconceived notions of innate femininity by imposing masculine structures that counter the female.

Pregnancies in *House of the Spirits*

The portrayal of pregnancies in Isabel Allende's *House of the Spirits* displays the true role of women within an androcentric institution: natural femininity disrupts the system when uncontrolled by men and men like Esteban attempt to reverse this by enforcing their control. During Clara's pregnancy, she is glorified and pampered by Esteban because her pregnancy is established as valuable. Esteban says, "The whole house was filled with joy. We opened a bottle of champagne, I had fresh flowers put in all the vases, ordered camellias, her favorite flower" (Allende, 127). Esteban's use of the word "filled" aligns with the container metaphors Lakoff and Johnson discuss in *Metaphors We Live By*. Lakoff and Johnson write, "Each of us is a container, with a bounding surface and an in-out orientation. We project our own in-out orientation onto other physical objects that are bounded by surfaces." Likewise, Clara's pregnant body, which contains a baby, parallels the house filled with joy. Both entities—womb and house—are containers with bounding surfaces and in-out orientations, as Lakoff and Johnson say. Esteban projects the joy of the baby in Clara's womb to the feeling within their house. The joy of the new baby further demonstrates the perceived worth of Clara's pregnancy. Furthermore, Esteban surrounds Clara with an abundance of care and feminine objects. Flowers, typically seen as delicate and gentle, parallel how women are viewed within society. The flowers are given to Clara in the same way offerings are typically given to Gods. These symbols enhance the divinity and glorification of Clara's pregnancy. In *Borderlands/La Frontera,* Gloria Anzaldúa echoes the treasuring of the female body when it bears life. She writes that pre-Columbian Americas considered the vagina to be, "the most sacred place on earth, a place of refuge, the creative womb from which all things were born" (Allende, 56). Anzaldua represents the female body as a sacred place that both deserves and provides protection by using words tied to religion, such as "sacred" and "creative womb." By likening a woman's pregnant body to a creator, like God, Anzaldua further presents the sanctity and value of pregnancy as viewed by the greater

institution. Esteban's treatment corresponds to Anzaldua's ideology. He not only views Clara's body as a safe place, but also as an entity to be nurtured, protected, and even worshiped.

Although Clara's pregnancy is treasured, the language used to describe it contrasts with Pancha's, demonstrating how men determine the value placed on women's pregnancies. Allende explores the nuance of Pancha's pregnancy through the lens of metaphor theory, displaying the disruptive nature of a pregnancy undesirable to men. Pancha García, a fifteen-year-old peasant working at Tres Marias, is raped by Esteban Trueba and consequently becomes pregnant with his child. The language surrounding Pancha's physical response to her pregnancy displays the burden of new life when it is unwanted by Esteban, the man. Allende writes, "[Pancha's] waist swelled rapidly, and her breasts drooped with the weight of the new life that was growing inside her" (70). The use of words like "drooped" and "weight" corresponds to the direction, down. The diction aligns with *Metaphors We Live By*. While discussing directional metaphors, Lakoff and Johnson write, "GOOD IS UP gives UP orientation to general well-being, and this orientation is coherent with special cases like HAPPY IS UP, HEALTH IS UP, ALIVE IS UP, CONTROL IS UP." Conversely, we find that bad is down, sad is down, sickness is down, death is down, and subjection to control is down. Pancha's breasts droop, and her body is weighed down due to the new life in her body, indicating her misfortune and more specifically, viewing her child as unwanted by its father. Not only is she burdened by new life, but she is also unable to control it. Again, from *Metaphors We Live By*, we know that "being subject to control or force is down." Pancha had no control over being impregnated, yet she will have to carry the weight for the rest of her life. She will be condemned by the surrounding patriarchal society for carrying a "bastard" child, even though she had no say in what happened to her (Allende, 74). Clara has the freedom to "swing" her "enormous belly" around, whereas Pancha's "waist swells" (Allende, 113). The connotations of the diction indicate that Pancha's pregnancy is perceived as constricting and disruptive, whereas Clara's is liberating and treasured.

Furthermore, Esteban's perception of Pancha's pregnancy parallels the devaluation of it from their surrounding society. He states that the only worthy pregnancies are those of "a woman of his own class, with blessings of the Church, because the only ones who really counted were the ones who bore their father's surname; the others might just as well not have been born" (Allende, 74). His lack of recognition of his other children, including Pancha's child, illustrates that he sees them as a worthless, forgettable burden when pregnancies are inconvenient and undesirable to him. Pancha and other women's pregnancies disrupt Esteban's status, so he chooses to ignore them to preserve the life he wants. Pancha's pregnancy creates tension and is presented as an adverse entity because it is not socially valued or beneficial to the male prerogative.

Disruption of Femininity in *Borderlands/La Frontera*

Conversely, Gloria Anzaldua reflects a disruption of inherent femininity in *Borderlands/La Frontera* by utilizing diction to show how androcentrism disrupts innate womanhood. Anzaldua's anthology primarily discusses borders in identity and culture through

the lens of gender. Her main message is to "live *sin fronteras*" or, without borders (Anzaldua, 118). Anzaldua implies that in order to survive, one must embrace all aspects of their identity. However, she also reflects that in an androcentric society, previously non-existent borders are imposed on women—disrupting their inherent nature and culture. She writes, "The male-dominated Azteca-Mexica culture drove the powerful female deities underground by giving them monstrous attributes and by substituting male deities in their place, thus splitting the female Self and the female deities. They divided her who had been complete, who possessed both upper (light) and underworld (dark) aspects" (Anzaldua, 49). Anzaldua reflects that a male-dominated, or androcentric, culture effectively erased and demonized powerful female figures by splitting them apart and imposing borders on their identities. Anzaldua's language corresponds to *Metaphors We Live By*. Lakoff and Johnson write, "GOOD IS UP gives UP orientation to general well-being, and this orientation is coherent with special cases like HAPPY IS UP, HEALTH IS UP, ALIVE IS UP, CONTROL IS UP." Inversely, it is implied that bad is down. Men pushing women "underground" suggests that they see women as subordinate to men. In contrast to "control is up" we find that a lack of control or being subject to control is down. In an androcentric society, men disrupt the initial position of power of women and subjugate them. Moreover, Anzaldua reflects on attempts to silence women through a story about an interaction with a dentist. She writes, "'We're going to have to control your tongue'… 'I've never seen anything as strong or as stubborn,' he says. And I think, you do you tame a wild tongue, train it to be quiet, how do you bridle and saddle it? You do you make it lie down?" (Anzaldua, 75). Again, Anzaldua presents the imposed suppressive control on a natural quality through the lens of metaphor theory. By utilizing words such as "wild" and "tame" Anzaldua implies that there is a natural, innate quality to a woman's tongue—that there is power in what she has to say. The dentist himself indicates that there is nothing stronger than a woman's tongue. Rather than trying to embolden this power, an androcentric society will try to suppress it. In this instance, a man decides definitively, that her tongue must be "controlled" and that it must "lie down." Both words correspond to *Metaphors We Live By*, where down indicates a lack of control, insinuating a diminution of a feminine quality.

Gendered Language in *Borderlands/La Frontera*

Anzaldua also incorporates gendered language, specifically Spanish, to demonstrate how androcentrism not only impacts interpersonal and societal inequity but our very language itself. She writes, "*Hocicona, repelona, chismosa,* having a big mouth, questioning, carrying tales are all signs of being *mal criada*. In my culture they are all words that are derogatory if applied to women—I've never heard them applied to men" (Anzaldua, 35). The seemingly subtle effect of using these gendered, derogatory words against women thereby influences our culture and how women are viewed in our greater society. The words *"hocicona, repelona, chismosa,"* are all snide ways to talk about how a woman talks too much, gossips too much, uses her voice too much. Using these specific derogatory words implies one thing: a woman should be quiet. Additionally, as Anzaldua says, these words all end in the feminine 'a", meaning that they will

never be applied to men whether that is socially or grammatically. Anzaldua touches on an important point: the interconnected nature of language and culture. As Gary Witherspoon writes in his article *Language in Culture and Culture in Language*, "[Anthropologists] tend to view language as a subcategory of culture…linguists tend to see culture as a dimension or component of the subdiscipline of semantics." Witherspoon indicates that language and culture are reciprocal entities—in the same way that language influences culture, culture influences language. This sentiment is particularly prevalent in a gendered language such as Spanish. The Spanish language has a masculine default, where even feminine nouns are derived from masculine versions (BBC: *The Subtle Ways Language Shapes Us*). By utilizing masculine language as the primary means of communication, the culture and language fuse together to cause male dominance not only in semantics but also in social, interpersonal connections. Caroline Criado Perez writes in her book *Invisible Women: Data Bias in a World Designed for Men*, "seeing men as the human default is fundamental to the structure of human society." Our culture and language are deeply androcentric and our identities as humans are defined by a masculine narrative. Anzaldua reflects this exactly in her anthology. "The first time I heard two women, a Puerto Rican and a Cuban, say the word "*nosotras*" I was shocked, I had not known the word existed. Chicanas use *nosotros* whether we're male or female. We are robbed of our female being by the masculine plural. Language is male discourse," she writes (Anzaldua, 76). Masculine language disrupts inherent femininity by imposing a masculine structure onto language and thus, on culture.

Circular Storytelling in *Beloved*

Furthermore, Tony Morrison's *Beloved* touches on the disruption of femininity through Paul D. 's disruption of Sethe's circular storytelling. Morrison emphasizes this form of storytelling through the imagery of Sethe circling around the kitchen while trying to tell Paul D. how she killed Beloved. Morrison writes, "She was spinning. Round and round the room...the wheel never stopped" (187). As Sethe revolves around the room, she tries to tell Paul D. the truth, but she is only able to do so in the way that comes most naturally to her: a circle. Paul D. attempts to understand what she is trying to tell him but "it made him dizzy…circling him the way she was circling the subject" (Morrison, 189). Sethe's way of storytelling confuses Paul D. and makes him dizzy, implying that Paul D. is not centered in his body. Being uncentered corresponds to a circle—as circles are shapes with distinct centers. By utilizing this language, Morrison further connotes that he is unaccustomed to a circular narrative. Paul D is not only uncentered in his body but also a world of cyclical, circular storytelling. This form is so foreign to Paul D. that he starts to disregard the story and method entirely to only focus on the answer he wants to get. "He caught only pieces of what she said-which was fine, because she hadn't gotten to the main part," Morrison writes (Morrison, 189). Paul D. only sees the importance of the beginning and ending to a story—the beginning being the question he asked to prompt Sethe, and the end being the final answer. Paul D. sees the story as linear as opposed to Sethe, who naturally tells it in a circle. In this fashion, Morrison touches on the gendered nature of storytelling and

how conventional stories, told linearly, are more masculine in form, whereas cyclical and circular stories are generally more feminine. Mary Dalton expands on this notion in her article *Conquer or Connect: Power, Patterns, and the Gendered Narrative.* She writes, "The circle is inclusive; it does not exclude. The symbol of the feminine is the circle, exemplified in the womb, the vessel, and the grail." In Beloved, that feminine form of storytelling is disrupted by Paul D.'s inability to understand and accept Sethe's circular explanation. Sethe initially decides to not break her natural storytelling, "[she] knew that the circle she was making around the room, him, the subject, would remain one. That she could never close in, pin it down for anybody who had to ask. If they didn't get it right off-she could never explain" (Morrison, 192). However, after explaining her story for some time, she realizes that Paul D. is unable to understand what she is trying to say and closes the circle—disrupting her natural storytelling so that he can grasp what she is trying to say. Additionally, Morrison's use of words such as "close in" and "pin it down" correspond to *Metaphors We Live By*. Pinning down and closing in give a sense of restraint and lack of control—indicating the restrictive nature of linear storytelling and conversely, how circular storytelling is more nuanced. Dalton comes to the same conclusion, "[circular storytelling] opens the opportunity for a discourse of possibility, or openness, that is precluded in the conventional (linear) structure." By inflicting a linear narrative onto Sethe's cyclical storytelling, Paul D. disrupts its nuanced, open nature.

Conclusion

By depicting feminine entities—bodies, language, and structure—as inherent qualities that are disrupted by androcentric conduct, authors such as Anzaldua, Allende, and Morrison further elucidate the importance of a feminine viewpoint. Feminine structures and voices must be uplifted in order to preserve nuance and balance in our existing systems. Establishing nuance in an androcentric society requires us to abandon our preconceived notions and instead look to what we can learn from every vantage point; female structures are not an exception nor a singularity.

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Veteran Affairs and Suicide By Jake Elgart

"My body has become nothing but a cage, a source of pain and constant problems. The illness I have has caused me pain that not even the strongest medicines could dull, and there is no cure. All day, every day a screaming agony in every nerve ending in my body. It is nothing short of torture. My mind is a wasteland, filled with visions of incredible horror, unceasing depression,

Illustration 1: Daniel Somers and his parents, Howard and Jean, celebrate Daniel's graduation from the Defense Language Institute in 2005. After his first deployment in Iraq, Daniel wanted to study Arabic to increase his skill set as an intelligence officer.

Cook, Chelsea C. "Family Photo." *Soldier's Suicide Note Goes Viral; Family Demands Better for Veterans*, 6 July 2013, https://www.cnn.com/2013/07/06/us/soldier-suicide-note/index.html. Accessed 6 Feb. 2023.

and crippling anxiety, even with all of the medications the doctors dare give. Simple things that everyone else takes for granted are nearly impossible for me. I can not laugh or cry. I can barely leave the house. I derive no pleasure from any activity. Everything simply comes down to passing time until I can sleep again. Now, to sleep forever seems to be the most merciful thing… Too trapped in a war to be at peace, too damaged to be at war. Abandoned by those who would take the easy route, and a liability to those who stick it out - and thus deserve better. So you see, not only am I better off dead, but the world is better without me in it…I am free. I ask that you be happy for me for that. It is perhaps the best break I could have hoped for. Please, accept this and be glad for me" (Somer).

-- Daniel Somer

These were the last word of Daniel Somer, a military veteran from the Iraq War who committed suicide several years ago (Cook). Somer's story is a lot like other military veterans; people who do and see unimaginable things in the name of freedom, only to return to the United States emotionally, financially, and physically unprepared to enter back into society. This unpreparedness and instability is ultimately what causes a majority of veteran suicides in the United States, and although efforts have been made to help veterans with this transition back into society, there's still a ways to go until veterans receive the treatment and support they very much deserve.
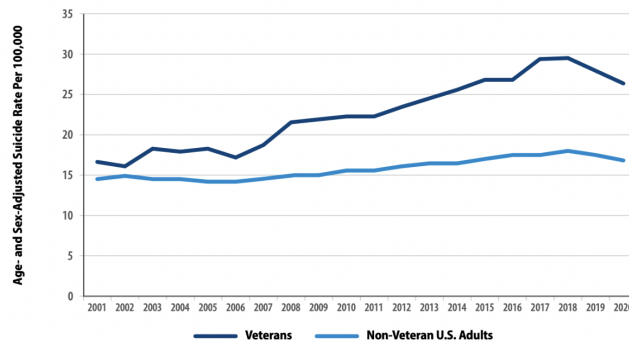

Figure 1: "Age and Sex Adjusted Suicide Rates, Veterans and Non-Veterans US Adults, 2001-2020." *Veteran Affairs*, 2022, https://www.mentalhealth.va.gov/mentalhealth/suicide_prevention/data.asp. Accessed 6 Feb. 2023.

According to the Veteran Affairs' Annual Veteran Suicide Prevention Report for 2022, the veteran rate of suicide in 2020 was 31.7 for every 100,000 people, while for the general population, the suicide rate decreased to 16.1 for every 100,000 people. Essentially, veterans, as of 2020, are two times more likely to commit suicide than average civilians.[62] Additionally, the Veteran Affairs' annual report also measured the suicide rates of veterans to civilians since 2001, and found that this trend is not new (Figure 1). Veterans have been, and are, at a higher risk for suicide than civilians for the past 20+ years. ("Va.gov: Veterans Affairs"). The data is clear, veterans aren't adjusting to society. A team of doctors conducted a study that was featured in the National Library of Medicine and has found that veterans are often diagnosed with PTSD, Depression, Anxiety, etc at least once during their lifetime, and are often diagnosed multiple times for various mental and physical ailments (Inoue et al). With all of these mental and physical health problems which ultimately lead to the high suicide veteran rate, what has the country done to help the millions of men and women who have served to protect the United States?

With all of this clear data, the United States handles its veterans with the Department of Veteran Affairs, also known as the VA. However, the VA has been notoriously blamed and criticized for their poor handling and treatment of veterans. Countless veterans have publicly stated that getting treatment from the VA is extremely difficult. Likewise, families of veterans who committed suicide have blamed the agency for their loved one's death. All the while, the VA claims they have a lack of funding and are short staffed. The VA is a very controversial federal agency. In a Pew research study done in 2015 (Figure 3), it was found that out of all the major federal agencies, the VA was one of the agencies with the lowest public ratings with only 52% of people viewing the agency as favorable and 38% viewing the agency as not favorable ("Most View the CDC Favorably; VA's Image Slips"). This trend continues as 5 years later, the Pew research center conducted the same study (Figure 2) and found that 65% of people view the agency as favorable while 22% view the
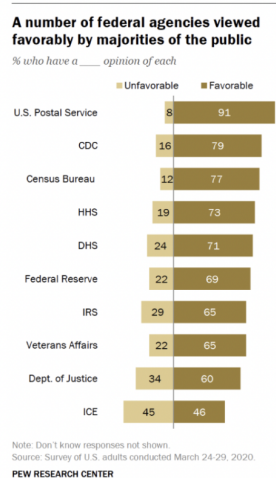
Figure 2: Atske, Sara. "Public Holds Broadly Favorable Views of Many Federal Agencies, Including CDC and HHS." *Pew Research Center - U.S. Politics & Policy*, Pew Research Center, 9 Apr. 2020, https://www.pewresearch.org/politics/2020/04/09/public-holds-broadly-favorable-views-of-many-federal-agencies-including-cdc-and-hhs/.
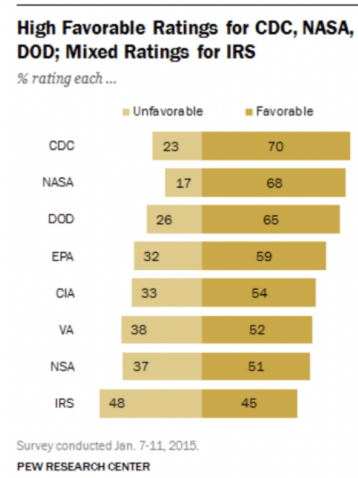
Figure 3: "Most View the CDC Favorably; VA's Image Slips." *Pew Research Center - U.S. Politics & Policy*, Pew Research Center, 22 Jan. 2015, https://www.pewresearch.org/politics/2015/01/22/most-view-the-cdc-favorably-vas-image-slips/ .

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[62] The graph is age and sex adjusted, meaning that based on all of the reported veteran suicides, the number is adjusted to be proportional to the age and sex of the general population. This means that, for this chart, a portion of veteran suicides are left out so that age and sex of the two data sets are proportional. However, the graph's general trend/shape is the same as if the data was unadjusted, but the veteran suicide rate would be at 31.7 instead of around 26.

agency as unfavorable, once again making the VA one of the least favorable federal agencies (Atske). So why is the VA one of the most non-favorable federal agencies? The answer to this question is twofold: the agency's use of government funding and the agency's inability to provide adequate care to veterans.

One of the biggest issues the VA has historically faced is their great lack of order and clarity about the agency's use of funding. First and foremost, Congress has raised the federal budget of the VA by over 300 billion dollars in the past 20 years as there's a notion between Congress and the VA that an increase in the agency's budget will allow the agency to accomplish their goals ("Annual Budget Submissions"). While there is some truth to this theory, as the favorability of the VA has increased, there's still a lot of complaints by veterans as a good portion of the VA's budget isn't used. The USA spending profile for the VA shows that in 2020, the VA was given a budget of 336.14 billion dollars, yet they only used 283.49 billion dollars, a recurring trend by the agency ("Agency Profile: Department of Veteran Affairs"). The Hill also explains that multiple representatives in Congress have explained that the agency not using all of the funding is directly linked to systemic issues such as a lack of leadership, staffing, technology, etc. (Riley-Topping). The government keeps pouring in more money into the VA but with the lack of organization, the VA doesn't use the full budget and doesn't use it right. The consistent trend of the agency not using the full budget has garnered a lot of criticism from veterans, and families of veterans, who can't get the medical support needed, which leads to the mass suicides, homlessness, and precarious lives of veterans.

Historically, the VA has also faced the issue of addressing and identifying veterans with mental health issues. Greg A. Greenberg and Robert A. Rosenheck, Professors of Psychiatry at Yale University explain that mental health issues weren't fully recognized as disabilities till the latter 20th century and it wasn't till the mid 2000's that a comprehensive mental health strategic plan was implemented into the VA (Greenberg and Rosenheck). With the lack of mental health resources till the mid 2000's, many veterans that served in the wars of the 1990's and early 2000's had to deal with mental health issues, without the aid of the VA. However, ever since the establishment of these comprehensive mental health programs, the US Department of Accountability has shown that between 2006 and 2019, the agency has expanded their mental health resources and care to over 90% of veterans and has increased funding on mental health by over 6 billion dollars ("Veterans' Growing Demand for Mental Health Services"). The widespread increase of mental health awareness, diagnosis, and treatment within the VA has helped with the overall decreasing veteran suicide rates, but from a study conducted by Ronald D. Hester and published in the National Library of Medicine, it has been found that there are still thousands of veterans that aren't receiving aid, benefits, treatment, etc, which leads to suicide (Hester). Since there is still a large portion of the veteran population that doesn't have access and in't diagnosed to mental health issues / disabilities, there's still a current issue with veteran suicides linked to the VA not being able to help the whole US veteran population.

Due to the VA being such a vital support network to veterans, as well as a recipient of government funds, the US Government Accountability Office has done multiple investigations

into the department. The Accountability Office has boiled the dysfunction with the agency to five major issues: ambiguous policies and inconsistent processes, inadequate oversight and accountability, information and technology, inadequate Training for VA staff, and unclear resource needs and priorities ("Managing Risks and Improving VA Health Care").

Ambiguous Policies and Inconsistent Processes

The VA is in charge of the whole veteran population of the United States, around 17 million veterans. With such a large veteran population, the VA explains that the agency structures itself into sub agencies, which are specific to certain issues (VA.gov). The Accountability office has explained that there is a lack of communication between the subdivisions of the agency, leading to ambiguous policies. Likewise, the ambiguous policies have hampered the overall organization of the agency, leading to inefficiency and a lack of communication within the VA, ultimately causing the agency to fall behind their veteran help quota. ("Managing Risks and Improving VA Health Care").

Inadequate Oversight and Accountability

With all of the subdivisions within the VA, the Accountability office has explained that there would have to be some sort of strong central leadership, however, there isn't one. There have been several turnovers in senior leadership within the agency, which is causing dysfunction and slowing down the agency's overall work. Furthermore, the VA is supposed to have an Under Secretary for Health to lead the various veteran health programs, but this position remains vacant and instead has had an "informal" executive in charge of the VA's departments regarding health. The creation of informal positions and lack of established positions doesn't help with the dysfunction, accountability, and overall services of the VA. ("Managing Risks and Improving VA Health Care").

Information and Technology

While the VA's leadership sector involving information has been stable, the agency has not upgraded their technology. This lack of upgraded technology creates multiple challenges for the agency in regards to efficiency and organization. Furthermore, the current systems used aren't able to hold the amount of information and veteran requests, which leads to delays and lost requests. There have been efforts to modernize and upgrade the technology, however the department doesn't have a clear plan or timeline of when this upgrade will occur ("Managing Risks and Improving VA Health Care"). Former United States Secretary of Veteran Affairs explans that an upgrade to the VA's technology can also make suicide prevention and access to healthcare easier (Principi). However, the issue still remains prevalent as the VA has been extremely slow with implementing and updating technology.

Inadequate Training for VA Staff

The VA's staff, who work the whole operation, aren't well trained. This lack of training is attributed to the leadership instability, but mostly the issue with the incompetence of the staff is

that there is no central annual training plan for the agency. This lack of central training hampers the communication and standards for the VA Staff. Along with the lack of training for the VA Staff, the agency also doesn't have a central department that enforces the overall goals of the agency and ensures that the individual VA sub-agencies follow and exceed the VA's expectations ("Managing Risks and Improving VA Health Care"). Furthermore, James Webb, a reporter for the *Military Times* and former Marine explains that 90% of the health departments of the VA are reporting that they are understaffed and can't meet the needs of the veterans (Webb).

Unclear Resource Needs and Priorities

The VA has put the agency's budget analysis and resource needs on the backburner. By not submitting the Federal government a breakdown of the budget analysis and actual needs of the agency, the government cannot provide resources and extra funding to the agency as there is no clear plan or organization on what and how the money will be spent ("Managing Risks and Improving VA Health Care").There is clearly an overarching issue with the VA, as demonstrated by the US Government and Accountability Office. The agency is unorganized, lacks leadership / stability, and technology to handle millions of veteran's needs. The inefficiencies and shortcomings of the agency end up hurting the United State's veterans. For example, Army Major Greg Black suffered from PTSD, brain injuries, anxiety, and depression. His mother explained that, "Greg struggled to get care from a broken medical system. Prescriptions didn't arrive on time; lab results were difficult to track down. He had been waiting for more than a year to get approved for psychotherapy" (Black). Black eventually killed himself as he wasn't being treated for his ailments and couldn't afford to pay for his own medical treatment. Black's story of not being able to get the help he needs is a direct reflection of the inability of the VA to function. All of the factors identified by the US Government and Accountability Office showing the inefficiency (due to the 5 factors) follow the situation in which Black, and numerous other veterans, have experienced. The lack of centralized leadership creates inconsistencies and instabilities between the VA's sub agencies slowing down the communication and effectiveness of the VA. Furthermore, the lack of updated technology constantly gets overdriven with veteran help requests leading to the "loss" and delays of these requests being fulfilled. Over the past few years, the VA has continuously been trying to reform, yet consistently falls short.

Illustration 2: Anne Black looks at a photo of her son, who died by suicide earlier last year (2022). He had suffered from a traumatic brain injury and severe PTSD from injuries sustained in military service.

Pinto, Anjali. "Anne Black and a Photo of Her Son, Gregory." *My Son Took His Own Life. This Is What It's like to Lose Someone You Love to Veteran Suicide*, 19 May 2022, https://www.today.com/parents/essay/veteran-suicide-army-son-mental-health-rcna27024. Accessed 6 Feb. 2023.

The Department of Veteran Affairs serves a very important role in helping with the mental and physical needs of the United State's veterans. However, there have been huge overarching issues hampering the effectiveness, stability, and efficiency of the agency. These issues not only hurt the agency, but negatively impact the veterans the agency was established to

protect. While the agency has helped thousands of veterans, they have not even come close to stopping the suicide rate of veterans -- a key directive of the department. The Veteran Affairs' Secretary Denis McDonough expresses to multiple media outlets that "One veteran suicide is one too many, and the VA will continue to work with our federal, state, local, and private partners to tackle this problem and save veterans' lives" (Shane). Once the Department of Veteran Affairs is able to confront and fix its many issues, they might one day live up to their goal of no veteran suicides.

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The Evolution of the United States Aid to South Vietnam By Jake Elgart

After World War II, a rise in Vietnam Nationalism and Communism in the North led to insurgencies throughout the former French colony, leading to the 2nd Indochina War. After years of fighting, by the 1950's the French couldn't justify holding onto its colonies in Indochina, which led to peace talks and Vietnamese independence. However, the growing power of the North Vietnamese Communists led the United States to heavily aid the South Vietnamese to prevent the spread of communism over the rest of Indochina ("Foreign Aid"). Between 1950-1973, the United States aided the South Vietnamese, however, this aid took different forms as the conflict progressed. Ultimately the United States went in a full circle with the type of aid given to South Vietnam as the aid in the 1970's was very similar to that of the 1950's.

Economic aid given by the United States to South Vietnam began when the French had no chance to hold onto their colonial holdings in Indo-china after the battle of Dien Bien Phu in 1954. By 1955, as the French began their withdrawal from Vietnam and the peace talks were occuring, the United States flooded the newly established Republic of Vietnam (South Vietnam) with foreign aid -- giving the new democratic republic, under President Diem, millions of dollars for military and social purposes ("Foreign Aid"). With the end of the Geneva Accords, the communist Democratic Republic of Vietnam (North Vietnam) was officially established and support for the regime was growing in popularity among the public of both North and South Vietnam. This popularity was detrimental to the survival of the Republic of Vietnam, as the Geneva Accords insisted that nationwide elections in Vietnam would be held to create a unified government. The support gained by the North Vietnamese prior to these elections worried President Eisenhower since the wide support almost ensured that the communist North Vietnamese would prevail. So, the Eisenhower administration began flooding the South Vietnamese with economic aid to secure the legitimacy of the South Vietnamese government and President Diem through civil services.

By 1959, after no elections were held to reunite Vietnam, North Vietnamese forces began to infiltrate the South via the Ho Chi Minh Trail. The purpose of these forces were to instigate violence, destabilize and overthrow the South Vietnamese government, and "liberate" the south (Brigham). As the conflict moved into the 1960's, starting with the Kennedy administration and later the Johnson administration, the US began devoting more funds to the south vietnamese government. However, instead of civil services, these funds were being used to train the Army of the Republic of Vietnam (ARVN) how to fight as well as securing the rural South Vietnamese population through the development of Hamlets ("JFK and Vietnam "). With the Gulf of Tonkin incident in 1964, the Johnson administration dramatically increased the amount of aid given to South Vietnam by increasing the amount of US troops present in the country as well as allowing these troops to engage in armed conflict (Germany). The aid given to South Vietnam through the 1960's contrasts completely with that of the aid in the 1950's. Whereas the economic aid given to the South Vietnamese in the 1950's was meant to help South Vietnam prevent major armed conflicts, stabilize the South Vietnamese government, and prevent direct US involvement in

South Vietnam, the aid given by the US in the 1960's brought hundreds of thousands of US troops into the country and provoked several major conflicts.

The rapid escalation of the conflict and US involvement by the mid 1960's led to many protests and discontent within the US and by the 1968 election, Richard Nixon was elected President, largely for his staunch opposition to communism and the opposition to the continuation of Johnson's policies ("Richard Nixon 1968 Presidential Campaign). Upon being inaugurated, Nixon set out to make it very clear to the US public that he was going to shy away from Johnson's policies and, rather focus on the strengthening of the South Vietnamese and transfer of the war to them:

The policy of the previous administration not only resulted in our assuming the primary responsibility for fighting the war, but even more significantly did not adequately stress the goal of strengthening the South Vietnamese so that they could defend themselves when we left…We have adopted a plan which we have worked out in cooperation with the South Vietnamese for the complete withdrawal of all U.S. combat ground forces, and their replacement by South Vietnamese forces on an orderly scheduled timetable." (Nixon)

Nixon's plan for Vietnam, addressed in this speech, gave way to what Nixon dubbed Vietnamization. This Vietnamization plan provided economic aid to South Vietnam and slowly withdrew US troops. By the 1970's, the US was withdrawing thousands of troops and gave economic aid in the form of training ARVN and providing the south with advanced weaponry ("Nixon and Vietnam"). The Vietnamization of the war closely resembled the aid given by Eisenhower in the 1950's as, like Eisenhower, Nixon was trying to cease direct US involvement in the war (i.e. ground troops and bombing raids). He followed, essentially, the exact beliefs Eisenhower held: the US's involvement in Indochina (and other regions) should strictly just be given economic aid so that countries can defend themselves against communist threats.

When looking at the various forms of aid the US gave to South Vietnam during the mid-20th century, I believe the US went in a full circle. Under Eisenhower, getting the US directly involved in the conflict in Indochina militarily didn't make sense so the US opted to give the country economic aid (for civil and military purposes) to combat the spread of communism. By the 1960's, economic aid didn't seem to benefit the conflict and so the US sent ground troops and got heavily involved in the various conflicts in Indochina. However, once the hope for victory became dismal, the US decided to take its combat troops out of the country and go back to the use of economic aid, like that in the 1950's.

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Insights to Reducing Susceptibility to False Memories Through Music Composition By Sara Singhal

Abstract

In a recent study combining research from eight memory implantation studies, researchers found that 22% of subjects reported "complete" or "substantial" false memories and another 9% reported "partial false memories". Other studies have also assessed whether music has an impact on the memory systems in the brain. According to Pfizer, research has found that listening to or making music "lights up" the limbic system, which processes emotions and controls memory in the human brain. However, false memory has not been assessed in relation to the creation of music. False memories, as defined by the American Psychological Association, are distorted recollections of events or recollections of events that never actually occurred. The objective of this hypothetical study is to aid researchers in determining whether composing music affects the susceptibility of 20 to 40 year-olds to false memories through the Deese-Roediger-McDermott (DRM) task. Results would be measured by asking participants, who would be split into sub-sets based on their experience composing, to complete a set amount of time composing a musical piece and subsequently completing the DRM task, which is a false memory paradigm. I hypothesize that participants with the most experience composing will display better recall memory and have the least amount of false memories as compared to groups with less experience composing and the control group participants. This hypothesis is based on prior research that has demonstrated that those who listen to and/or create music have lower rates of stress, anxiety, and poor concentration, meaning that music is contributing to the brain in a positive manner. As a result of the study, researchers can determine the effect that composing music has on false memory susceptibility. Based on the results, researchers and medical professionals will be able to guide memory patients and the public towards developing less susceptibility to said memories.

1 - Introduction

False memories, as defined by the American Psychological Association (American Psychological Association 1), are distorted recollections of events or recollections of events that never actually occurred. "Complete" or "substantial" false memories were found in 22% of the subjects of memory implantation studies, and "partial false memory" was found in another 9% of subjects (Nash et al. 31). As such, the prominence of false memories seems to be an issue that affects our present day. However, the field of false memory in research is not extensive, as the topic began to gain popularity only beginning in the 1990s. Because of this, music and its ties to false memory have not been extensively researched, but research on listening to music and its connection to the brain's memory functions implies that the two could have a connection. Pfizer stated that the limbic system, a system processing emotions and controlling memory, "lights up" when listening to or making music according to various research studies (Fink 1).

Much of the research that exists on music in relation to memory, like the aforementioned research, focuses on these specific forms of music: listening to or playing music. Such studies fail to mention how music exists in many forms, including music composition. Musical composition, as defined by Britannica, is the act of conceiving a piece of music (Crossley-Holland & Ringer 1). Moreover, the lack of investigating false memory in these studies leads to a substantial gap in the field. In order to explore whether or not all forms of creating and listening to music affect memory, and more specifically false memory, this paper aims to aid in evaluating the question of "to what extent does composing music affect false memory susceptibility in adults ages 20 to 40 years old?".

1.1 - Structure of Review

In order to determine that there is a relevant gap in research pertaining to false memory and music composition, literature was gathered on both music and false memory. It was found that literature on false memory and literature on music composition was scarce. Therefore, much of the review focuses on music's effects on the brain and its connection to general memory, later transitioning to and discussing ties to false memory. After this synopsis, a proposal for a study that aims to bridge these gaps in literature is provided.

2 - Literature Review

False memory is a topic that has only recently been researched. Although false memories were known of since the time of the psychologist Freud, the first influential study in the field was published in 1975 (Psychologist World 1). As such, it makes sense that its relation to music is not entirely known. Looking at the few amount of papers that have been published on false memory and on music in this narrow period, there is shown to be a significant gap in the research on false memories involving the composition of music.

2.1 - Music and the Body

Music has been used to distract from and alleviate physical pains for decades (de Witte et al. 135) and has recently begun to be researched. A study by researchers from Mexico and Denmark in 2019, for instance, explored fibromyalgia and how music reduces the pain of the condition. Fibromyalgia is a chronic pain condition that affects about 4 million US adults and is associated with problems with thinking, memory, and concentration (Centers for Disease Control and Prevention 1). According to the study, listening to music that was self-chosen and relaxing alleviated some of the patients' pains (Pando-Naude et al. 1). Listening to music in relation to pain relief was also explored in a 2017 study by researchers in Tunisia, in which they looked at the effects of musical therapy under local or general anesthesia in abdominal surgery patients. Their results found that listening to music under anesthesia can lower cortisol levels during surgery and decrease pain and stress after (Kahloul et al. 1-5). These decreases in pain from both this study and the fibromyalgia study may be the result of music providing a distraction and facilitating positive emotions, shifting brain activity away from the connectivity patterns related

to pain (Pando- Naude et al. 5). In this sense, music may be a way to alleviate from normal stress functions in the human brain that affect false memory.

2.2 - Music and the Brain

This hypothesis on shifted brain activity seems to be supported by some of the literature existing independently on music and its effects on the brain (Umbrello et al. 7-13). A study on critically ill patients and music therapy found that 30 minutes of music therapy a day was associated with lower rates of anxiety and stress (Umbrello et al. 7-13). This is consistent with the aforementioned shift of brain activity, as the causes of anxiety and stress are said to be shifted away. However, in a 2020 experiment exploring the effect of background music on sustained attention, the researchers found that subjects listening to their preferred background music were able to be more focused and have their minds wander less compared to subjects not listening to music (Kiss & Linnell 2313-2325). These contrasting results, one which portrays music as a distraction and the other which portrays music as a focus aid, make it difficult to support the hypothesis completely. They also bring to light how music can be used and presented in different forms, such as through music therapy or through background music. Regardless, the literature displays that music has numerous positive effects on the brain.

2.3 - Music and Mood, and its Effects on Memory

Mood and emotion are also significant features of the human experience, and swings in mood are often associated with some physical ailments and mental disorders (Sekhon & Gupta 1). A study from a researcher at the University of Zurich found that listening to or making music increases blood flow to regions of the brain that generate and control emotions (Jäncke 1). For instance, the limbic system, a system that is involved in processing emotions and controlling memory, is said to "light up" when music is perceived (Jäncke 1). Keeping the mention of memory in mind, a study from the University of Virginia on mood and the false memory effect used music to manipulate mood. Sad music inspired sad emotion, which resulted in less susceptibility to false memory, while happy music and resulting happy emotion led to increased susceptibility to false memory (Storbeck & Clore 785). Music was also used to manipulate mood in a study from the University of Groningen, in which visual perception was being studied. This study involved "false alarms", strongly influenced by mood. One of the primary conclusions was that mood, manipulated by music, may directly alter perception of the world (Jolij & Meurs 1). This literature combined incites the question of how music, independent of other factors, influences memory, and whether different forms of music can affect memory in the manner that different moods were in Storbeck and Clore's study (Storbeck & Clore 785).

2.4 - Music and Memory

There is some existing literature on music in relation to memory independently (Simmons-Stern et al. 1)(Roden et al. 1)(Leggieri et al. 1), albeit existing primarily with listening to or playing music. A study on music-based memory enhancement in Alzheimer's Disease

found that participants who heard lyrics sung rather than spoken scored better on a general memory test of the lyrics of a song (Simmons-Stern et al. 1). Another study by two psychology professors in Germany instead tested children who attended music lessons vs. children who didn't in memory over a set period of time. The children who attended music lessons showed greater improvements in terms of memory than children in the control group (Roden et al. 1). Whereas the other study looked at listening to music in relation to memory, Roden et al.'s study investigated playing music, finding similar results. However, a study on music and patients with Alzheimer's disease from the University of Toronto found that music listening and active music therapy had two different effects, with listening being relaxing and music therapy giving social benefits (Leggieri et al. 1). These social benefits include interactions between the patient and the therapists and acts of clapping, dancing, and playing instruments, all of which encourage social relationships with others and emotional introspection (Leggieri et al. 1). These results point to a potential difference in the way the brain is affected based on the method of music. Additionally, it's important to note that the composition of music is not acknowledged in these studies, displaying that the composition of music and memory has not been researched. In terms of false memory, music in relation to false memory has been researched but with limited literature on the subject, contrasting results, and no investigation of the composition of music. A study from Keele University investigated the effects of music genre and tempo on false memory formation, which meant that participants listened to background music. The researchers found that slower tempos resulted in higher susceptibility, but genre had no significant differences, meaning that music did have an effect through tempo (Kamal & Berry 42). Furthermore, in another study investigating the effect of music on stress and false memory, no significant differences were found. The author used exposure to music, and also suggested that music may not be best for alleviating stress from false memory (Gatmen 1).

The field of music has an overwhelming lack of research on false memory in relation to it. Most existing relevant literature also doesn't factor in composition of music. Moreover, because of several studies displaying that music has a profound effect on the brain and the questions that literature on music and mood incite, a study on false memory in relation to music composition would be a valuable addition to both the independent and combined fields.

3 - Proposed Study–3.1- Participants

For the most credible and robust study, researchers should aim to include at minimum 50 participants. This is line with the participant count for studies in the false memory field such as the mood and false memory study by Storbeck and Clore (Storbeck & Clore 785). In a previous study, I determined that the age group of 41 to 55 year olds was more susceptible to false memories than 13 to 18 year olds, meaning that susceptibility increases as age increases. Because of this, the age group of 18-41 year olds seems to be a middle ground. Furthermore, the age group of 20 to 40 year olds narrows this down a little more. Therefore, participants should be aged 20 to 40 years old. This would exclude anyone within this age group with a history of

trauma, depression, and/or high stress, as these individuals are suggested to have a higher risk of producing false memories that may interfere with such a study (Otgaar et al. 1).

3.2 - Materials

The Deese-Roediger-McDermott task is a false memory paradigm also referred to as the DRM task. This is a commonly used paradigm for the field of false memory, used in literature throughout the field (Storbeck & Clore 1) (Pardilla-Delgado & Payne 1), making it a reliable and credible method to conduct the proposed study (Pardilla-Delgado & Payne 1). This paradigm involves presenting lists of 15 semantically related words from Stadler, Roediger, and McDermott's lists, explained in their 1999 study and included in its appendix (Stadler et al. 494-500). All 15 of the words are related to a "critical lure", which refers to a non-presented word that is highly associated to the words presented in the list. It can be conducted in an auditory or visual fashion, with the difference between the two only being that one requires auditory software and one requires visual software. Overall, its goal is to assess whether participants falsely recall or falsely recognize a non-presented word, which would be a false memory. Because of this, the DRM task includes two parts: the free recall portion and the recognition portion. The free recall portion requires all participants to have a blank piece of paper or a blank online document, such as one on Google Docs or Microsoft Word, ready. Furthermore, the recognition test involves using experiment creation software in which participants can indicate whether the word they are being presented was part of the DRM task list or was not (Pardilla-Delgado & Payne 1).

In order to assess how composing music affects false memory susceptibility, participants should have access to a composition software. Flat, which can be accessed at flat.io, and Noteflight, accessed at noteflight.com, are two online music notation platforms that are easily accessible. Experimental group participants should create accounts or use previous accounts if applicable for one of these softwares or a similar software in order to compose music.

3.3 - Procedure

Once a substantial amount of eligible 20 to 40 year old participants are gathered, participants should disclose hours spent composing music. Groups should be 0 to 10 hours, 10 to 30 hours, and 30+ hours, or adjusted as seen fit. Half of participants in each group should then be assigned to the control group, and the other half should be assigned to the experimental group.

The control group should participate in only the Deese-Roediger-McDermott Task. For the free recall portion of the task, the control group should be presented with either a visual or auditory DRM task list and then given 10 minutes to recall as many words as possible, written down on a medium of choice. An inclusion of the critical lure in said list should be deemed a false memory. The free recognition portion should involve participants indicating on a computer whether certain words were included in the list or not. If a non-presented word is indicated by a participant as otherwise, it should be deemed a false memory.

The experimental group should be required to compose a musical piece before participating in the Deese-Roediger-McDermott Task. All participants in the group should be given one hour to compose an original music piece. Afterwards, with as little delay as possible, participants should complete the DRM Task in the same fashion as the control group. This will ensure that there are no differences in results based on a change in the DRM task itself.

4 - Discussion and Conclusion

The brain although complex in nature is responsible for controlling memory and vision, among other things (Johns Hopkins Medicine 1). With this, the literature review sought to compile existing research that explores false memories and its possible association with music. The relationship between false memories and music remains understudied. A protective effect and/or the identification of whether or not music is positively associated with the reduction of false memory propensity has not yet been concluded. The increasing reports of false memories or the distorted recollections of events led us to explore music as a potential therapy (Nash et al. 31). The present research proposal was comprised of a literature review as well as a hypothetical research study that may aid in filling in the gap and proposing future research examining music composition as a therapeutic mechanism to aid in false memory propensity.

From the literature review, we identified three major takeaways. First, there is a lack of literature looking specifically at the composition of music in the field of false memory. Second, the relationship between false memory and music has not been well characterized. Lastly, very few studies have investigated the differences or conserved facets between listening, playing, and composing music as well as memory altering neurodegenerative diseases other than Alzheimer's Disease in relation to music. Thus, it's important to identify through additional research what benefits patients of such diseases, as music therapists decide interventions based on the needs displayed (Parkinson 1). Consequently, the proposed study brings to light the question of whether all music forms serve as an efficient therapy or method to decrease memory altering diseases. Potential findings may be that the composition of music creates a creative and inspiring atmosphere which allows the composer to focus more efficiently, resulting in false memory susceptibility to decrease, such as in studies by Hogenes et. al that suggest better levels of comprehension from music composition (Hogenes et al. 1). An alternate finding may be that the composition of music increases stress in participants and increases susceptibility. Such potential findings can influence not only the field of music therapy but also methods of treating Alzheimer's Disease and similar diseases. Furthermore, potential limitations of the proposed study include difficulty with software, as much of the DRM task requires specific software that can influence a study if not created correctly. Another limitation includes finding a minimum of 50 eligible participants, as United States federal data has shown that the share of adults reporting symptoms of anxiety and/or depressive disorder are the highest in those 18-24 years of age and 25-49 years of age (Lee 1). These limitations could be overcome by carefully following the Deese-Roediger-McDermott task requirements, and by incentivizing to colleges and similar institutions that include both music and non-music focused areas. Taken together, the proposed

study would help enhance existing literature in the fields and include more research on false memory and music to aid with music therapy for memory altering neurodegenerative diseases.

5 - Acknowledgements

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Happiness and the Economy: Evidence from More than 100 Countries By Athipatana Iamphongsai

Abstract

The relationship between happiness and economic indicators has long been a topic of debate and discussion among economists. Many researchers have been interested in the topic, specifically the effects that inflation and unemployment have on happiness. In this article, I study the influence that inflation and unemployment have on happiness by using the largest most up-to-date possible dataset. The data used for analysis are inflation rate, unemployment rate and happiness index from over 100 countries. I calculate correlation coefficients, run trendline regressions and draw scatter plot diagrams to mathematically analyze the data. The trendline regressions show that as inflation and unemployment increases, the overall happiness in a country tends to decrease. In fact, the calculation of the correlation coefficients shows that unemployment has a greater impact on happiness than inflation does (-0.19 vs -0.17). According to this study, inflation and unemployment inversely affect happiness. This study solidifies the belief that a better economy leads to higher social well-being, or happiness

Keywords: Happiness; Inflation; Unemployment; Correlation Analysis

Introduction

Humans have long been intrigued by the relationship between economic indicators such as income, GDP, inflation, and unemployment on social well-being, or what we call happiness. Easterlin (89-125) was one of the first authors to introduce literature on this topic by analyzing the relationship between income and happiness among the citizens of nineteen countries. His results show that the richest people tend to be the most happy. However, as time passes by and the per capita income in the country increases, the average happiness among the citizens of a nation does not increase. This result led to the famous Easterlin's paradox which has been studied by various researchers including Clark et al. (95-144), Angeles (67-73), and Frank (1188-1191).

Another notable contribution to the field is Oswald (1815-1831), who examines the influence that economic growth within a nation has on the well-being of the citizens of the nation. Most politicians and policymakers assume that developing a country's economy will positively affect the overall well-being of a nation's citizens. Nearly everyone believes that this assumption is a fact, but nobody validified it until Oswald came along. Oswald proves this statement by analyzing well-being data in western countries. He used data on reported happiness, reported life satisfaction, reported job satisfaction, and the number of suicides. Oswald's result suggests that, in a developed country, economic growth only slightly increases the overall well-being. This result contradicts with the general consensus that economic growth is essential for great well-being.

Later, Di Tella et al. (335-341) was one of the novel researchers who introduced the study of the correlation of happiness with inflation and unemployment. The authors gathered information on happiness data in twelve European countries and the United States of America from the Euro-Barometer Survey Series from (1975-1991) and the United States General Social Survey (1972-1994). Their results confirm that an increase in inflation and unemployment rate has adverse effects on the overall happiness of a nation. Blanchflower extends the research beyond inflation and unemployment by studying the effects that GDP per capita and interest rates have on overall happiness. His results show that GDP per capita and interest rates are inversely proportional to happiness, but to much less extent than that of inflation or unemployment. Moreover, the paper concludes that unemployment has greater effects on happiness than inflation. Other studies regarding the relationship between economics and happiness include Frey and Stutzer (402-435) which studied the influence of economic variables and institutional factors on happiness, Ruprah and Luengas (59-66) which examined the correlation of happiness with inflation and unemployment in Latin America, and El Ouardighi and Munier which researched the influence of economic variables and heterogeneity/nonlinearity on happiness.

In this paper, I also analyze the influence that inflation and unemployment have on happiness. However, previous papers on this topic have limited their data only to some continents and some of the data sets are no longer up-to-date. Therefore, the current paper differs from other papers in the sense that I use the biggest and most up-to-date happiness data. I gathered information on happiness data from the World Happiness Report which includes data from over 100 nations each year.

The rest of the paper is organized as follows: In section 2. I present the data that I gathered and the methodology I used to investigate the information. Then in section 3., I present my results using scatter plot diagrams and analyze the results. Finally, in the last section I provide some concluding remarks and a discussion.

Data and Methods–Data

I use happiness data from the World Happiness Report. The World Happiness Report is a publication of the Sustainable Development Solutions Network. The report was created to raise awareness on the importance of happiness for government policy. The World Happiness Report collects data on six variables that they believe affect the overall happiness of people in a nation and estimates the correlation these variables have with happiness. These six variables are GDP per capita, social support, healthy life expectancy, freedom, generosity, and corruption. However, the happiness rankings that are present in the report do not have any association with data on the six variables. Rather, life evaluations from the Gallup World Poll are the basis for the happiness rankings each year. Happiness scores are collected by asking people to rate their lives on a scale of zero to ten, where zero represents the worst possible life and ten represents the best possible life. The happiness index for a nation comes from averaging the happiness scores of nationally representative samples over three years. Then, the report will use the happiness index to rank

countries from happiest to unhappiest. In this paper, I use the happiness index as our only metric to evaluate happiness. I collected the data for every possible country from 2013 to 2022.

Another variable that is present in the current paper is inflation. For variable inflation, the primary metric that I use is the data that is present in the series Inflation, consumer prices (annual %) from The World Bank's World Development Indicators (WDI). Inflation, consumer prices (annual %) is a measure of the change in the average cost to buy a basket of goods. This information is gathered by the International Monetary Fund. I collected the data for every possible country from 2013 to 2022.

The final variable that is present in this paper is unemployment. For variable unemployment, the primary metric that I use is the data that is present in the series Unemployment, total (% of total labor force) (modeled ILO estimate) from The World Bank's WDI. This is simply the unemployment rate that is estimated by the International Labor Organization (ILO). I collected the data for every possible country from 2013 to 2022.

Table 1 below presents descriptive summary statistics for all the variables I use in the empirical analysis, particularly, the mean (average), the median, the standard deviation as well as the minimum and the maximum values of all three variables: Inflation (in percentage), unemployment (again in percentage) and happiness levels.

Table 1. Descriptive Summary Statistics for the Whole Dataset

Variable	Mean	Median	Std. Dev.	Minimum	Maximum
Inflation (%)	5.742440128	2.807	22.7749	-3.23338934	557.2018174
Unemployment (%)	7.310169091	5.590	5.3383	0.100	29.806
Happiness (Index)	5.523989183	5.504	1.1290	2.69300008	7.842

Methods

I gather information on happiness data, inflation, and unemployment from the sources stated above. Then, for each year, I determine the countries that have data on all three desired variables. Once I have determined all the countries, I fill out an excel sheet with all the determined countries on one column and three other columns that report inflation, unemployment rate, and happiness index for each year. Then, I use this excel sheet to calculate correlation coefficients, run trendline regressions and draw scatter plot diagrams.

Results

Below I will present the correlations between inflation and happiness as well as unemployment and happiness in various scatter plot diagrams separately for years between 2013 and 2022
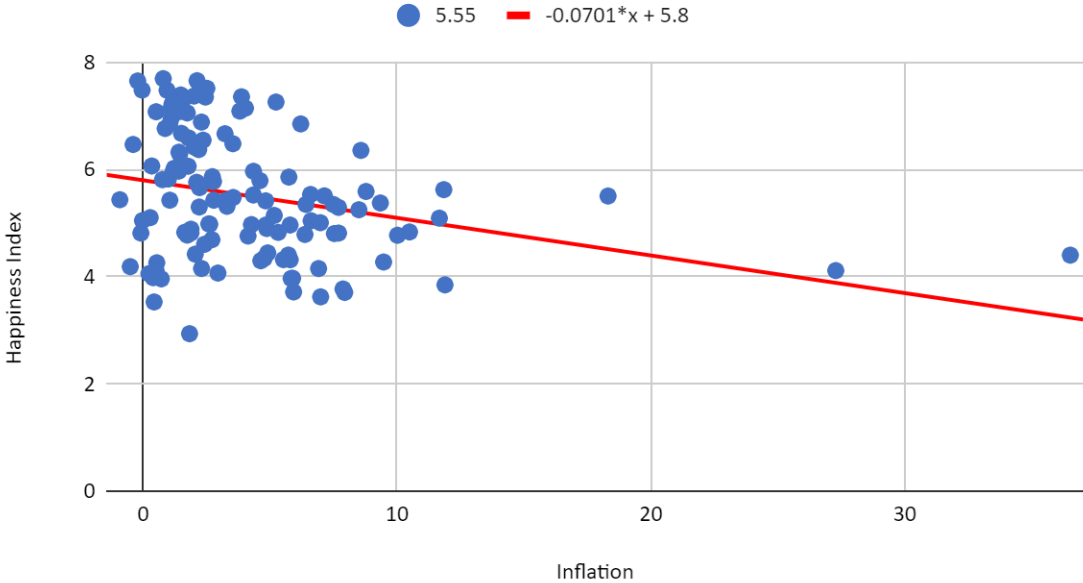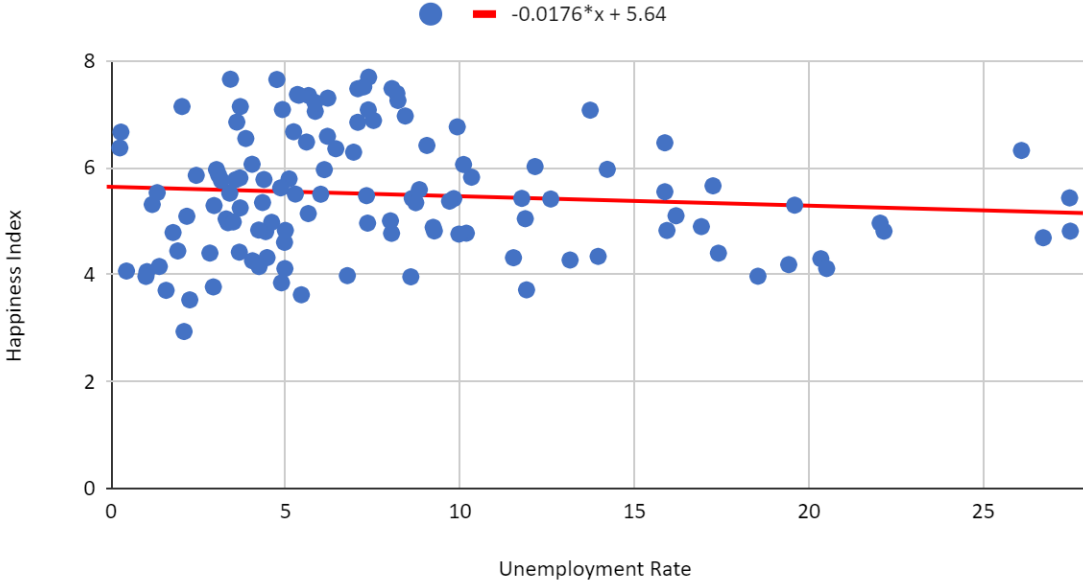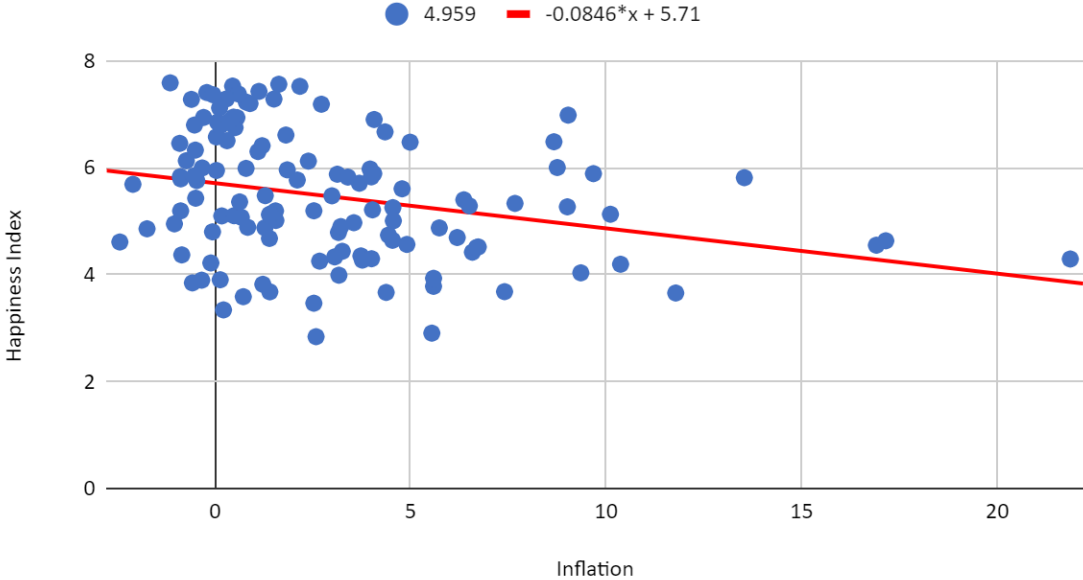
Figure 1. Happiness vs. Inflation in 2013

Figure 2. Happiness vs. Unemployment in 2013

Happiness vs. Inflation
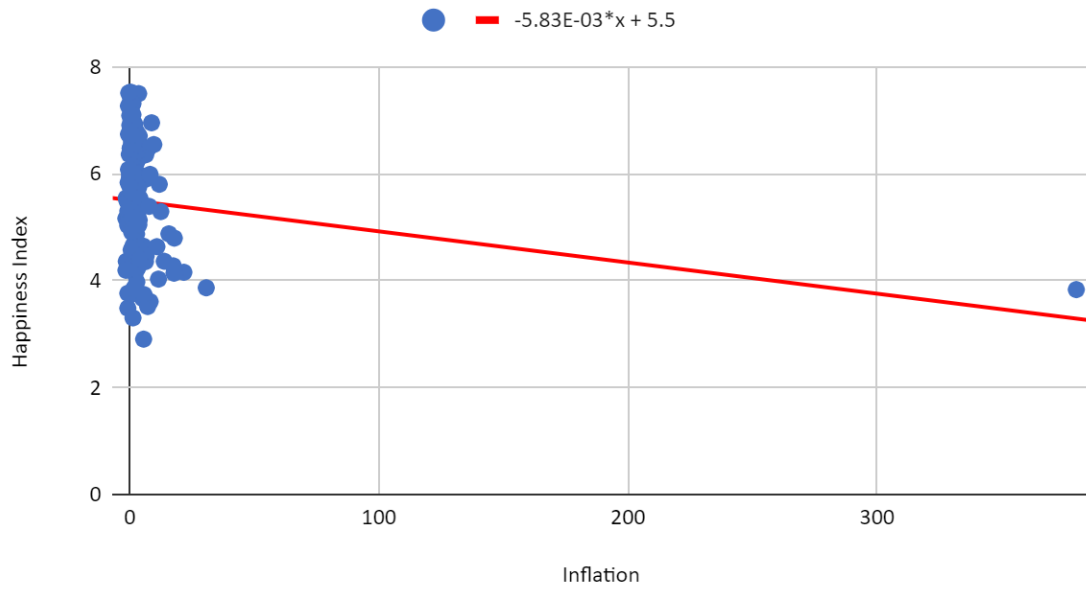

Figure 3. Happiness vs. Inflation in 2015

Happiness vs. Unemployment
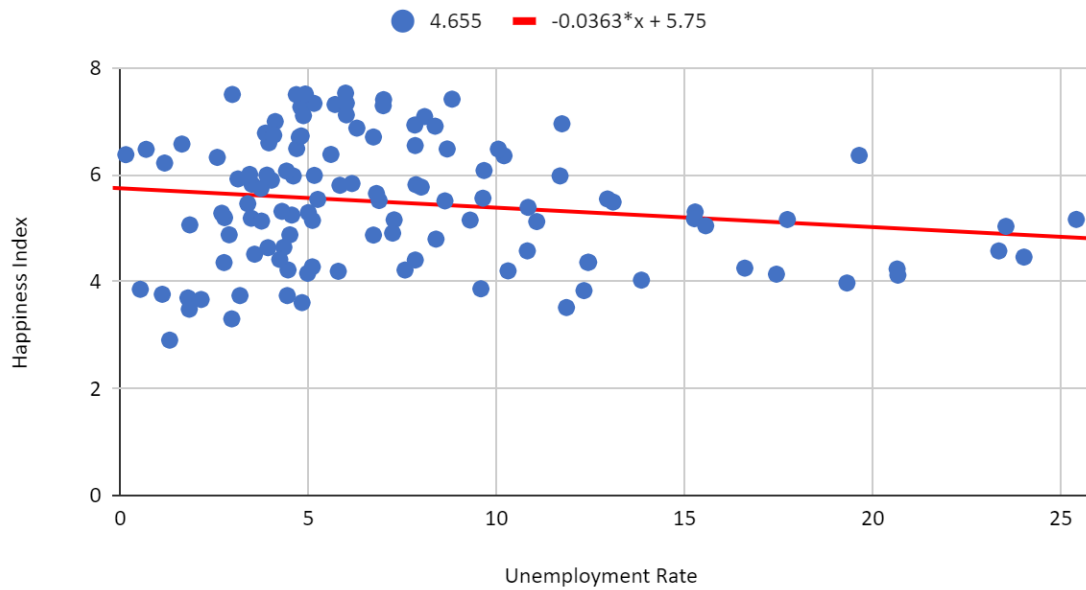

Figure 4. Happiness vs. Unemployment in 2015

Happiness vs. Inflation

Figure 5. Happiness vs. Inflation in 2016

Happiness vs. Unemployment

Figure 6. Happiness vs. Unemployment in 2016

Happiness vs. Inflation

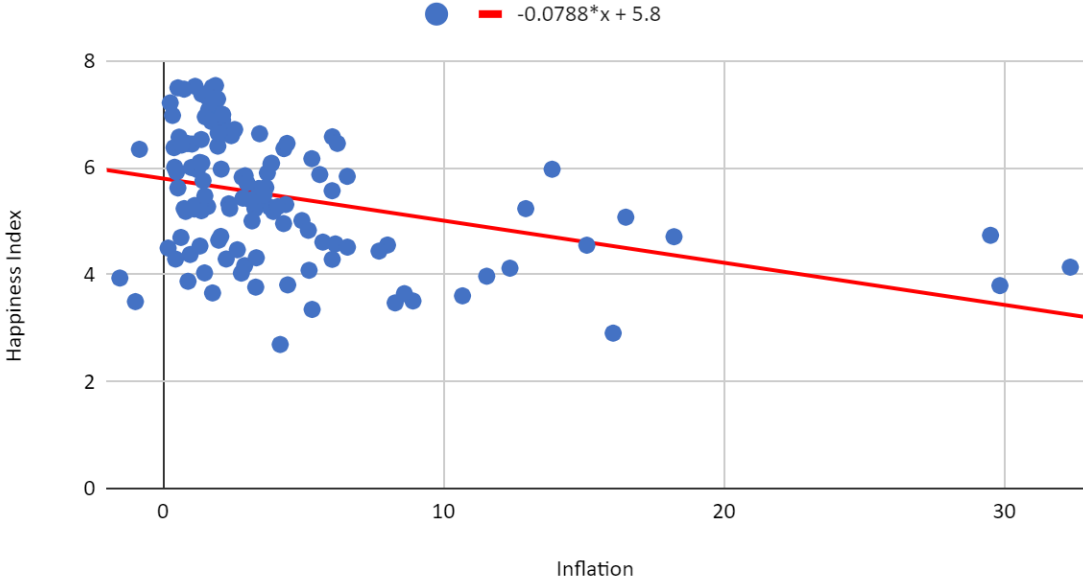-0.0788*x + 5.8

Figure 7. Happiness vs. Inflation in 2017

Happiness vs. Unemployment

4.644000053   -0.0395*x + 5.75

Figure 8. Happiness vs. Unemployment in 2017

Figure 9. Happiness vs. Inflation in 2018

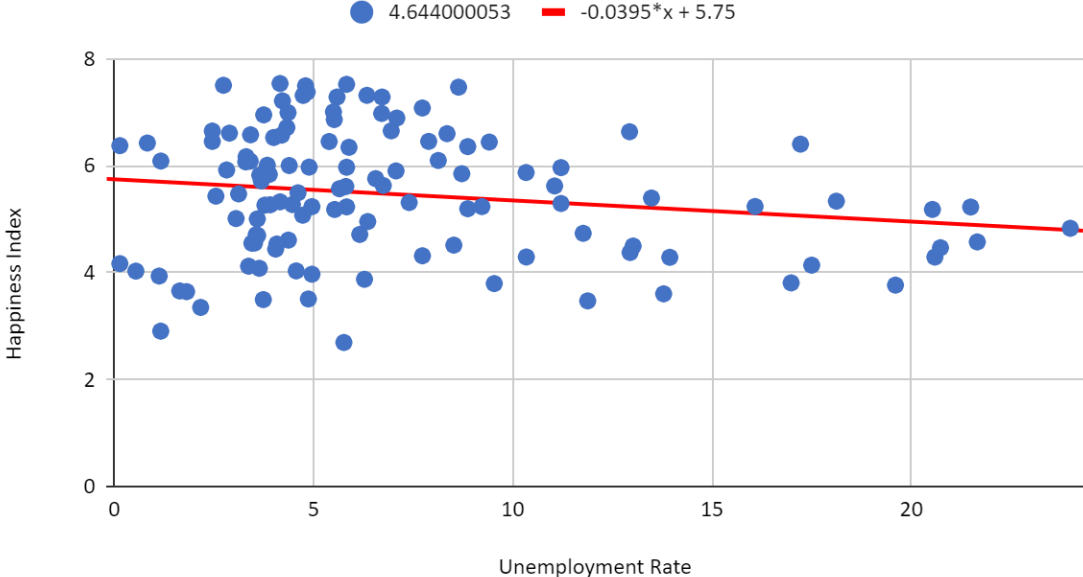**Figure 10. Happiness vs. Unemployment in 2018**

Happiness vs. Inflation

Figure 11. Happiness vs. Inflation in 2019

Happiness vs. Unemployment

Figure 12. Happiness vs. Unemployment in 2019
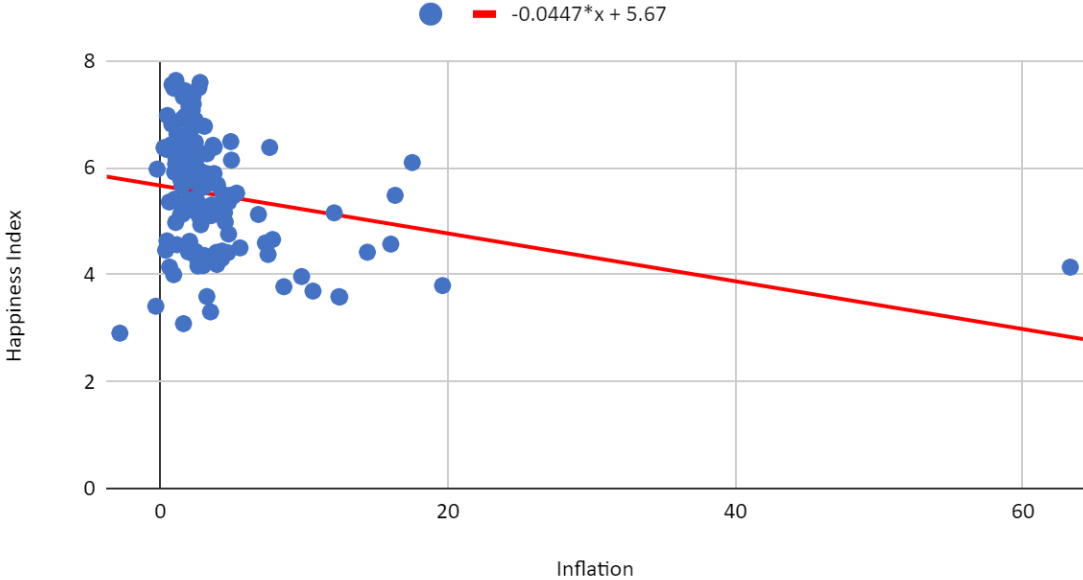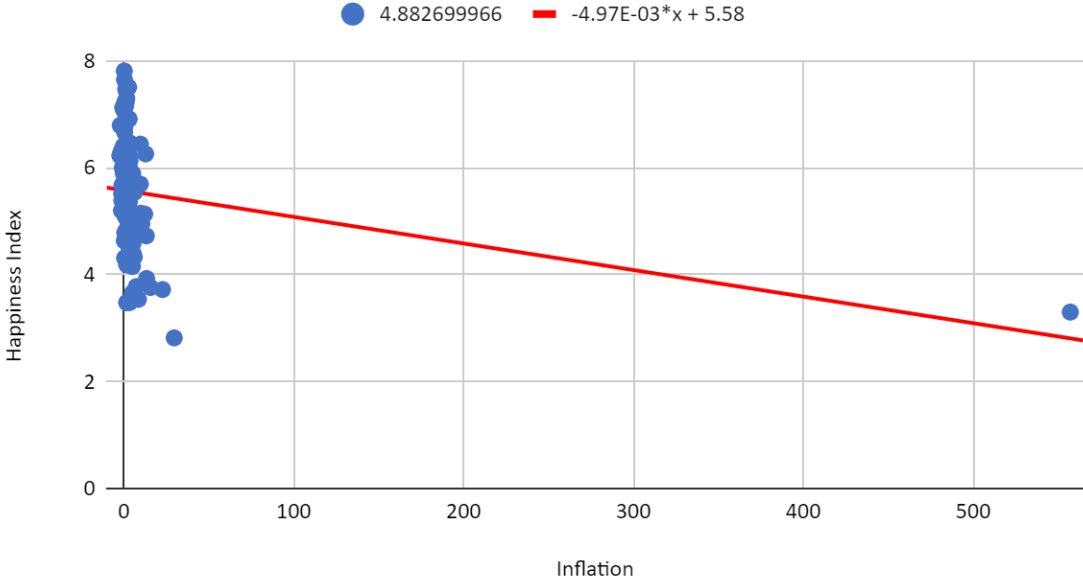
Figure 13. Happiness vs. Inflation in 2020

Figure 14. Happiness vs. Unemployment in 2020

Happiness vs. Inflation
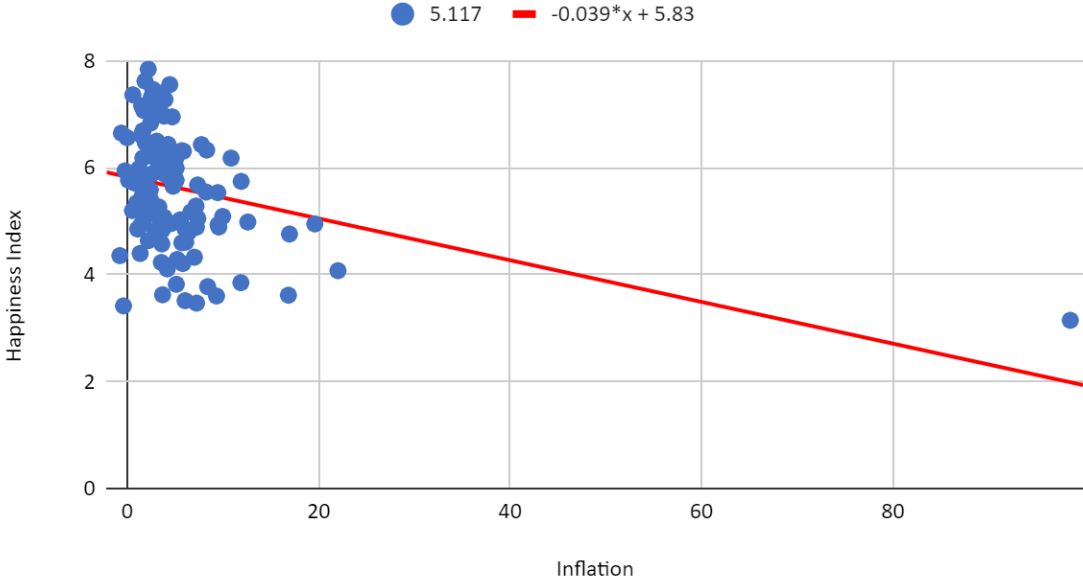
Figure 15. Happiness vs. Inflation in 2021

Happiness vs. Unemployment

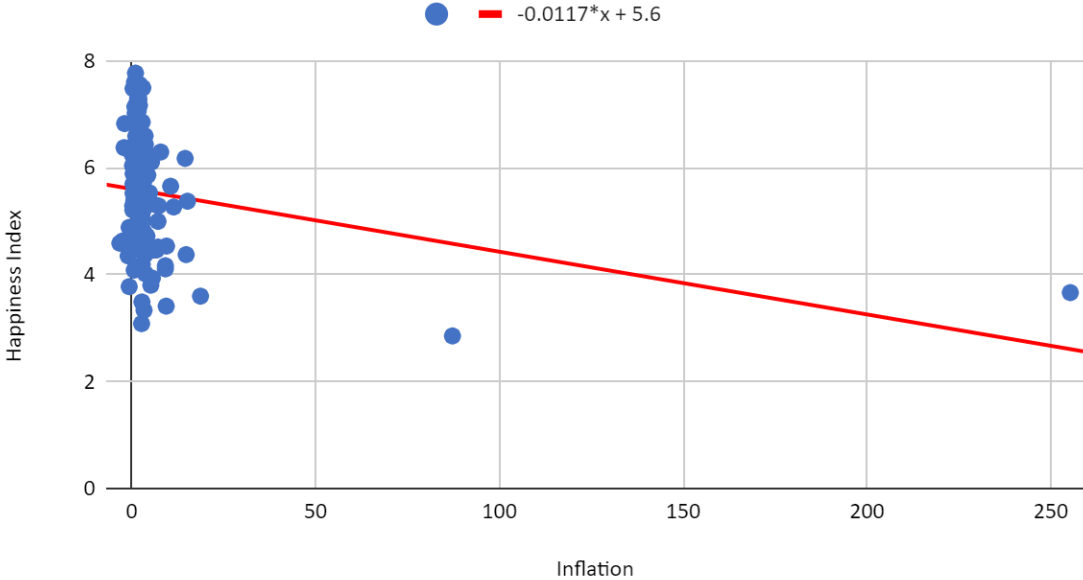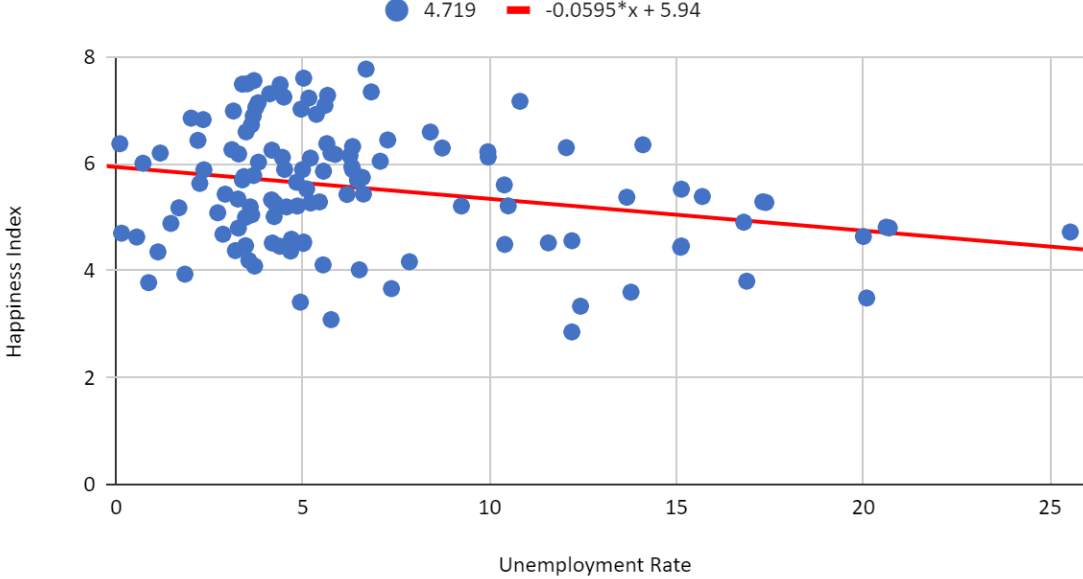**Figure 16. Happiness vs. Unemployment in 2021**

Happiness vs. Inflation

-0.0282*x + 5.99
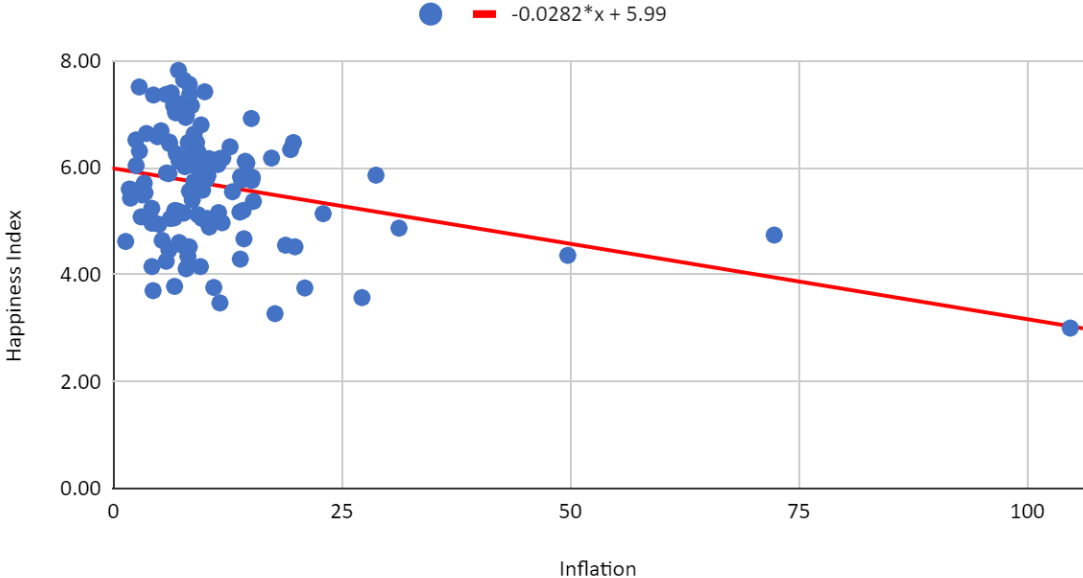
Figure 17. Happiness vs. Inflation in 2022

Happiness vs. Unemployment

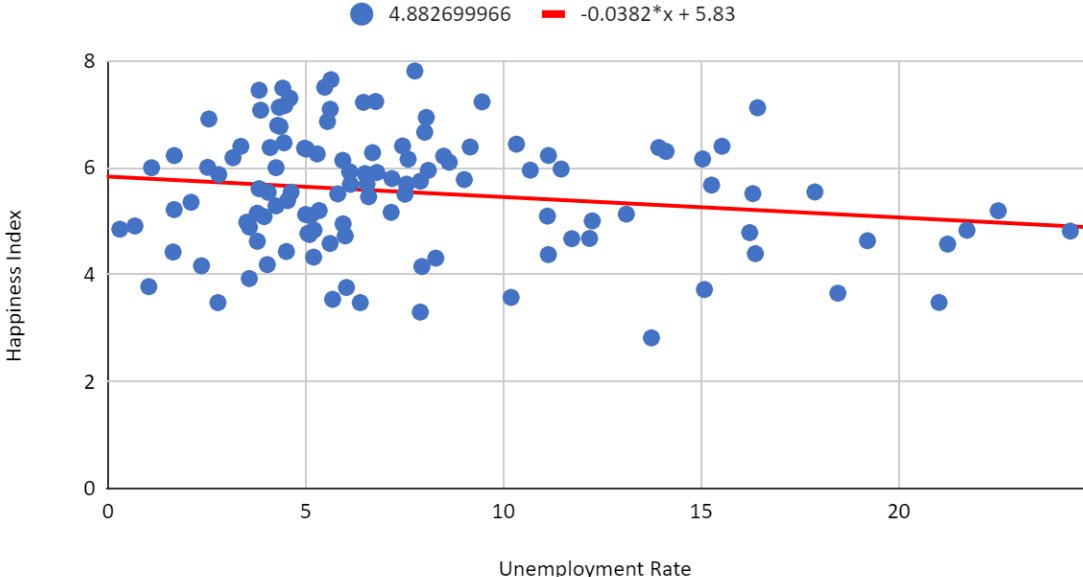5.20   -0.0604*x + 6.08
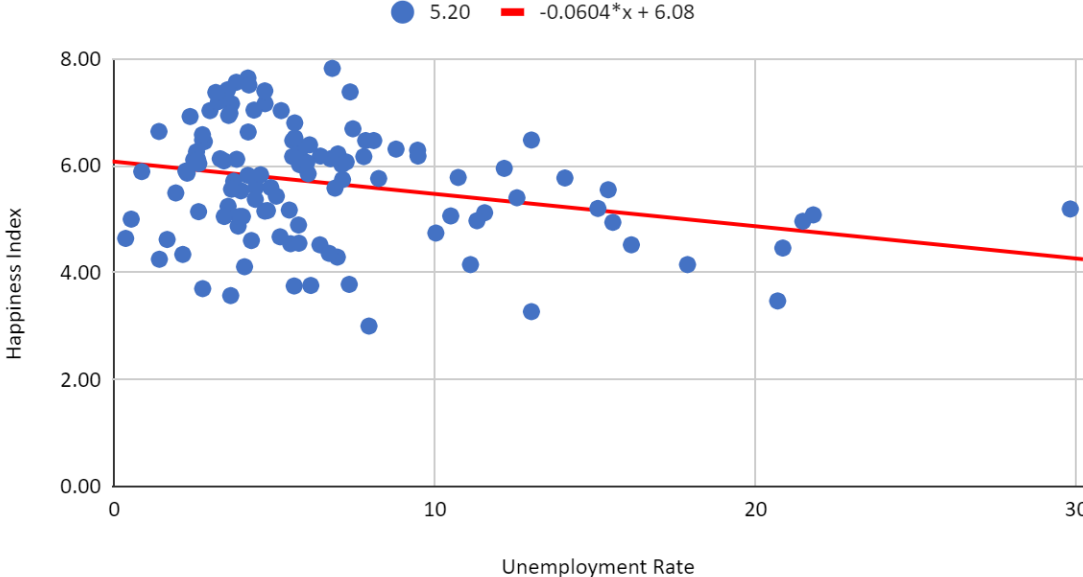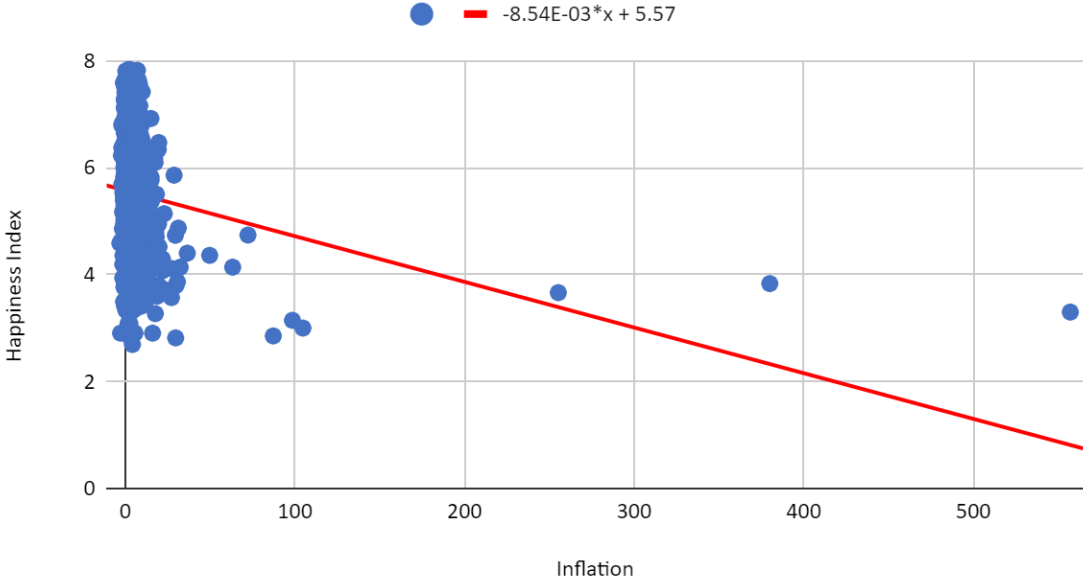
Figure 18. Happiness vs. Unemployment in 2022

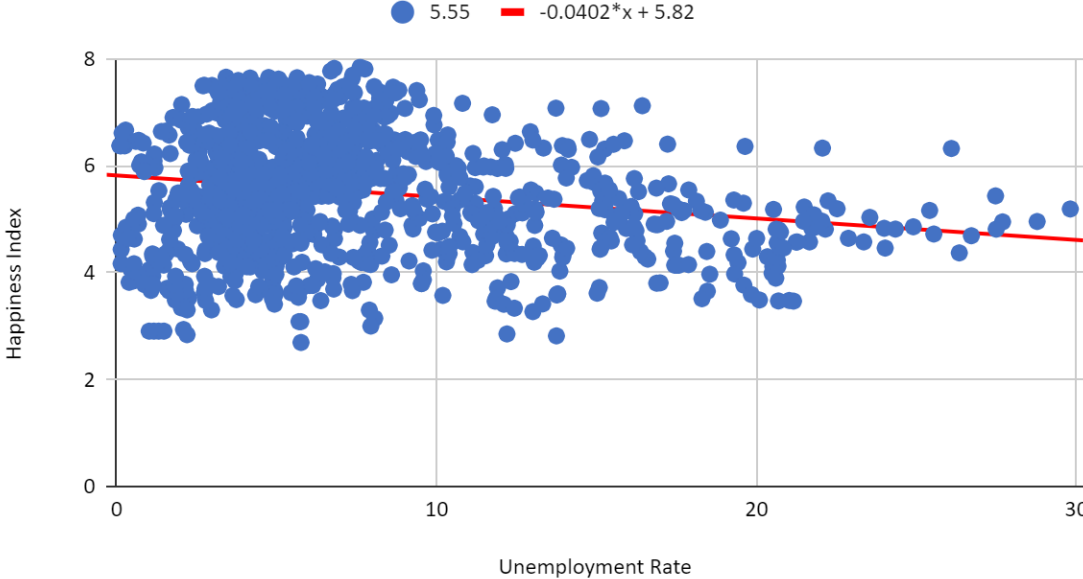**Figure 19. Happiness vs. Inflation All Years**

Figure 20. Happiness vs. Unemployment All Years

Table 2. The Correlation of Happiness With Inflation and Unemployment

Correlation of Happiness with	Inflation	Unemployment
2013	-0.297165678	-0.09524923354
2015	-0.2865615709	-0.1392357301
2016	-0.1724145953	-0.1754896955
2017	-0.3721139129	-0.1795222788
2018	-0.2569970262	-0.202853117
2019	-0.252065551	-0.2699288052
2020	-0.2278767516	-0.182280346
2021	-0.3381727751	-0.2228190924
2022	-0.3252065977	-0.2839340867
For All years	-0.1723257124	-0.1896740477

Figure 1. shows a scatter plot diagram that expresses the relationship between happiness and inflation in 2013, and Figure 2. expresses the relationship between happiness and unemployment in 2013. Figure 3. to Figure 18. run in the same pattern from 2015 to 2022. There is no scatter plot diagram present for the year 2014 because The World Happiness Report was not published in 2014. Moreover, Figure 19. illustrates the relationship between happiness and inflation for all the years studied, and Figure 20. does the same for happiness and unemployment for all the years studied. Although each scatter plot diagram has its own unique characteristics, it can clearly be seen that all of the scatter plot diagrams have a trendline with negative slope. This demonstrates that happiness, to some extent, is inversely proportional to inflation and unemployment.

Table 2. shows the correlation coefficients between happiness and inflation, and happiness and unemployment for years between 2013 to 2022. Clearly, all of the correlation coefficients presented in the table are negative. This further reinforces the observation that an increase in inflation and unemployment will lead to less happiness. Furthermore, when all years are viewed as a whole, the correlation between happiness and unemployment is more negative than the correlation between happiness with inflation. Hence, we can come to the conclusion that both an increase in inflation and unemployment will have a negative impact on human's overall well-being. However, the information from the correlation coefficients tell us that unemployment has a slightly larger influence on happiness than inflation.

Conclusion

In this paper, I study the influence that inflation and unemployment have on the overall happiness of people. I gathered information during the time period 2013-2022 from over 100 countries. Then, I took this information and analyzed it through drawing scatter plot diagrams, running trendline regressions and calculating correlation coefficients to mathematically analyze the data. My results from all of the aforementioned methods suggest that as inflation and

unemployment increases, happiness tends to decrease. In fact, my analysis also provides evidence that unemployment has a more significant impact on happiness than inflation does.

The results from this paper certainly solidify the common belief that a better economy leads to higher social well-being, or happiness. However, the significance of economic prosperity on happiness is still a matter of debate and discussion. Therefore, future research on similar topics should aim to determine the significance of economic indicators on happiness. For example, future papers may try to determine an equation that estimates the overall happiness of a country's citizens from economic indicators such as inflation, unemployment, and GDP per capita. Furthermore, I believe that this paper will serve as an overall analysis for a large number of countries over several years. I believe that others can extend from this paper by analyzing a certain country in more depth and over a longer period.

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Optimization of Tritium Breeding Ratio in a DT and DD Submersion Tokamak Fusion Reactor By Vikram Goel

Abstract

The mass of stars is enough to confine a plasma to fuse light atoms, but this is not possible to engineer on Earth so nuclear engineering can rely on the magnetic confinement of a plasma using superconducting coils. There are, however, numerous engineering challenges that must be addressed, the foremost of which is the Tritium Breeding Ratio (TBR). This paper will address this issue and investigate some of the materials used that can increase and hone the rate at which Tritium is produced within the breeding blanket layer of Submersion Tokamak reactors, a design that uses magnetic confinement of a plasma in the shape of a torus to execute nuclear fusion. Modelling on how neutron multipliers, enrichment and neutron energy spectrum may affect the Tritium breeding ratio (TBR) tallies in submersion tokamak reactors is undertaken. Using the Paramak module in Python to construct several geometries and then using OpenMC to run a simulation, an observation of how these factors affect the TBR is possible. This will mainly observe different material choices that have been considered and their TBR based on their cross sections, dose rate, thermal properties and safety. Since Lithium reacts with the neutrons in the plasma to produce Tritium through the Li-6(n, alpha)H-3 reaction, this paper will look at Lithium based and therefore, materials containing Lithium-6. Then, altering the neutron energy spectrum between 2.5 and 14 MeV to account for DD vs. DT plasma, the difference in these compounds' Tritium breeding efficacy is noted. Neutron energy spectra are an important factor in optimising the TBR levels as the neutrons generated by the fusion reactions in the plasma interact with the breeder material in the blanket and produce tritium through the reaction with Lithium. The TBR is a very important statistic to consider when designing fusion reactors as Tritium is a rare isotope of hydrogen that is used as fuel in fusion reactions and has a short half-life, making it essential to produce tritium within the fusion reactor itself. Without the tritium breeding capability, it would not be feasible to generate energy via fusion. A TBR greater than unity indicates that the reactor can generate more tritium than it consumes, ensuring self-sufficiency in the tritium inventory and since tritium is the most reliable and efficient fuel for these reactors, optimising the TBR becomes one of the most important problems in the long road to commercialization of nuclear fusion.

Introduction

In the realm of energy production, nuclear fusion has emerged as a field of immense importance and potential as a promising source of clean and sustainable power. Fusion energy, simply put, is the energy released when light atomic nuclei combine to form heavier nuclei. This process occurs at incredibly high temperatures and pressures, replicating the conditions found in the core of stars. Unlike current energy sources, such as fossil fuels, it produces virtually no greenhouse gas emissions or long-lived radioactive isotopes. Furthermore, fusion energy has the

potential to provide an almost limitless source of power, promising a sustainable and clean solution to our ever-growing energy needs.

To comprehend the various forms of nuclear fusion reactions, it is essential to explore the fundamental principles governing these processes. Fusion reactions can occur between different isotopes, with the most promising reactions involving deuterium (H2) and tritium (H3) nuclei. The fusion of these hydrogen isotopes releases a significant amount of energy and produces alpha particles as a byproduct. Additionally, alternative fusion reactions, such as the fusion of deuterium with helium-3 or boron-11, offer unique advantages and challenges, making them worthy of investigation, this paper will not delve into these though they are worthy of investigation.

To study and analyse the complex behaviour of nuclear fusion reactions, scientists often employ Monte Carlo simulations. These simulations utilise probabilistic methods to model the behaviour of particles within a system, providing insights into the dynamics of nuclear reactions. Monte Carlo simulations involve the generation of random numbers to determine the characteristics of each particle, allowing researchers to predict the behaviour and outcomes of fusion processes accurately. By simulating a large number of particles, scientists can obtain statistically significant results and optimise experimental designs, ultimately advancing our understanding of fusion energy and aiding in the development of practical fusion reactors.

One of the most important statistics concerning fusion reactors is the Tritium Breeding Ratio, hitherto TBR. This is a representation of the ratio of the rate at which tritium is produced in a fusion reactor to the rate at which it is consumed. Since Tritium is the most important fuel source in most reactors, it is essential to produce Tritium within the reactor itself: Tritium has a very short lifespan (12.3 years) and out of all the Hydrogen in the universe, tritium only makes up 10^{-18}% while deuterium sits at 0.2%. This small quantity is meaningless and therefore tritium is made artificially using CANDU fission reactors so it is not viable to continuously add tritium to reactors, therefore, maintaining a TBR greater than unity is essential for commercialising DT nuclear fusion.

The main component of nuclear fusion reactors, specifically tokamaks, that is affiliated with the TBR is the breeding blanket. The breeding blanket is usually made of either Solids, Liquids (PbLi), Molten Salts (FLiBE), or pure Lithium. For this paper, a survey of two several breeder materials was undertaken as well as observing the impacts of Li6 enrichment and neutron multiplier concentrations.

3: Methodology–OpenMC, DAGMC, Paramak and Defining Computational Intensity

Neutronics modelling and simulation is conducted using a monte carlo simulation tool, known as OpenMC. The OpenMC module simulates neutral particles (presently neutrons and photons) moving stochastically through an arbitrarily defined model that represents a real-world experimental setup [10]. It was developed by the Computational Reactor Physics Group (CPRG) based at the Massachusetts Institute of Technology (MIT) and has been extensively utilised in the area of nuclear engineering.

For this research, a geometry for a Submersion Tokamak reactor was constructed using the Paramak python module developed by Jonathan Shimwell [2]. This library makes use of parametric shapes, components and reactors, and is essential for constructing complex geometries that could be assigned different materials within the OpenMC model. Though OpenMC manipulates Boolean operators to construct simple geometries, it is difficult to construct a complex tokamak with a high degree of similarity to what is used in actuality through OpenMC alone. Upon constructing the geometry, Paramaks computer-aided design (CAD) would be converted into a 'dagmc.h5m' file, the format which works with OpenMC, using the cad_to_dagmc python module. Then, a neutronic simulation was conducted using a Python script. Within the OpenMC model, the different parametric shapes could be assigned to various elements and densities then, after introducing a neutron source a simulation using 10 rounds of 10,000 particles was conducted.

Within the model, interchanging between Lithium compounds was simple and separate tallies for these different blanket materials were generated using the 2.5 and 14 MeV neutron energy spectra.

The Monte Carlo Simulation

OpenMC uses a method that resembles the MC21 monte carlo code (A neutron and photon transport code). To provide workability in a macro environment OpenMC uses an analogue estimator to obtain its tallies for reaction rates, using massive amounts of nuclear data, a survey is taken of the number of actual reactions that occur and then this is used for their estimates on what the reaction rates and therefore, the scores should be.

This is represented by the equation:

$$R_x = \frac{1}{W} \sum_{i \in A} w_i$$

"Where Rx is the reaction rate for reaction x, i denotes an index for each event, A is the set of all events resulting in reaction x, and W is the total starting weight of the particles, and w_i is the pre-collision weight of the particle as it enters the event."
OpecMC Analog Estimator Formula [1]

This analogue estimator is the simplest way to estimate and is easy to implement, using this OpenMC may use nuclear cross sections data for neutron multipliers and Li6 to generate its scores on the TBR, but this estimator has variance since low-probability reactions will require an immense amount of information and particles to calculate to a high degree of accuracy. Therefore, OpenMC also uses a collision estimator and a track length estimator to get around this issue.

The collision estimator does not simply add to a tally once a reaction has been carried out, it will use every collision to add to the score, for example, in the context of Tritium

Breeding, it will not only add to the tally every time tritium is produced but every time there is a collision between the reactants that may or may not produce tritium.

Materials

The design used for this paper is the Tokamak, it is the leading style of fusion reactor and its geometry is shown in Figure 1. The magnetic coils that were created for this simulation were Niobium Titanium (NbTi) coils chosen due to their superconductivity, high critical current density, fabrication availability and mechanical strength. These attributes mean that it has zero electrical resistance, allows a high current to pass through without reverting to its conducting state, can be easily made into wires and coils and importantly, can withstand the immense electromagnetic forces within a tokamak. We also used a similar metal, Nb3Sn for the outer toroidal field coils for the same reasons, Tungsten for the first wall and components directly adjacent to the plasma due to its thermal properties and Titanium supports. A Beryllium blanket wall was used, to maximise neutron multiplication and Stainless Steel 316 for the poloidal field coils casing as it tolerates elevated temperatures.
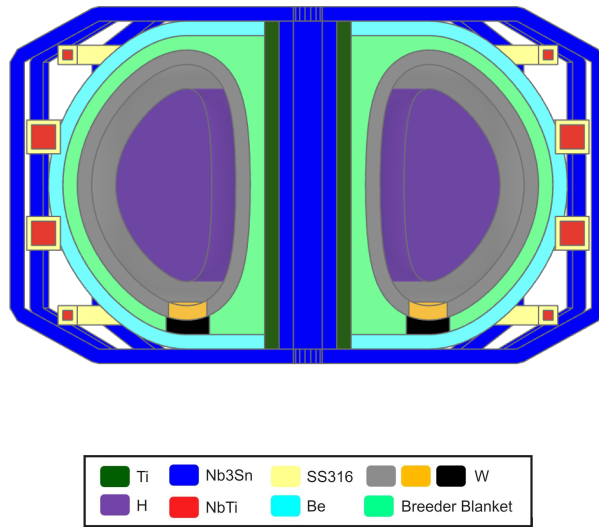
Figure 1, Diagram of the Geometry of the Submersion Tokamak

For this simulation, we observe how these different materials compare when used as breeder blankets in producing Tritium. This will be done with both Deuterium-Tritium (D-T) and Deuterium-Deuterium (D-D) fuel. While D-T is a lot more powerful and yields more energy and tritium, the deuterium isotope of hydrogen is far more abundant. It has a longer life making it less expensive and more feasible for implementation. The two hydrogen plasmas will react to form 14.1 MeV and 2.5 MeV neutrons as shown:

$$D + T \rightarrow [\alpha + 3.5 \text{ MeV}] + [n + 14.1 \text{ MeV}]$$

$$D + D \rightarrow 3He + [n + 2.5 \text{ MeV}]$$
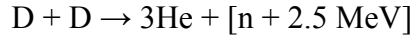
A Beryllium (Be) or Lead (Pb) neutron multiplier will increase the number of neutrons by initialising the (n,2n) reaction. For the breeder blanket materials, a variety of Lithium-based alloys and compounds were used, Lithium is especially important for the breeder blanket as it reacts with neutrons to produce tritium and, when paired with a Beryllium (Be) neutron multiplier, it will efficiently produce tritium at a rate higher than unity (TBR = 1). It is the most reliable element to use in breeder blankets as its only two stable naturally occurring isotopes react with the neutrons as shown:

$$^6Li + n \rightarrow \alpha + T + 4.78 \text{ MeV}$$
$$^7Li + n \rightarrow \alpha + T + n + 2.47 \text{ MeV}$$
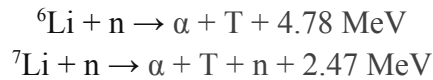
Energy Production and extraction within these tokamak reactors is a tedious engineering task: The kinetic energy of the incident neutrons must be converted into thermal energy for it to be excavated by the coolant. The breeder blanket can augment the incident energy via exothermic reactions including the $^6Li(n,t)^4He$ reaction which has a Q value of 4.79MeV. Assuming the use of Pb multipliers, DT fusion devices will perform better multiplication due to high neutron multiplication cross-section at those energies as shown in Figure 2.
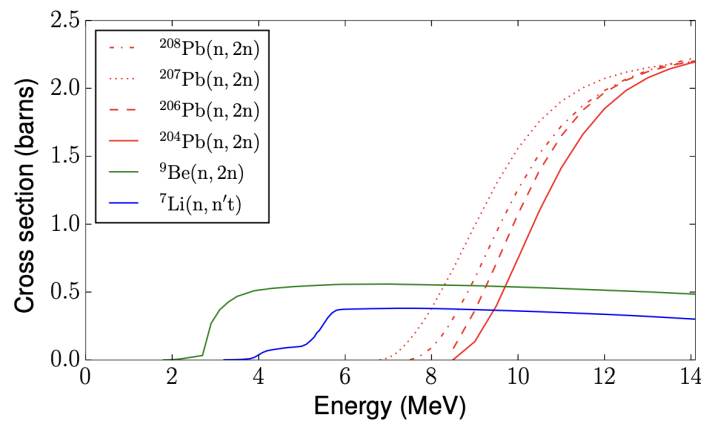
Figure 2: Cross Section vs Energy, Chadwick, M et al. [3]

Results

Shown below is a table consisting of the Tritium Breeding ratio for several Lithium-Based materials that are used as a breeder blanket in a Submersion Tokamak with both 14.1 MeV and 2.5 MeV neutrons, these were obtained upon the completion of the monte carlo simulation:

Lithium-Based material	Tritium Breeding Ratio	Tritium Breeding Ratio

	Tally (14MeV)	Tally (2.5MeV)
Li2ZrO3 (Lithium Zirconate)	0.974073	0.490369
Li2TiO3 (Lithium Titanate)	0.980266	0.501079
Li4SiO4 (Lithium Orthosilicate)	1.00325	0.525374
LiCl (Lithium Chloride)	1.04656	0.539386
FLiBe (LiF and BeF2)	1.08196	0.569398
Li2O (Lithium Oxide)	1.09383	0.542774
Li17Pb83 (90% Li6)	1.14519	0.570423
Li (Pure Lithium)	1.10905	0.543946

Table 1: TBR Results

Lithium - 6 Concentration

It appears as though the concentration of Lithium-6 is the factor that most affects the TBR as it has a high cross-section for neutron absorption and is the isotope of Lithium that produces the Tritium via Li6(n, alpha)H3, so the TBR of breeder material Li17Pb83 was measured over different levels of enrichment of Lithium-6:
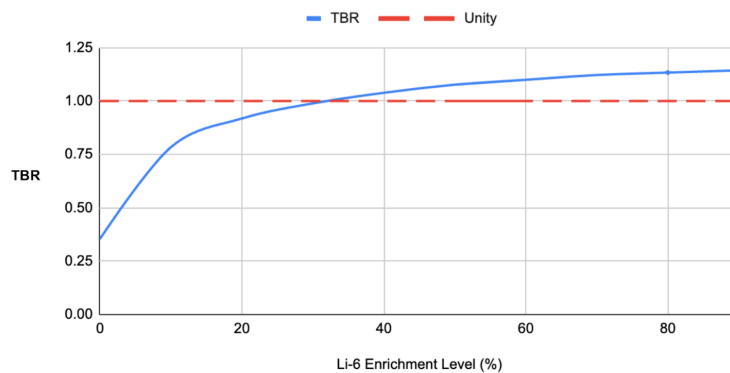

Figure 3: Enrichment vs TBR

Li17Pb83 is usually used as a breeder with a Li-6 concentration of 90% or higher, this is feasible as it has a low overall Lithium concentration and high reliance on the lead as a multiplier. The graph between li6 enrichment as a decimal and the TBR can be described by this equation with under a 5% margin of error for the largest outlier:

Y = 0.34 log [1.4(X) + 1.11], {0<X<1}
Where Y is the TBR and X is the Li6 enrichment as a decimal

Since lead, as shown in Figure 2, has a high cross section for neutron multiplication by the (n,2n) reaction at ~6.5 MeV or higher, D-D neutrons (<6.5MeV) perform worse at a Tritium breeding rate of less than half of what it is for D-T neutrons (>6.5MeV).

The answer considering the TBR is clear: The higher the concentration of Lithium and thereby, Lithium-6, the greater the raw Tritium Breeding, but this is not to say that pure Lithium-6 is the best material to use as a breeder - there are many other factors to consider, Pure Lithium has inferior thermal properties when compared to Lithium Titanate or Lithium Orthosilicate and is unable to withstand immense heat, it is also more unstable than these compounds and therefore poses a safety risk when used in the breeder blankets. It is also not as strong mechanically and is far more pliable in its pure state, a reason why alloys or compounds prove beneficial. The material must withstand extreme temperatures, and electromagnetic forces so Lithium is simply not as reliable.

Furthermore, as this graph for Li-6 concentration vs TBR is logarithmic, there is little need, in most cases to enrich further than 40%, increasing Li-6 concentration to this level changes the TBR by about 0.7, but a further increase to 90% will only change the TBR by about 0.1.

Ceramic, Liquid and Molten Salt Blankets

The breeder materials observed using the OpenMC simulation are ceramic liquid and molten salt breeders. Li_4SiO_4 (Lithium Orthosilicate), Li_2O (Lithium Oxide), Li_2ZrO_3 (Lithium Zirconate), and Li_2TiO_3 (Lithium Titanate) make up the ceramic breeders, they all have TBRs close to 1, ranging from 0.97 to 1.0 (nearest hundredth) and their energy multiplication are also similar with Lithium Titanate coming out on top at 1.15 and the lowest at 1.05 [4]. They have similar thermal properties including their melting point and thermal expansion. Their thermal properties and resistance to strong electromagnetic forces within the tokamak make them especially useful over pure Lithium or weaker alternatives. Lithium vacancy in Li_4SiO_4 may interact with tritium resulting in some confinement, an essential outcome for extracting energy and recycling Tritium efficiently. The formation energies of the vacancy−tritium complexes are in the range of 0.41 - 1.28 eV under oxygen-rich conditions [6].

Liquid breeder materials have several qualities that make them superior when compared to their ceramic counterparts including thermal conductivity, fabrication availability and the ease at which they can be removed for Tritium Extraction [8]. PbLi100, a liquid breeder that we simulated in addition to those in the table above, has a TBR of 1.24918 with D-T and 0.639227 with D-D, topping both categories.

PbLi100	1.24918 (DT TBR)	0.639227 (DD TBR)

Table 2: PbLi100 TBR

Though Lead Lithium with its high TBRs may seem ideal, they suffer from high inefficiency as the next chapter describes.

Dose Rates

Even Li17Pb83 and other PbLi-based breeders have the highest TBRs at around 1.2 in our simulation. But still, these liquid breeders with high cross sections for neutron multiplication and tritium production may not be as efficient as FLiBe, the leading molten salt blanket. FLiBe is usually a mixture of LiF and BeF2 and is one of the molten salt blankets. Though it may not have such a high TBR, it is incredibly efficient in absorbing radiation. Below is a graph illustrating how FLiBe and PbLi compare with Lithium and other blankets in terms of their Dose Rates over time:
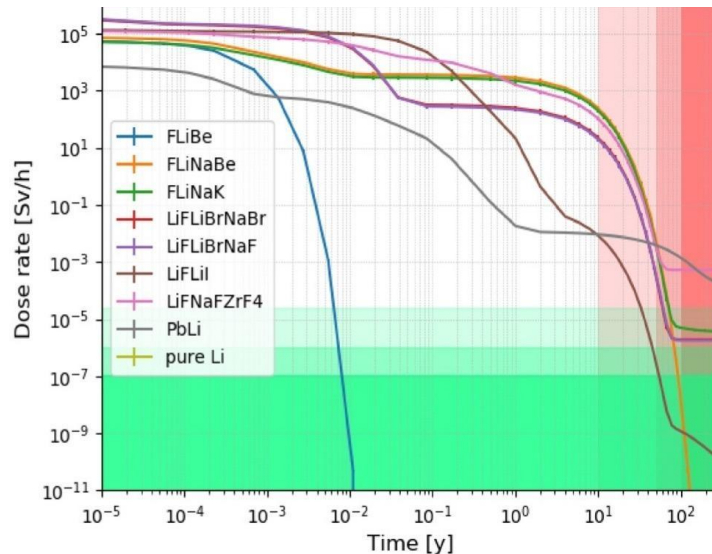
Figure 5: Neutronic comparison of liquid breeders for ARC-like reactor blankets, Stefano Segantin, Raffaella Testoni, Massimo Zucchetti,

The green areas in Figure 5 represent the recycling limits, and only FLiBe and a few other salts can meet these limits in a short amount of time whereas PbLi is far more inefficient. FLiBe has a high heat capacity and a high melting point, attributes that may contribute to its efficiency [9].

Neutron Multiplier Concentration

Another question regarding the materials to use in a breeder blanket to maximise tritium breeding and efficiency is the ratio of neutron multipliers to the Lithium material, the two materials needed for the two reactions used to produce the hydrogen isotope. This chart illustrates the TBR of a Lithium based blanket paired with a simple Lead neutron multiplier over different ratios of Pb to Li. (This used a fixed mass of Li6, therefore, the Li6 was always 0.2 x

total breeder blanket mass, it was adjustable in the simulation by calculating the required fraction out of total Lithium to make it 20%, for example, 90% Lithium x 22.2..% = 20% Lithium-6):

Figure 6: TBR against Lead concentration in Breeder Blanket

The parabolic shape of these results is due to there being a constant mass of Lithium-6, this means that at lower lead concentration, there is no extra Li-6 that could significantly increase the TBR and at higher lead concentration, this helps the TBR to increase as there is a better concentration of multipliers. In Li17Pb83, there is a much higher concentration of lead, but this is compensated with high Li6 enrichment, therefore, it makes sense to assume a relatively constant amount of Lithium 6 should be present.
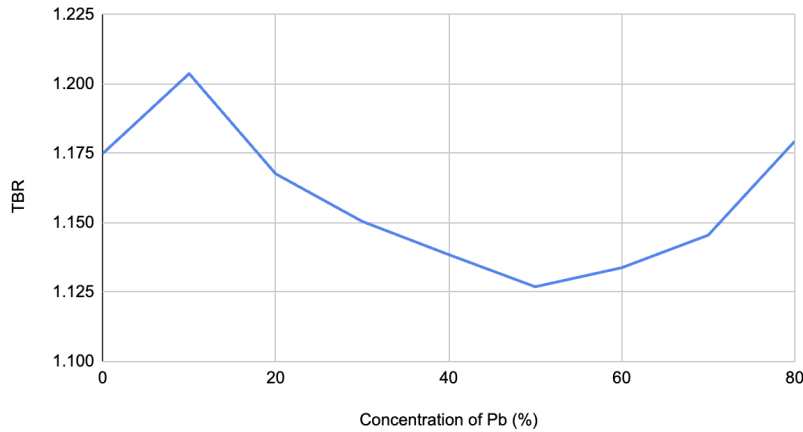
Conclusions

This paper has observed the effects, advantages and results of using different types of blanket materials, different levels of Li-6 enrichment and concentration of neutron multipliers. We have also addressed other concerns such as thermal properties, energy multiplication and dose rates/efficiency.

In the matter of the TBR, the best blanket material appears to be Li17Pb83, it is the breeder that, unlike FLiBe, has no toxicity [11] and unlike PbLi100, is not so inefficient in terms of dose rate. It also has relatively low concentrations of Lithium, a scarce material that may prove difficult to obtain in the coming decades. This liquid breeder also comes with the advantages that liquid breeders have over their solid counterparts as previously discussed and it has a very high TBR when compared to most other materials. FLiBe was a very successful breeder especially when one takes into account the dose rates and apart from the hazard risks with this breeder it may be the most successful one that was used.

To further advance our understanding of the topic of breeder blankets and tritium breeding, further research into other attributes must be explored such as different thicknesses of breeders and alternate fuel sources such as boron-11 or helium 3. It is also essential to address the issues of tritium extraction and confinement aside from uranium beds that may be

proliferation concerns. Construction of several breeds of tokamaks and even stellarator reactors using Paramak or the new Parametric Stellarator python libraries to pair with an OpenMC simulation could also be researched to further understand the TBRs of different blanket materials in more than one type of reactor.

The field of computational application for nuclear engineering should be used to predict and theorise on how these reactors and particles interact and will, in the future, be of great use as fusion becomes the energy source for our planet's fossil fuel-free future.

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How Different Transformers Models Perform in Mimicking Personal Chatting Style
By Himir S Desai

Abstract

We train a transformer language model to chat like a specific person. This is achieved by training the model on the actual chat history of a person on various social media platforms like WhatsApp and Telegram. For the purpose of this paper, we train the model on my personal chat histories. Then, we define a metric which can be used to quantify the performance of any model trained on the data. Different trained models will be evaluated using this metric during the training process and after the model is fully trained. Similarly, the same model is compared with itself but with different learning rates while training. Then, we investigate the optimal learning rate for training the model. The model for which optimal learning rate is found is GPT-2 which has 137 million parameters. The training is done using the Hugging Face Trainer API.[1]

Introduction

Artificial intelligence is getting popular attention nowadays. The ability of a computer to learn things like we humans do is something which a computer was never able to do before. In earlier times computers needed to be fed in exact instructions to do their tasks and they only followed those instructions. Today we can teach a computer to do certain things by giving it some examples and then it can do things which it was never programmed for. That is Artificial Intelligence and the ability of a machine to learn new things is known as machine learning.

A machine learning model trained on human chat data can replicate the writing style of that person in chats with another person. This creates a model capable of producing different outputs given the person with which it is talking to. Its applications can be diverse, varying from simulations to investigations.

In order to gauge whether the model is running correctly or not, we need something which can provide us with a quantitative measure of the model's accuracy. For this, a metric for accuracy needs to be defined. The metric being used in this study to evaluate model performance is called perplexity. It tells us how accurate the model is on the given dataset; moreover, it also gives us an estimate of how good the model will perform on giving new text inputs not included in the original training data. It is a commonly used metric for evaluation of Natural Language Processing (NLP) models. A lower perplexity means our model is accurate, on the other hand, a higher perplexity translates to our model not performing well.

For a model to learn to do certain tasks it needs time, just like us humans, and it can be controlled by the programmer through a hyperparameter known as learning rate. It is the rate at which a model learns to do its task. A higher learning rate is generally correlated with a less accurate model while a lower learning rate, which corresponds to a higher learning time, achieves a higher accuracy.

The learning rate is a critical hyperparameter in machine learning models since it can have a substantial impact on the model's performance and convergence pace. Optimization of

learning rate is finding a balance between train time and accuracy of the model. By plotting a perplexity vs training steps graph for different learning rates, we determine the optimal rate.

Preparing the Data

To prepare the datasets we first refactor the .txt files provided by WhatsApp, and .json files by Telegram to a common format, removing all the metadata.

The default format for WhatsApp chat history files is:

[06/05/23, 8:43:39 PM] **Person** 1: hello
[06/05/23, 8:43:42 PM] **Person** 1: How **are** you?
[06/05/23, 10:59:32 PM] **Person** 2: hello
[06/05/23, 10:59:37 PM] **Person** 2: I am doing great
[06/05/23, 10:59:39 PM] **Person** 2: What about you?

And the default format for Telegram chat history is:

```
{
 "id": 1
 "type": "message",
 "date": "2023-04-22T22:47:18",
 "date_unixtime": "1682183838",
 "from": "Person 1",
 "from_id": "userxxxx361302",
 "text": "Hello",
 "text_entities": [
  {
   "type": "plain",
   "text": "Hello"
  }
 ]
},
{
 "id": 2,
 "type": "message",
 "date": "2023-04-22T23:01:34",
 "date_unixtime": "1682184694",
 "from": "Person 2",
 "from_id": "userxxxx481377",
 "reply_to_message_id": 21302,
 "text": "Hey!",
 "text_entities": [
  {
```

```
    "type": "plain",
    "text": "Hey!"
  }
]
```

The final refactored form of the messages looks like this:

```
Person 1: Message 1
Person 2: Message 2
.
.
```

Then this is directly converted into a dataset object using the Hugging Face datasets library. A dataset object is a form of saving the training data such that the model can easily access it and learn on it batchwise. A batch of this dataset object contains 8 consecutive messages from the train data it feeds the model with.

Preparing the Model

We train 4 different models on the same data and will compare the outputs. Them being GPT-2, GPT-2 Medium, Bloom, GPT Neo. Out of these 4 we use the GPT-2 model to investigate the optimal learning rate later on in the study. The Hugging Face Transformers library is used to load the models and their tokenizers

```python
from transformers import GPT2Tokenizer, GPT2LMHeadModel

tokenizer = GPT2Tokenizer.from_pretrained('Project/model/')
tokenizer.add_special_tokens({'pad_token': '[PAD]'})
model = GPT2LMHeadModel.from_pretrained('Project/model/')

def replyGPT2(text):
    encoded_input = tokenizer(text, return_tensors='pt', skip_special_tokens=True)
    maxl = len(encoded_input['input_ids'][0]) + 30
    output = model.generate(
        encoded_input['input_ids'],
        max_length=maxl,
        top_k=5,
        top_p=0.10,
        do_sample=True,
        )

    return tokenizer.decode(output[0])
```

The above is one of the 4 models. Similarly, all the 4 models are incorporated into their respective functions. The first line imports our models in the python script. The next 3 lines initialize the tokenizer and the model. Then, the function replyGPT2 is defined. It takes in the input text, then converts it into tokens and then it is passed into the model.generate function. The maxl variable here refers to the maximum length of the output string. The function then returns the decoded output, one which a human can understand.

Using the model

After training the model it will be saved to the above entered location. Now to access the model you will need to load the model and its tokenizer and use the model.generate method to generate text. We have already done that in *Preparing the Model* part portion. Now we just need to use the reply<modelname> function which he defined to test out the model.

```
text = """
Person 1: Hello
Person 2: Hey! How are you doing?
Person 1:"""

print(replyGPT2(text))
```

On running the following code our expected output should look something like this:

Person 1: Hello
Person 2: Hey! How **are** you doing?
Person 1: Yeah I am doing great, what about you?

Training the Model

We will be using Hugging Face[1] Trainer API for fine-tuning the models. Hugging Face[1] Trainer API is a high-level API that provides an easy-to-use interface for training and fine-tuning transformer models. Fine-tuning is the process of tailoring a previously trained model to a given task or domain by training it on a smaller, task-specific dataset.

The train function (see next page) takes in 7 arguments. They are:

1. train_file_path: The path of the text file with the data on which the model is to be trained.
2. model_name: The model which has to be trained on the given data.
3. output_dir: the directory in which the trained model will be saved.
4. overwrite_output_dir: Whether to overwrite the output directory should there be any other file/s in it.
5. per_device_train_batch_size: When training on multiple CPU/GPU cores, this defines the batch size per core.
6. num_train_epochs: It is the number of times the model will train itself on the dataset, improving each time it relearns.

7.	save_steps: Number of training steps after which a checkpoint is saved.

```python
from transformers import TextDataset, DataCollatorForLanguageModeling
from transformers import GPT2Tokenizer, GPT2LMHeadModel
from transformers import Trainer, TrainingArguments

from datasets import load_dataset

def train(train_file_path, model_name,
      output_dir,
      overwrite_output_dir,
      per_device_train_batch_size,
      num_train_epochs,
      save_steps): ...

train_file_path = r"Project/TrainData/Data/chatWhatsApp.txt"
model_name = "gpt2"
output_dir = r"Project\models"
overwrite_output_dir = False
per_device_train_batch_size = 8
num_train_epochs = 200.0
save_steps = 50000

train(
   train_file_path=train_file_path,
   model_name=model_name,
   output_dir=output_dir,
   overwrite_output_dir=overwrite_output_dir,
   per_device_train_batch_size=per_device_train_batch_size,
   num_train_epochs=num_train_epochs,
   save_steps=save_steps,
)
```

Perplexity–What is Perplexity?

In simple words, perplexity is a statistical measure of a model's confidence for predicting a given text. It can be used to compare different models. It can also be used to compare the same model with different parameters, learning rate in our case.

GPT-2[3]

GPT-2 is a transformer model pre-trained on a very large corpus of English data in a self-supervised fashion. This means it was pretrained on the raw texts only, with no humans

labeling them in any way (which is why it can use lots of publicly available data) with an automatic process to generate inputs and labels from those texts. It has 137 million parameters. The perplexity during training period is shown below.
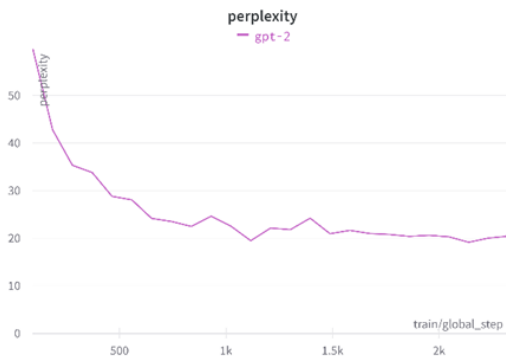
GPT-2 Medium[4]

      GPT-2 Medium is the 355M parameter version of GPT-2, the one shown above, a transformer-based language model created and released by OpenAI. The model is a pretrained model on English language using a causal language modeling (CLM) objective. The perplexity during training time is shown above.

Bigscience Bloom[5]

      This is an even larger model with 560M parameters. It is multilingual and is developed by big science for the purpose of scientific studies on language models. Its perplexity chart while training is given below.
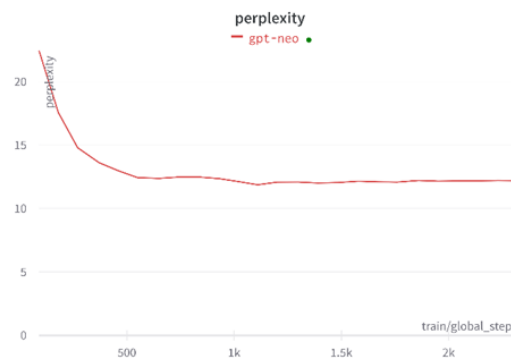
GPT Neo[6]

      This is a smaller 150M parameter model designed using EleutherAI's replication of the GPT-3 architecture.[7] The perplexity chart while training is given above.
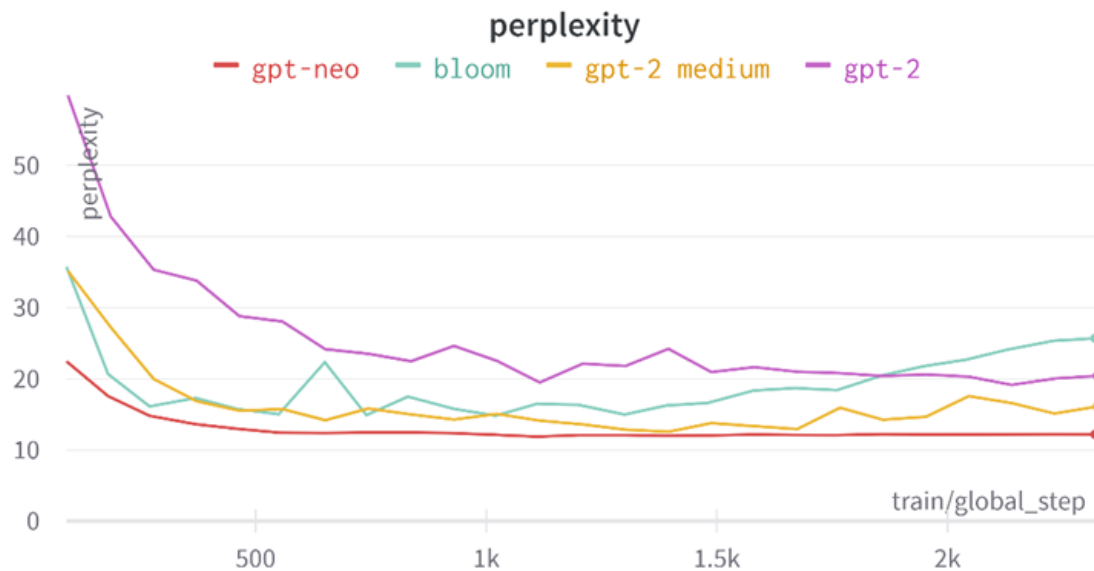
Combined Graph for all the models

Analysis

As seen from the graph above, different models give different perplexities after training, and it cannot be simply understood which model is best without a detailed look.

First it was thought that higher the number of parameters higher will be the model performance, but it can be clearly seen that is not the case. In fact, the model with one of the lowest number of parameters did the best and the one with the largest number of parameters performed the worst.

The 2 models, GPT-2 and GPT-2 Medium, are built on the same framework and only differ in number of parameters and so we see that the larger model, GPT-2 Medium, performs better with its perplexity always lower than GPT-2's during the entire learning duration.

Bloom being a multilingual model naturally requires a higher number of parameters, which lowers its performance when only learning one language. And hence despite having the highest number of parameters it performed the worst. GPT Neo on the other hand is built over GPT-3 and so performs the best out of the 4.

Model Name	Number of Parameters	Perplexity
GPT-2	137M	20.4
GPT-2 Medium	355M	16.1
Bloom	560M	25.7
GPT Neo	150M	12.2

Learning Rate–What is the Learning Rate?

In the training of neural network models, the learning rate is a crucial hyperparameter. It regulates how much of the network's weights are updated every iteration of the optimization method. Selecting an adequate learning rate is essential to attaining high model performance since it can have a substantial influence on the network's performance.

Experiment

We will graph the perplexities of the GPT-2 model while training it with different learning rates.
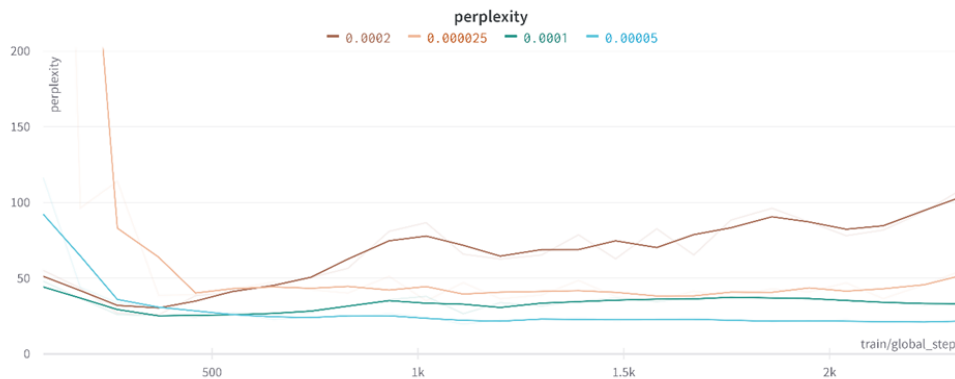
The first graph above (smoothed out) shows the perplexity while training at learning rate 0.000025, 0.00005, 0.0001 and 0.0002. It is evident that a very high learning rate (0.0002) causes the accuracy to worsen, and a very low learning rate (0.000025) causes the model to learn very slowly and so is the second worst performing. Learning rate 0.00005 looks like the best one out of these 4. So now we will decrease the variation and investigate learning rates closer to 0.00005.

The above graph shows perplexity while training the model with learning rates 0.00004, 0.00005 and 0.00006. We see that the perplexity after the training is finished is almost the same. This suggests that we have reached our minima. A minima is a point when the rate of change of a function is equal to zero and the value of the function at that point is locally the lowest. As changing the learning rate doesn't change the perplexity when it is near 0.00005 means that the

rate of change of perplexity with respect to learning rate approaches zero when learning rate is 0.00005.

We found our optimal learning rate for training this model which is equal to 0.00005.

Learning rate	Perplexity
0.000025	50.25
0.00003	38.01
0.00004	22.04
0.00005	21.90
0.00006	21.10
0.0001	33.57
0.0002	108.55

Inference

From the above experiment we got to know a range for optimal learning rate that is 0.00004-0.00006 for this particular task and model. It is recommended to employ this method to find the optimal learning rate which can vary from model to model and purpose to purpose

Conclusion

In conclusion, this study presents a detailed approach to training and evaluating transformer-based language models for the purpose of replicating individual writing styles while chatting.

Perplexity provides a standardized measure of the model's performance and offers a means to compare different models and their parameter configurations. Its role in assessing accuracy on existing data demonstrates its significance in natural language processing evaluation.

The investigation into learning rate optimization exemplifies the process of refining model performance. The experimentation and subsequent identification of an optimal learning rate range serve as valuable insights for practitioners navigating the intricate landscape of model training.

The comparison of distinct models—GPT-2, GPT-2 Medium, Bloom, and GPT Neo—unveils nuances in performance that transcend the conventional belief that larger parameter counts guarantee superior results. This nuanced perspective reinforces the essence of model architecture, training data relevance, and fine-tuning in determining a model's efficacy for specific tasks.

In conclusion, this research advances our understanding of personalized artificial intelligence model development and its implications for human-computer interaction. The paper's insights into metrics, learning rate optimization, and model selection contribute substantially to the field of NLP (Natural Language Processing), offering practical guidance for constructing AI-driven chatbots that replicate individual writing styles.

A Brief Review of the Relationship Between Entrepreneurship and Economic Factors By Sia Sinha

Abstract: This paper examines the crucial interaction between entrepreneurship and economics, focusing on how it affects both new and established companies in the context of the changing business environment. Economic factors have a considerable impact on entrepreneurs' decisions, strategies, and overall results. This study elucidates the symbiotic link between these realms by drawing on well-known academic publications.

In the dynamic world of business, the intricate relationship between economics and entrepreneurship is a critical determinant of success. Economics provides the foundation upon which entrepreneurial ventures are built, guiding decisions, shaping strategies, and influencing outcomes. This essay delves into the pivotal role of economics in entrepreneurship, highlighting why understanding economic principles is essential for aspiring entrepreneurs. In order to illuminate how economic principles affect entrepreneurial endeavors, this article explores the symbiotic link between entrepreneurship and economics. To do so, it draws conclusions from significant scientific works.

Literature Review

In-depth research by Zahra and Wright (2017) on the connection between economics and entrepreneurship emphasizes how economic considerations influence the course of startups. They focus on the relationship between economics and entrepreneurship by highlighting the impact of economic considerations on startup programmes. Entrepreneurs' ability to capitalize on opportunities and add value is determined by market circumstances, resource availability, and supply-demand dynamics. This study dispels the myth of isolation by proving how entrepreneurial activities are integrated into economic ecosystems. This study emphasizes how integrally ingrained entrepreneurial endeavors are into economic ecosystems rather than being in a vacuum.

Zahra and Wright (2019) go into further detail on the idea of risk and knowledge asymmetry in entrepreneurship in a subsequent paper. They investigate the influence of economic theories on the choices made by entrepreneurs in light of uncertainty and information shortages. The authors contend that uncertainty is an intrinsic component of entrepreneurial undertakings and emphasize the role of entrepreneurs as actors who manage, alleviate, and occasionally profit from this uncertainty. According to this article, entrepreneurs must examine prospects through the prism of economic principles of risk and information to avoid potential hazards.

By shifting our attention to the larger context, North (1990) analyzes the function of institutions in economic growth in his fundamental study. Despite not being specifically about entrepreneurship, North's work offers significant insights into how formal and informal

institutions affect entrepreneurial activities. This viewpoint supports the notion that historical, cultural, and regulatory variables form economic settings and have a substantial effect on the course of entrepreneurial endeavors.

Collectively, the publications under consideration highlight how closely business and economics are related. Entrepreneurial decisions, tactics, and results are significantly influenced by economic concepts, which range from market dynamics to risk assessment and institutional issues. Entrepreneurs who are aware of and use these economic insights are better able to deal with obstacles and take advantage of opportunities, improving their chances of success.

Discussions

The relationship between entrepreneurship and economics is still a crucial issue to research as the business landscape changes. A thorough grasp of economic concepts and their complex interplay with entrepreneurial endeavors may be helpful to both researchers and practitioners. Entrepreneurs may improve their decision-making, adapt to shifting economic environments, and strengthen the whole economic ecosystem by accepting these ideas.

Economics serves as a guiding beacon for entrepreneurs as they navigate the intricate terrain of business. The principles of economics equip entrepreneurs with essential tools and insights that are indispensable for success in a competitive marketplace. In this essay, we delve into various ways in which economic principles play a pivotal role in shaping entrepreneurial endeavors.

At the heart of economic decision-making lies the efficient allocation of limited resources – time, capital, and labor. The principles of scarcity, choice, and opportunity cost illuminate entrepreneurs' path, ensuring that these finite resources are directed towards activities that yield the greatest returns. This skill is especially vital in an environment characterized by cutthroat competition, where adept resource management can spell the difference between survival and stagnation.

Understanding the dynamics of supply and demand is another cornerstone of economics that holds paramount significance for entrepreneurs. Economics provides them with a lens through which they can scrutinize market trends, decipher consumer preferences, and anticipate shifts. Armed with this comprehension of market forces, entrepreneurs can fine-tune their offerings – be it products, services, or pricing strategies – to precisely align with customer demands, thus securing a competitive edge.

The art of pricing is yet another realm where economic principles wield considerable influence. Economics offers insights into diverse pricing strategies – from cost-plus pricing to value-based pricing and competitive pricing. Entrepreneurs must weigh production costs, competitor pricing, and customer willingness to pay to determine the optimal pricing strategy. A well-informed pricing approach can not only bolster profitability but also sustain market competitiveness in the long run.

Risk and uncertainty are inextricably linked to entrepreneurial pursuits, and economic theories of risk serve as a compass in this realm. Entrepreneurs grapple with assessing potential

risks that their ventures may encounter. By leveraging economic principles, entrepreneurs evaluate these risks and deliberate over potential outcomes, thereby making informed decisions that help mitigate adverse impacts. This thorough understanding of risk empowers entrepreneurs to craft contingency plans, thereby minimizing the vulnerability of their business endeavors.

Recognizing opportunities amidst the complex landscape of a marketplace is a trait that economics instills in entrepreneurs. Economic principles enable entrepreneurs to identify demand-supply gaps, discern changing consumer preferences, and anticipate emerging trends. Armed with this insight, entrepreneurs are better poised to craft innovative solutions that cater to unmet needs. This knack for spotting opportunities early on enhances the prospect of creating ventures that are not just unique but poised for success.

The journey of entrepreneurship is invariably linked with growth, and economics acts as a guiding compass in this expansionary journey. Concepts like economies of scale, diversification, and market expansion are rooted in economic principles, offering entrepreneurs strategic direction on when and how to scale their operations. These strategies not only optimize profitability but also enhance operational efficiency and pave the way for sustainable growth.

Moreover, a comprehensive understanding of economic principles extends its reach to encompass the regulatory landscape. Economic policies and regulations shape the contours of the business environment. Entrepreneurs who adeptly grasp these factors can navigate the labyrinth of legal and regulatory challenges, ensuring compliance and sidestepping potentially costly legal issues.

Lastly, economics underscores the significance of sustainable business practices. Entrepreneurs are urged to contemplate the lasting implications of their decisions – be it on profits, social responsibility, or environmental impact. A business that seamlessly aligns economic considerations with ethical values is poised to thrive over the long haul.

In conclusion, the symbiotic relationship between economics and entrepreneurship is undeniable. From resource allocation to market understanding, pricing strategies to risk assessment, economics is the bedrock upon which entrepreneurial decisions rest. Entrepreneurs who assimilate economic principles into their decision-making processes are better equipped to navigate challenges, capitalize on opportunities, and foster innovation. Thus, economics isn't merely a theoretical construct; it's the compass that guides entrepreneurs towards sustainable success.

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Matthieu Aikins: The Man that Risked his Life for a Story By Vera Iliadi

  With a taste for adventure and a willingness to explore, young Matthieu Aikins sets off for a backpacking, couch crashing, and hitchhiking trip that led him to Afghanistan for a cheap visa. Years later he was on a raft in the middle of the Aegean sea on his way to Lesvos, Greece as a refugee from the West trying to make it to Europe.

  For many years Aikins lived his life without knowing where the next day would take him. His career as a journalist blew up shortly after a story he wrote for Harper's Magazine about drug trafficking in Afghanistan. Soon he would write for bigger publishers such as the New York Times Magazine. Aikins has experienced many risky events. In 2016 he set on an undercover mission. His task was to be an undercover refugee from Afghanistan to Greece and report his experience. After 5 years he published his first and award-winning book called, "The Naked Don't Fear the Water"

  "The Naked Don't Fear the Water" is a story about a man named Omar. Omar is based on Aikin's friend and adventure companion who was going on this trip of refuge for a better life and a visa. The book shows the rawness of the journey. "It was the hardest story, the scariest story I have ever done," Aikins says to describe his journey.

  Aikins claims that he was prepared for his story. He had spent years learning the language and getting to know the culture. "Both myself and the photographer I worked very closely with Jim, we spent years in the country, we learned the language, we built a network, we peaked. We built the kind of support system that allowed us to not only survive but keep working through what was a very very very tense period." Through this very fretful period, Aikins experienced a very heavy amount of trauma. He explains that every person reacts differently to trauma and he goes on to say that he was very lucky that his mental health didn't "wear him out too much." He explains how there are several tools that one can use when seeking out help, such as therapy. Even in these emotionally tiring situations, it is important to be brave. "I always look at what people who are living there or are used to it are doing, you know if they're not too worried that's what I try to focus on," Aikins explains that he tries to impersonate people's reactions to try to calm himself and keep himself brave.

  During these stressful times, Aikins isn't the only one who needs to keep himself calm and optimistic. His family has to join him in being courageous. Aikins talks about his parents and says in a quiet and weak voice, "It had a negative effect on me and if I wasn't careful it would spread to them." Along with wanting to protect his family from intrusive emotions he also explains how difficult it is to maintain a relationship. "You don't want to bring that ugliness into their lives, you don't want them to have to deal or hear about it," Aikins says while talking about how he tried to protect the people he cares about. "When I went to Afghanistan I took off a lot. I didn't see my family much. It's a cost that you impose on your loved ones with this kind of work and I'm lucky that they were very supportive… but it's not easy for them."

  As a young child, Aikin was a very outdoorsy child. Whenever his dad was home from the navy he would go camping, sailing, and hiking. He learned to tolerate chaos and discomfort

and navigate with a compass at a very young age. His dad was never really around; he would leave for long periods. Whenever Aikins was asked to talk about his father or mother his voice got quieter and soft. Aikins was the eldest of four. Even when his father was away he never felt the need to be a father figure to his three younger brothers. Instead, he would entertain them. "I was a voracious reader but I think my earliest work as a writer was creating games for my brothers." From a young age, Aikins developed the skills that he now needed to use in his everyday work.

38-year-old Aikins is now touring Europe for his new book "The Naked Don't Feat the Water " and is soon going back to Halifax, Canada to visit his family and friends that he yearns to see.

When asked to recall something he would have done differently throughout his journey he said, "It was a mistake to think that in those situations I could be a journalist."

Golden Dawn: A Breach in Greek Citizen's Human Rights By Vera Iliad

In his notable "I Have a Dream" speech Martin Luther King Jr. mentioned, "Until justice rolls down like water and righteousness like a mighty stream." The I Have a Dream speech was a pivotal turn in human history. Cautiously it helped societies all over the world realize how many cultures were affected by the injustice of the government. In the 21st century, society longs to think that racism is far behind us. But even today cultures keep being victims of their human rights being violated. Minorities all around the world go through this injustice. Especially in countries with refugees, like Greece. Since Greece is a homogeneous country, the difference stands out.

Ξένοι. A Greek word meaning foreigner. In the Greek language, this word can imply a hateful meaning. Anyone different is a Ξένος. That one word can separate a country in half. From the year 2009 to 2015 there have been over eighty hate crimes. The organization responsible for committing these hate crimes was Golden Dawn. Golden Dawn was a neo-nazi political party in Greece. These hate crimes targeted citizens who were part of the LGBTQ community, immigrants, refugees, and eventually, it targeted any citizen who opposed the neo-nazi ideology.

Golden Dawn was founded in 1985 by Nikolaos Michaloliakos. Golden Dawn started as a neo-nazi out-of-law organization. Michalolikos would recruit young Greek citizens who were vulnerable and without a strong political background. He would make them commit several crimes. Such as theft and so on. In 2012 the party became the third most popular political party in the Greek parliament. This occurred because at the same time a left-hand party called Syriza was about to become the next Greek government. The two traditional middle and right-hand parties of Greece saw Golden Dawn as an opportunity to minimize the chance of Syriza getting elected from citizens that were frustrated from the economic crisis. Liana Kanelli a Communist party MP, says in an interview with the Guardian, "They polarise the people who are afraid. The desperate people and the people who are terrorized." Golden Dawn told them what they wanted to hear and promised them things that could not happen. The organization at the time would turn Greek citizens against refugees and immigrants. They promised that once they got rid of the immigrants and refugees the economy would flourish. Telling them things such as "They are the ones who are stealing your jobs and they should be punished." or "They are the reason that we have fallen into this economic crisis." Once Golden Dawn was elected into the Greek parliament, they gained economic and political power. The number of hate crimes doubled. In 2011 the murder of Manolis Kantaris had been committed. Manolis Kantaris was murdered in the center of Athens. The far-right parties claimed that "brown skin immigrants" had committed the murder. June 12, 2012 assault on Egyptian fishermen near Athens. One of the fishermen said, "They blame us for the crisis in this country. We haven't created this crisis. We work hard, we earn our money. Just like the 55,000 Greeks that live in Egypt. They should find those who kill and steal. We work to earn our money like anyone else." A gay man around the same was out with his friends and got attacked. He states, "The police were here, but they did nothing. They

just sat there." November 15, 2012 assault on Albanian woman in Thessaloniki. July 5, 2012 attack on a greek ani-fascist citizen. There were hundreds more assaults, attacks, and murders from the years 2009-2015. One thing that they all have in common is the victim. Every victim is considered a minority. How would they stand a chance in court against one of the country's wealthiest political parties? Whom would the court believe?

Golden Dawn was able to make these crimes disappear. Many of the attacks were not published because most of the victims were Ξενοι. Golden Dawn had the money and power to make the attacks go away for many years. Kostantinos Halastras was in the police force. He was found in the possession of a forged ID. The name on the ID was Alexandros Kasidiaris, the brother of Ilias Kasidiaris one of the eighteen MPs of Golden Dawn. This only implies that Golden Dawn had people working on the inside helping them cover up these inhuman crimes. Money also played a big part in this. Ilias Kasidiaris' net worth is about four million euros. It is thought that the party would bribe people from the force and the law to cover the crimes up. A Pakistani community leader states the following about the police, "They support them, saying things like 'Go on. We stand next to you.'" A high-ranking police officer also states, "An organization cannot act illegally. It cannot attack immigrants and bring them to the police stations beaten up, while the officers on duty don't arrest its members who did the beating. That is unacceptable."

In 2013 the murder of Pavlos Fyssas a famous rapper made the headlines. Fyssas was also a well-known anti-fascist public figure of his generation. Many of his songs spoke harshly against Golden Dawn's ideology. This made him an easy target. His murder had finally brought awareness to all the other attacks. This did not only open a trial for the rapper's murder but also a trial of Golden Dawn. The trial began on April 20, 2015, and ended in 2020. This trial is the largest Nazi trial after World War II. Sixty-eight people were charged for belonging to a criminal organization. The defendants, which included the entirety of leaders of Golden Dawn were charged with multiple crimes such as murder, weapon possession, and racketeering. They denied all charges. They are all now sentenced to thirteen years in jail.

These hate crimes weren't only inhuman but they also violated six human rights. Article 1: Right to Equality
Article 5: Freedom from Torture and Degrading Treatment
Article 7: Right to Equality before the Law
Article 14: Right to Asylum in other Countries from Persecution
Article 18: Freedom of Belief or Religion
Article 19: Freedom of Opinion and Information

A solution to prevent these hate crimes from happening in the near future is to educate people. Young adults have to speak up about how inhuman this ideology is. Peaceful protests and speeches from young people might help inspire the older generations to think next time they vote.

Golden Dawn getting voted into parliament has made a big dent in Greece's history. It is a shame that a beautiful country like Greece is now engraved with such a dark past.

Unraveling the Cosmos: Evidence and Theories of the Big Bang By Richa Shukla

Abstract

The Big Bang theory is the prevailing cosmological model that explains the origin and evolution of the universe. This review paper examines the observational evidence that supports the Big Bang theory and explores the proposed triggers for the cosmic event. By analyzing a wide range of astronomical observations, such as the cosmic microwave background radiation, the abundance of light elements, and the redshift of galaxies, we gain insights into the early stages of the universe and its subsequent expansion. Additionally, I delve into the theoretical frameworks that attempt to explain the triggers for the Big Bang, including the FRW equations, inflationary cosmology, string theory-based conclusions, quantum fluctuations, and the multiverse hypothesis. This comprehensive analysis provides a deeper understanding of the observational evidence and proposed triggers for the Big Bang theory.

I. The Big Bang

The Big Bang theory is a fundamental concept in the field of astrophysics that illuminates the origin of the universe. It suggests that the universe began as an extremely hot and dense singularity, and expanded and cooled repeatedly to the vast structure we observe today, which continues to expand. If we looked at the universe directly after the Big Bang, as NASA says, we would see a "10-billion-degree (Kelvin) sea of neutrons, protons, electrons, anti-electrons, photons, and neutrinos." As the temperature of the universe cooled, more and more elements started to form and create astronomical phenomena, which can tell us about the fate of the universe (Bolles, NASA.com).

Some believe that since the universe expanded with a Big Bang, it will eventually collapse with a Big Crunch. Scientists Paul Steinhardt and Neil Turok developed a model of the universe being cyclic, with a bang and a crunch for endless time. In the formation of the universe, there are radiation, matter, and dark energy-dominated epochs. In their model, the universe begins to expand and accelerate in its expansion for trillions of years until the potential energy of the universe is zero. Since the universe is a closed system, energy is conserved, which means that the universe begins to contract and accelerate in its contraction, converting what was maximized kinetic energy into gravitational potential energy (Steinhardt and Turok 1436-1439). The Big Crunch, which is hailed by astrophysicists as a complete model of cosmic history, as most topics are often open-ended or unknown to some degree, illustrates just one of many key concepts drawn from the Big Bang theory. But it remains a theory, since there has been no possible way to witness the Big Bang and discover what truly triggered it, and if the Big Crunch ever happened, it would be outside of the scope of human existence. Therefore, we must establish the evidence of the Big Bang, because it provides so much insight to the development of the universe and even the possibilities of a multiverse.

In this paper, I extensively compile and discuss the main pieces of observational evidence for the Big Bang and elaborate on why some of the observational evidence could have caused the Big Bang.

II. FRW Equations

Before deriving the metric for the expansion of the universe, we must first discuss general relativity, special relativity, and the curvature of the universe. Einstein's special relativity introduced groundbreaking concepts, such as spacetime and time dilation, while general relativity, extended these principles to encompass gravity and introduced the notion of spacetime curvature. The theories of special relativity and general relativity constitute the pillars of modern theoretical physics. Special relativity revolutionized the understanding of spacetime and introduced the notion of the speed of light as a constant. In contrast, general relativity, offered a profound new understanding of gravity as the curvature of spacetime due to the presence of mass and energy. These concepts, when connected with the cosmological framework of the FRW equations, offer crucial insights into the large-scale evolution of the universe.

Special relativity rests upon two postulates - the Principle of Relativity and the Speed of Light Postulate. The former asserts that the laws of physics remain invariant for all observers in uniform motion relative to each other. The latter states that the speed of light in a vacuum is constant, denoted as 'c,' regardless of the observer's motion. These postulates led to groundbreaking phenomena such as time dilation and length contraction. Furthermore, special relativity introduced the concept of spacetime as an inseparable entity, wherein events that are simultaneous for one observer may not be simultaneous for another, depending on their relative motion.

General relativity expanded the principles of special relativity to encompass gravity and its representation as the curvature of spacetime. In this theory, massive objects, such as stars and planets, induce curvature in the surrounding spacetime. The strength of this curvature depends on the mass of the object. Objects moving through this curved spacetime experience gravitational forces, leading to the familiar concept of gravity as the warping of the fabric of the universe. Einstein's field equations form the mathematical foundation of general relativity, relating the spacetime curvature (metric tensor) to the distribution of matter and energy (stress-energy tensor). Solving these equations for a given scenario yields the spacetime geometry, which dictates the motion of objects under the influence of gravity.

The Friedmann-Robertson-Walker equations, derived from general relativity, describe the large-scale dynamics of the universe in a homogeneous and isotropic setting. These equations govern the expansion or contraction of the universe over time and are instrumental in modern cosmology. By incorporating the energy density of matter, radiation, and dark energy into the FRW equations, cosmologists can infer the past and future evolution of the cosmos, including crucial epochs like the Big Bang and the cosmic microwave background radiation.

Now, we will derive the metric for the expansion of the universe.

$$ds^2 = -dt^2 + (dx^2 + dy^2 + dz^2)$$

This is a metric for the universe as flat space.

$$ds^2 =- f_0(t, x, y, z)dt^2 + f_1(t, x, y, z)dx^2 + f_1(t, x, y, z)dy^2 + f_1(t, x, y, z)dz^2$$

We can simplify this, because since the universe is considered isotropic, it looks the same from every point, so x, y, and z don't change the functions, so they are just functions of time.

$$ds^2 =- f_0(t)^2 dt^2 + f(t)^2 dx^2 + f(t)^2 dy^2 + f(t)^2 dz^2$$

We can simplify this further:

$$ds^2 =- f_0(t)^2 dt^2 + f(t)^2 (dx^2 + dy^2 + dz^2)$$

But, in order to simplify this further, we need another equation:

$$d\tau = f_{0dt}$$

And we can substitute this into the metric and replace f with a (for the scale factor) and get:

$$ds^2 =- d\tau^2 + a(t)^2 (dx^2 + dy^2 + dz^2)$$

Initially, the metric for the expansion of the universe started out with four functions and four variables, but we were able to simplify it to the most general form of the metric in a homogeneous isotropic universe.

The $a(t)$ function is called the scale factor, which represents the radius of the universe as a function of time.

$a'(t) = da/dt$: This is the rate at which the universe expands or contracts.

d^2a/dt^2: This is the acceleration of the expansion or of the contraction of the universe.

Once we have the metric for the expansion of the universe and understand what the scale factor means, this points to conclusive evidence that the universe is undergoing the results of the Big Bang[3].

There are three main stages of the Big Bang that quantum fluctuations could have interfered with (this is where we get into the FRW equations): radiation, matter, and dark energy (as I mentioned earlier).

There are three FRW equations that describe how the universe evolves are

$$\text{Hubble's law: } H^2 = \frac{8\pi G}{3}\rho - \frac{k}{a^2}$$

the energy conservation equation: $\rho + 3H(\rho + p) = 0$

and the equation of state: $p = \omega\rho$, where H is the Hubble constant, a measure of the expansion rate of the universe, a is the scale factor of the universe mentioned earlier, ρ is the total energy density of the universe, p is the pressure of the universe, k is the spatial curvature of the universe, and ω is the equation of state parameter.

The first equation relates the Hubble constant to the spatial curvature and the energy density of the universe. The energy conservation equation describes the change in the density of the universe over time. The third equation relates the pressure and energy density of the universe. In a radiation dominated universe, the energy density is dictated by relativistic particles like photons and neutrinos, which have a high pressure, so $\omega = \frac{1}{3}$ (which makes sense, because if the density of a system increases, then the pressure increases, and $\omega = \frac{p}{\rho}$, so it is a directly

proportional relationship). Hubble's law is derived from the field equation of general relativity by Einstein (which would take much longer to do), and when coupled with the other two equations, they can describe the evolution of the early universe, during the Planck epoch. As a result, the scale factor a increases exponentially with time, which indicates that the universe is expanding at an increasing rate during the radiation stage.

The exact rate of expansion depends on the value of the spatial curvature parameter, k. If $k = 1$, the universe is closed and will collapse within itself (the Big Crunch). If $k = 0$, then the universe is considered flat, and it will expand forever. Finally, if $k = -1$, the universe is open and it will expand forever, but at a slowly decreasing rate.

However, the universe is not in a radiation dominated era (we aged out of that). The universe was then in a matter dominated era, and the equation of state parameter $\omega = 0$, because the pressure of matter is negligible compared to its energy density. The evolution of the universe after a radiation dominated era can be described with the scale factor also increasing exponentially with time, yet at a slower rate than in a radiation dominated universe. This is because the pressure of matter is significantly lower compared to the pressure of radiation.

The rate of expansion, yet again, depends on the value of k, but also the matter density parameter, Ω_m (and the k values mean the same thing as I calculated previously). The current value of the matter density parameter is estimated to be around 0.3. This indicates that the universe is in a matter dominated era, and that the universe will continue to expand at a decreasing rate until the matter density parameter becomes negligible. At that point, the universe will enter a dark energy dominated era, leading to the rate of the expansion of the universe increasing.

However, in a dark energy dominated universe, this is where the FRW equations start to change. In a universe dominated by dark energy, the FRW equations predict that the expansion rate of the universe will accelerate, because dark energy has a negative pressure. This causes it to not push galaxies together, but push them apart, and as the universe expands, the density of dark energy decreases. Yet, the negative pressure remains constant, which means that the expansion rate of the universe continues to accelerate. Here is a simplified version of the FRW equations for a dark energy dominated universe:

$$H^2 = (8\pi G \Lambda)/(3c^2)$$
$$a^2 = (8\pi G \rho)/(3c^2)$$

This is where H is the Hubble constant, a is the scale factor, Λ is the cosmological constant, a measure of the amount of dark energy in the universe, ρ is the total energy density of the universe, G is the gravitational constant, and c is the speed of light. As shown above, the expansion rate of the universe is proportional to the square root of the cosmological constant. This implies that the more dark energy present in the universe, the more the rate of the expansion will increase.

The current phase of the universe is the dark energy phase, and it started about 5 billion years ago. Since the rate of acceleration is increasing, it is likely that the universe may never have a Big Crunch.

So far, we have discussed four main pieces of observational evidence for the Big Bang, four potential triggers for the Big Bang, and a timeline for the universe since the Big Bang as a result of these triggers within a comprehensive literature review. Now, we can move to a discussion and some main conclusions.

However, this is where we can delve into "the bounce." We can start with a hypothetical situation: right after the Big Bang, if there is one billion times more radiation than matter, and if there is one billion more times matter than dark energy, then we can ask how the universe will evolve. If the universe starts at a singular point and continues to expand, then radiation redshifts by a factor of $\frac{1}{a^3}$, so the radiation may decrease from 10^{21} to 10^{18} and ultimately become less and less dense as the universe expands. As the universe expands, the radiation will redshift to the point where it is equal to the amount of matter in the universe, which is called matter-radiation equality. As the amount of matter is so small at the beginning of the radiation dominated era, when the two are equal, the presence of radiation and matter becomes smaller and smaller as the universe expands. The amount of dark energy in the universe is also incredibly small compared to radiation and matter, but the difference is, the density of dark matter does not change no matter how much the universe expands. So as the universe expands, the presence of dark matter dominates as the density of radiation and matter decrease.

If the density of dark matter is positive, then that means that the universe would expand, essentially, forever. Yet, we can ask, what would happen of the density of dark energy was negative? That would mean that the same thing would happen, but in reverse. If the universe was extremely large, then that means that the universe could contract to make the dark energy density equal to the density of the radiation and the matter in the universe, and the universe could contract to a singular point, eventually getting hotter and hotter, kickstarting what could be another Big Bang. Essentially, this supports cyclic cosmology, which we will touch on in the potential triggers of the Big Bang.

III. Observational Evidence

When answering the research question "What observational evidence supports the Big Bang theory, and what are its proposed triggers?", we must keep the purpose of this review in mind, which is to critically analyze and synthesize the existing literature. There are many pieces of observational evidence that strongly support the Big Bang, and there are many possible triggers proposed for the Big Bang.

The first one is the Cosmic Microwave Background Radiation (CMB), which is a faint radiation that permeates the universe, and is the afterglow of the Big Bang. The CMB is the redshifted radiation of the initial plasma in the universe. The Cosmic Background Imager (CBI) in Chile detected and collected data in this study to determine that CMB has an almost perfect blackbody spectrum (Cartwright et al. 11-16). Furthermore, the deviations measured in a CMB

spectrum from a blackbody spectrum were less than 50 parts per million (Sheshadri 858-867). Observations with CBI were also remarkably consistent and provided evidence that CMB is uniform and is nearly isotropic from Earth (Cartwright et al. 11-16). CMB radiation is also related to the thermal and ionization history of the universe and can be illustrated with the Friedmann Robertson Walker (FRW) metric, which is considered a relic radiation of the early universe. CMB radiation is also anisotropic, which means that the item exhibits different properties when measured along different axes (Sheshadri 858-867). When this anisotropy was discovered, it provided conclusive evidence that this was a result of the motion of the earth against the isotropic CMB radiation, and since small scale inhomogeneities were discovered, this provided very conclusive evidence that small imperfections were a result of structural formation over billions of years (Narlikar 1071-1076). The CMB is so substantial in regard to evidence, because it is direct proof. Because the CMB is isotropic and anisotropic, with such small deviations, these small deviations indicate that slight parts of the CMB are hotter. This indicates that the hotter regions will accurse more matter and eventually come together to form large celestial bodies, like nebulas and galaxy clusters, and further expand the universe. When we detect the small imperfections in the CMB, we could see galaxies form there in millions or billions of years because of the Doppler Shift.

Another piece of observational evidence proving the Big Bang renowned in scientific literature that connects to CMB is the continuing expansion of the universe. We touched on the metric for the expansion of the universe earlier with the derivation and what the scale factor means. The ongoing expansion of the universe is not really expanding into anything, but rather the points of the universe are shifting, so it looks like the universe is expanding.
Another strong point of observational evidence is the redshifts of galaxies. When the universe expands, the distance between galaxies increases, while also stretching light. If a distant galaxy is observed, the light emitted from it (in the past) is redshifted. For example, if blue light was emitted 10.0 billion years ago from the galaxy to reach observers on earth, by the time it reached earth it could be at a longer wavelength, like red. Since we can measure the wavelength of light from a distant galaxy, its redshift can be determined, and we can relate the redshift to the age of the galaxy. The universe's age is 13.8 billion years, so we observe the distant galaxy as 3.8 billion years after the Big Bang (Spergel 125-133). The Hubble-Lemaitre Law says that galaxies farther away from the earth have higher redshifts, which indicates that these galaxies are receding from the earth at faster and faster velocities. Since the universe is expanding, this means that these distant galaxies prove the universe is expanding uniformly and accelerating in its expansion, meaning that this is solid observational evidence for the Big Bang ("A Sober Assessment of Cosmology at the New Millennium" 653-657).

Finally, another key piece of observational evidence is the abundance of light elements in the universe. The primordial nucleosynthesis that occurred in the first few minutes after the Big Bang was when the universe was extremely hot and dense, and the formation of the lighter elements, such as hydrogen, helium, small amounts of lithium, and smaller amounts of beryllium, occurred. The formation of such large amounts of lighter atomic nuclei corresponds to

the number of lighter elements present in the universe. When deuterium (an isotope of hydrogen without a neutron) and helium ions were formed, the universe was about 300,000 years after the Big Bang, and by the time the universe had reached 400,000 years, it had cooled down to the point where such atoms became charged with electrons and neutral ("A Sober Assessment of Cosmology at the New Millennium" 653-657). But, no literature really gives specific figures as to what the composition of the universe is, because it is so vast and impossible to know since it is infinite. However, the theoretical uncertainties (or margins of error) in abundances are known: 0.15% for helium-4, 3% for deuterium, 3% for helium-3, and 15% for lithium-7. However, in particular astronomical bodies, abundances are predicted as following: in high redshift hydrogen clouds, the percent of primeval deuterium is 10%, in metal-poor, the percent of primeval helium is 5%, and in old Population II halo stars, the percent lithium abundance is 30%. These percent abundances are in fact consistent with observed abundances in baryon density. This baryon density is consistent with the anisotropy of the CMB radiation, which means this nucleosynthesis did in fact correspond with the Big Bang, since the CMB radiation are the present-day remnants of the Big Bang ("A Sober Assessment of Cosmology at the New Millennium" 653-657). We have covered four key pieces of observational evidence for the Big Bang; now, let us review some possible triggers of the Big Bang and how they relate to the observational evidence.

IV. Potential Triggers

One possible cause of the Big Bang could be inflation. The inflationary cosmology theory proposes that the universe expanded exponentially and extremely quickly following the Big Bang, and that this cosmic inflation could have been triggered by a scalar field or inflation. It is theorized that when the universe suddenly started inflation, the kinetic energy of the universe was driven to match the gravitational potential energy of the universe. This led to immense stretching in the fabric of the universe, which supposedly erased the fluctuations that would accompany such a large presence and influx of multiple types of energy. While the universe expanded, some regions of the universe had more matter than others, making some high-density regions and low-density regions. The regions with higher density also went through cosmic inflation and as the universe cooled, these denser regions collapsed and began to form astronomical bodies like stars, galaxies, planets, nebulas, and the low density regions formed into interstellar space after the universe slowed down its inflation (d'Inverno and Bickers 70-120; Spergel 125-133). If all the dense regions of the universe collapsed into smaller regions, then after the universe inflated, it would be mostly flat. This is consistent with the theory: our observable universe sits inside a much larger, flat bubble ("Origin of the Universe" 36-43). Furthermore, the inflationary theory does have some merit: in a flat universe, the kinetic energy and gravitational potential energy of the system should be equal. And when they were measured, (the ratio of the two types of energy) was equal to 1, within a 0.1 error margin ("A Sober Assessment of Cosmology at the New Millennium" 653-657).nThis indicates that the trigger of the Big Bang being inflation does have some merit to it.

Yet, there are several problems with the inflation theory, which are worth reviewing. First, for the actual inflation of the universe to match the size of the universe and not have many fluctuations, the model for the inflation must be extremely fine-tuned and have special initial conditions that may be unrealistic. And while other theories can be tested by computer models or done on small scales in the lab, inflation requires unquantifiable amounts of energy and can never really be tested. Most importantly, it does not explain the origin of the universe; it simply explains how the universe expanded ("A Sober Assessment of Cosmology at the New Millennium" 653-657). Another theory that does connect to inflation is the multiverse hypothesis. The multiverse hypothesis states that if inflation happened in our universe infinitely many times, why couldn't some of the denser regions of the universe turn into another universe and go through inflation repeatedly, making infinitely many universes? Since nothing can travel between these infinitely large regions or universes, they have no effect on each other ("Origin of the Universe" 36-43). There are also different levels of parallel universes. A Level I multiverse is the typical one we see in science fiction movies and novels: there's a copy of each of us. After calculations and research, the conclusions were that our nearest individual copy was meters away, and that an entire Hubble volume identical to ours was meters away (Tegmark 40-51). This theory is somewhat plausible with the inflationary theory of the Big Bang, but there are several problems with this theory as well.

For example, we can say that parallel universe #2099 is going through cosmic deflation. If our nearest individual copy is meters away and our most distant visible objects are meters away, there is no possible way we could ever observe this happening or see our carbon copy of ourselves, ever (Giovanetti et al.) Furthermore, we would never be able to know if that universe is deflating, because our universe (#1) is also infinite and completely isolated. These theories are also just as vast as cosmic inflation or eternal inflation; there's no way (yet) to test infinitely many universes and alternate versions of ourselves ("Origin of the Universe" 36-43; Tegmark 40-51).

We will move on to what might be the most complex: string theory, which also relates to eternal inflation and the multiverse hypothesis. String theory is a framework that aims to unify the fundamental forces of nature and describe the quantum behavior of gravity. One key element of string theory is a brane, which refers to an extended object or surface that can exist within higher dimensional spacetime[11]. Branes can come in many different dimensions: 0-dimensional particles (point particles), 1-dimensional strings, 2-dimensional surfaces (membranes), and higher-dimensional branes. Branes are key to string theory and the Big Bang for many reasons. Because the classic Big Bang model predicts a point of infinite density before the actual bang (which is where our current understanding of physics breaks down), brane cosmology has a solution (Magueijo and Baskerville 3221-3236). It proposes that the Big Bang is the result of a collision between branes, and that instead of a point of infinite density, there was a phase of contraction before the Big Bang (Arkani-Hamed et al. 62-69).

Next, string theory relates quite closely to the multiverse hypothesis and cosmic inflation. In string theory, there are branes and anti-branes. They attract each other, and they are to each

other matter and antimatter, electrons and positrons. Since they attract each other, this can make their dimensions increase. Then, the positively charged energy inside of the branes could provide the energy to start inflating (the Big Bang) and the negatively charged energy inside of the anti-brane could provide the energy to start deflating (the Big Crunch) (Arkani-Hamed et al. 62-69). Because branes are theorized to form in these big bangs of energy, then why couldn't branes and anti-branes attract each other and do this repeatedly, to make infinitely many Big Bangs and Big Crunches (Guth and Kaiser 884-890; Steinhardt 36-45)? But, after twenty years, string theory still has no way of being tested in a laboratory setting, and the Large Hadron Collider being constructed now may not even be enough to test string theory and its branes[17]. Since string theory is broad to the point of inconceivable experiments, let us move on to the final theory of the origin of the universe discussed in this paper: quantum fluctuations, which also relate to the FRW equations I mentioned previously. The vacuum of empty space, according to other interpretations of quantum mechanics, is not truly empty: it is filled with fluctuations of energy. It is possible that these fluctuations were amplified in the early stages of the universe, and that they led to the formation of energy and matter, initiating the Big Bang. Since particles and fields can be described as wave-like entities in quantum mechanics, these waves fluctuate and can change many things, like the position, energy, and momentum of a particle, for example. In the earliest stages of the universe, also known as the Planck epoch, quantum fluctuations are theorized to be present in the fields that govern the dynamics of matter and energy, and these fluctuations caused small, random variations in the density and curvature of spacetime (Steinhardt 36-45). During the process of cosmic inflation, such quantum fluctuations became stretched across large scales, and went through several stages (radiation, matter, and dark energy epochs) to form large scale structures like galaxies, nebulas, and clusters (Burgess and Quevedo 52-59). Through gravitational attraction, regions of higher density attracted more matter (which aligns with cosmic inflation) and regions of lower density attracted less matter, which led to the formation of the universe as it is today (Steinhardt 36-45).

V. Discussion

We will discuss the main findings of the equations and literature, synthesize the findings and the implications, identify places where there were gaps in the literature, and suggest future areas of research.

These equations and this review has provided a comprehensive overview of the observational evidence through a quantitative and qualitative lens, supporting the Big Bang theory and the proposed triggers for the Big Bang. Several key pieces of evidence were discussed, including the Cosmic Microwave Background Radiation (CMB), the ongoing expansion of the universe, the redshifts of galaxies, and the abundance of light elements in the universe. In regard to specific observational evidence, it seems that the main piece of evidence that almost every trigger and potential evidence revolves around is the Cosmic Microwave Background radiation. The CMB is the invisible afterglow of the Big Bang, and it led to many scientific discoveries and evidence for the Big Bang. It is the most important piece of

observational evidence, and the CMB provides a lot of insight for mathematical and quantitative evidence for the expansion of the universe as well as early epochs of the universe. The detection and analysis of the CMB radiation have provided strong evidence for the Big Bang theory. The nearly perfect blackbody spectrum and the uniformity of the CMB radiation, as observed by instruments like the Cosmic Background Imager (CBI), support the idea that it is the afterglow of the initial plasma in the universe. The anisotropy of the CMB radiation also indicates the presence of small imperfections, which are believed to be the result of structural formation over billions of years.

Yet, the CMB does not stand alone. The expansion of the universe, connected and inferred from the redshifts of galaxies is another significant piece of observational evidence for the Big Bang. The Hubble-Lemaitre Law demonstrates that galaxies farther away from Earth have higher redshifts, indicating that they are receding from us at faster velocities. This consistent pattern of redshifts suggests a uniform and accelerating expansion of the universe, which aligns with the predictions of the Big Bang theory.

Furthermore, the abundance of light elements in the universe, such as hydrogen, helium, and small amounts of lithium, also supports the Big Bang theory. The primordial nucleosynthesis that occurred shortly after the Big Bang explains the formation of these elements in the hot and dense early universe. The observed abundances of these elements, as predicted by theoretical models, are consistent with the anisotropy of the CMB radiation and provide further evidence for the Big Bang. As every main piece of observational evidence is based on the CMB, we can conclude that it is the most significant piece of data surrounding the Big Bang.

Moving on to the proposed triggers of the Big Bang, the discussion focused on four main hypotheses, all interconnected: inflation, the multiverse hypothesis, string theory, and quantum fluctuations. Inflationary cosmology suggests that the universe underwent an exponential expansion triggered by a scalar field or inflation. While inflation can explain the rapid expansion of the universe, it faces challenges regarding fine-tuning and the inability to explain the origin of the universe itself. The multiverse hypothesis, which suggests the existence of multiple universes resulting from inflation, attempts to address some of the limitations of inflation. However, it presents its own set of challenges, including the inability to observe or interact with parallel universes and the lack of empirical testing. String theory, a framework aiming to unify the fundamental forces of nature, also relates to inflation and the multiverse hypothesis. It introduces the concept of branes, extended objects in higher-dimensional spacetime, and proposes that the collision of branes could have triggered the Big Bang. While string theory offers a potential explanation for the singularity problem, it remains a highly theoretical framework without empirical confirmation. Lastly, the literature review explored the role of quantum fluctuations in the origin of the universe. Quantum fluctuations in the fields governing matter and energy are hypothesized to have caused variations in the density and curvature of spacetime, ultimately leading to the formation of the universe. The process of cosmic inflation stretched these fluctuations across large scales, contributing to the formation of structures in the universe. Yet,

since quantum fluctuations could not trigger the Big Bang alone, they are not technically a potential trigger, but could be in combination with others.

A few places where the evidence lacked was in the quantitative aspects of causes for the triggers. As theories for the triggers for the Big Bang became more abstract, the literature seemed to become more and more conceptually based. While there was mathematics for quantum fluctuations and the eras of the universe as well as the expansion of the universe, there was little to no math provided in articles concerning string theory and the multiverse hypothesis. However, there was quantitative physics provided in literature concerning the observational evidence for the Big Bang. As physics is required to make many of these observations, it makes sense that there was an abundance of mathematics.

Finally, I will illustrate future areas of research in this field. Currently, we are exploring many apparent triggers of the Big Bang. As I mentioned earlier in the derivation of the dark energy era, we are currently in the time of dark energy domination. Many believe that dark energy and dark matter hold the key to many discoveries in the universe and understanding the dynamics of the universe. Another area of exploration is the presence of the CMB radiation and how it could relate to cosmic inflation. Within inflation, the potential mechanisms could help us understand what the future of the universe may look like as well.

Overall, this review paper underscores the wealth of observational evidence supporting the Big Bang theory and the diverse range of proposed triggers for this cosmic event. While each hypothesis has its strengths and weaknesses, further research and experimentation are necessary to gain a deeper understanding of the origins of our universe.

V. Acknowledgments

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The Effect of Populism on the Political and Social Views of Europe: The Divide Between Advantaged and Disadvantaged and the Threat of Democratic Backsliding By Helen Sharp

Abstract

      Social divisions and resentment are omnipresent in all societies today, but in some they are more obvious than others. An example of a country in which these divisions are particularly clear is Germany. This is due to its previous divide between communist East Germany and democratic West Germany that went on for just over thirty years, ending with reunification in 1991. Now, Germany has been reunified for longer than it was divided, but the impact is still felt. Due to the higher average socioeconomic status and overall quality of life in the West, a large amount of resentment is felt in the East with consequences such as East Germans being more likely to support extremist, far right parties. Divisions like the one seen in Germany are felt across Europe and the world. This paper looks at three other countries. The first two countries, France and the Netherlands, both struggle with divisions based on socioeconomic status and race, and both, like Germany, have a large far right party that preys on these divisions. Unlike the other three countries, the United Kingdom does not have one far right party, but rather a disorganized mass of parties on the far right. Even so, there are quite high levels of political resentment in the UK. Overall, political and social divisions exist in different ways but also with remarkable similarities everywhere. This paper explores the consequences of these divisions and how they can lead to events such as democratic backsliding and populism.

Introduction

      Differences in social and political views are inevitable in today's society. Whether they are between individuals, larger groups, or whole regions, they can cause widespread discontent and social unrest. There are many potential causes of these differences, with one likely cause being a critical juncture. A critical juncture is a turning point in a country's history. An example of a critical juncture that has caused a large amount of social and political differences is the divide between East and West Germany from 1949 and 1991. Differences in leadership led to a fragmented country when Germany was finally reunified (Spiegel). West Germans tend to have a much more favorable view of the current government and economy, and East Germans have high levels of resentment towards the West and the current government, pushing many of them towards far-right parties such as the Alternative for Germany (AfD) (Gramlich). Social and political differences do not solely exist in countries that have experienced a physical divide. Three countries that experience significant divisions are France, the Netherlands, and the United Kingdom, which all mirror Germany in different ways. This paper focuses on Europe, but political and social divides are not a solely European issue. They exist all over the world and are extremely detrimental to the countries they are in. They also lead to an increased influence from far-right extremist parties, which are very dangerous and lead to even more polarization, causing the cycle of social and political divisions to continue. This leads to the threat of democratic

backsliding, where the government works to limit the checks and balances in their respective countries. This is a trend over the last ten years, seen in places like the United States in the case of Donald Trump, and the consequences still aren't fully felt. There's a global trend of resentment and division in various countries, which results in high amounts of political and social anger and unrest. This can have other detrimental effects on the state of democracy and general quality of life in entire countries.

Background

Across Europe and the world, people hold a variety of different political and social views. These differences can be explained in many ways, from the culture of one's family or community, someone's personal experiences, or a number of other factors. For example, although Europe can be thought of as a single, unified entity with similar views throughout it, there are large, invisible cultural borders that separate countries and communities. Some parts of Europe are wealthy and have liberal views, while others lean very far right, and still more remain influenced by their previous communist economies.

There are a number of different types of views that can be held by individuals and communities. Some political views include opinions of their country's government, as well as specific political parties within that country. Others include perspectives on the economy, attitudes towards minority groups, the perceived roles of women, the importance of religion, and quality of life overall. Different people can have drastically differing opinions of these topics, which brings the question to light of how people obtained these differences of opinion. Many factors can be held accountable for this, one of which is a critical juncture.

A critical juncture is a turning point in a country's development that impacts the course of a country as a whole. One critical juncture that has been seen in many countries is a divide, splitting the country in half. This has been seen in the form of North and South Vietnam, North and South Korea, North and South Italy, East and West Ukraine, and East and West Germany. These divides are often derived from wars or other conflicts and result in countries that develop separate economies, governments, and cultures as a whole. This leads to the question: what happens when these completely separate entities merge? Can they become one country again, or will differences remain long after reunification?

One particularly notable and relevant example of a country being divided then reunified is that of East and West Germany. In 1945, following World War Ⅱ, Germany was split into four zones, each controlled by one of the Allied powers: the United States, the United Kingdom, France, and the Soviet Union. In 1949, following the Potsdam conference, the zones controlled by the United States, the United Kingdom, and France merged to form the Federal Republic of Germany, while the Soviet Zone became the German Democratic Republic (Spiegel). The Federal Republic of Germany was operated as a Western liberal democracy, while the German Democratic Republic was a Soviet satellite state. These were run as separate countries with extremely different policies and values until they reunified in 1991 ("End on WWⅡ").

After the Berlin Wall fell in 1989 and reunification officially occurred with the fall of the

Soviet Union in 1991, these differences still persisted. This paper is looking at how these differences affect social and political attitudes of West Germans compared to East Germans. Examples of political attitudes include views of the government, support of the far-right party in Germany the Alternative for Deutschland (AfD), and views of the economy (Gramlich). As for social attitudes, these are more focused on general satisfaction and quality of life of people in East versus West Germany (Pickel). Therefore, this paper attempts to answer the question of how the divide between East and West Germany affects current social and political attitudes, and how this compares to social and political attitudes across Europe.

This paper will look at three countries along with Germany: France, the Netherlands, and the United Kingdom. France's political and social divides mainly surround the controversial far right party, the National Front, and its leader Marine Le Pen. Some of Marine Le Pen's views include strong anti-immigration stances and a strong sense of French nationalism from a white, Christian perspective. Although the more moderate Emanuel Macron is currently president, Le Pen has a considerable amount of support from the French public, but there is also a large amount of people who are strongly opposed to her (Sorman). More important than the divide between left and right is the divide in France between different socioeconomic statuses. In terms of social views, France can generally be divided into those who have the chance for upward mobility and those who do not for a variety of reasons, and then is further divided into those who choose to be mobile and those who do not. Unlike Germany, which has a clear divide, these groups are not located in specific areas, but are rather spread throughout the country (Cautrès). The last main division in France is that of race: with increasing amounts of immigration from North Africa, there has been pushback from the French far right.

As for the Netherlands, their government is made up of a coalition of parties that have always been mainly centrist, but support is rising for their far right party, the Party for Liberty (or PVV), along with other center-right parties such as the Forum for Democracy and the People's Party for Freedom and Democracy (Pas). The PVV was previously led by Geert Wilders, who was highly critical of Islam and the European Union, and these values are instilled in the PVV, and subsequently the other right-wing parties in the Netherlands (Wildman). There is not a lot of social controversy in the Netherlands, but there have been a rise of protests by farmers against agricultural restrictions, indicating a larger state of resentment within the working class in the Netherlands (Pas).

Finally, the UK has had a long history of far-right groups, peaking during WW Ⅱ with the rise of the British Union of Fascists. The far right in the UK is currently composed of many smaller parties, such as the National Action, Britain First, the British Democrats, the English Defense League, the UK Independence Party, and the British National Party. These far right parties have common values such as being anti-immigration (Wildman). The support for these far right groups is largely in the older generation in the UK, but still heavily impacts British politics, which is clearly seen in policies like Brexit. These three countries have numerous similarities and differences with Germany and each other, but one thing all of these countries have in common is distinct social and political divides, although they take different forms. The

first case this paper will look at is Germany and the legacy of the divide between the East and the West.

East and West Germany from 1945 to the Present Day

The Federal Republic of Germany was operated as a Western democracy, with the freedoms, economy, and quality of life as such. After the Potsdam Conference in 1945 it was divided into zones controlled by the US, UK, and France, and they sent money and aid to rebuild after the war in the Marshall Plan, so its economy was on an upward trajectory by the time the Federal Republic of Germany was formed in 1949 (Dobbins *et al.*). The effects of this aid have lasted to this day, for Germany's economy was in ruin after WW Ⅱ and relied on this foreign aid to rebuild the country. Its citizens also had all the rights and freedoms of living in a Western democracy ("End of WWII").

In stark contrast, the German Democratic Republic was controlled as a Soviet satellite state, with strict surveillance and a totalitarian Communist government (Von Bredow). The economy was never rebuilt like West Germany's was, and this was worsened by the government's poor economic decisions, including sending most of East Germany's remaining resources to Russia. There was a lot of discontent in the workforce and little to no technological advancements in factories, which also harmed the economy. The quality of life there was poor overall, which was only worsened by the lack of freedoms that the government enforced. Due to these conditions, many East Germans would try to flee to West Germany despite severe consequences. This was especially prevalent in the city of Berlin. Berlin was in East Germany, but because of the size and importance of the city, half of it belonged to West Germany. In the beginning, people in Berlin could practically move freely through both sectors of the city. Due to this, many East Germans realized how much better life was in West Germany and fled to the West German sector of Berlin. This resulted in the building of the Berlin Wall around West Berlin in order to keep East Germans in the Eastern sector and prevent them from seeing how much better quality of life was in West Germany (Spiegel).

The Berlin Wall fell on November 9th, 1989, and Germany formally reunified on October 3rd, 1990. The fall of the Berlin Wall is thought to be the mark of the fall of the Iron Curtain and the Soviet Union, reunifying Europe as a whole ("Fall of Berlin Wall"). However, in Germany, there is still a clear divide between East and West. This may be due to a number of problems during the reunification of Germany. There were three main issues faced during reunification. The first was that unification occurred during a time in which western Europe was trying to reach a 'political union', which did not mesh well with the nationalism many East Germans felt. The second is that the states to the east of Germany were increasingly unstable economically, which

put a lot of economic strain on Germany. The third is that a high number of extremist right wing parties built on xenophobic values rose shortly after reunification due to the political discourse within Germany (Von Bredow).

This divide in Germany is present in everyday life, and manifests itself in a couple of major ways. First of all, the economic conditions of East and West Germany are still extremely different. Some major statistical differences support this. Unemployment is 2.1% higher in former East Germany than it is in former West Germany, and this has fallen considerably in recent years due to various government initiatives. In the early 21st century, unemployment rates in former East Germany were almost 10% higher than in former West Germany. Those who are employed in East Germany have less disposable income than workers in the West by about 14%. Individual monetary earnings are clearly less in East Germany than they are in West Germany, and in addition to this the economy as a whole is worse off. The gross domestic product (GDP) per capita in East Germany is almost 25% less than the GDP per capita in West Germany (Gramlich). These different economic conditions have in turn shaped political and social attitudes in East Germany, especially their views of the West.

The first way that these economic conditions influence Eastern views on West Germans is that the standard of living in East Germany is generally poorer than that of West Germany, and the vast majority of Germans on both sides of the divide are aware of this (Gramlich). This knowledge has led to a persistent feeling of economic injustice, inequality, and differences of opportunity for East Germans, which has translated to less of a sense of optimism about their lives and the futures of their children (Gramlich). Furthermore, even though the economic situation in East Germany is drastically better than it was before reunification, many East Germans believe that they are worse off than they were before the fall of the Berlin wall. Many say that they feel abandoned by the government and feel like second class citizens in the new, reunified Germany (Buck). These feelings of abandonment and economic injustice heavily impact East German political attitudes and behaviors.

Survey data has found that East German satisfaction with the current government is about 15% lower than that of West Germans (Pickel). Due to this dissatisfaction and feelings that the government is not taking care of the needs of East Germans, there is a strong East German identity within them, but much less of an overall 'German' identity. Part of their identity is evident on an even smaller scale, connecting with their specific regions more than they do with the country as a whole. This identity strongly affects the lives and choices of East Germans, with studies showing that the majority of East Germans who move to West Germany (usually for better job opportunities) move back to East Germany when they have children, if not sooner (Porzio and Heise).

Economic, political, and social conditions have led to a pervasive feeling in East Germans (along with some West Germans) that they have been left behind by the government. This comes from situations such as feeling no other option than to leave jobs with better pay and opportunities due to the lack of a 'German' identity. These concerns have made many East Germans dislike or distrust the current government, pushing them to extremist or fringe parties. One such party is the Alternative for Germany, or AfD. The AfD is built on principles such as being anti-immigration and against the European Union (Chen). These principles appeal to many East Germans due to their feelings of abandonment from the government. A widely held belief

in East Germany is that the government has forgotten them in favor of focusing on international affairs, so the AfD has promised to focus on what's going on in Germany and is appealing to people who share those views.

It's clear that these views work in garnering support from the East– East Germans are twice as likely to have a favorable view of the AfD as those from the West. Currently, the AfD is polling at 18% nationally with 12% of West Germans and 24% of East Germans expressing favorable views of them (Chen). This support is trending upwards, which is thought to be a direct consequence of relatively recent influxes of immigrants and refugees. People in the West have begun to notice this rise in support in fringe parties from the East, and from this has sprung a lot of judgment and vilification from the West to the East (Gramlich). This development has worsened the divide between East and West, and the cycle of resentment has led to additional support for far right parties.

Overall, there are stark differences between East and West Germany that can be clearly seen through the economic conditions, feelings of injustice, and the conflicted feeling of a 'German identity'. These lasting differences exemplify the case of the divide to the reunification of Germany as a critical juncture in the country's history. Even though the Berlin wall and by extension the Iron Curtain have fallen, there is still very much a metaphorical wall between East and West Germany, even though over thirty years have passed since they were officially reunified. The differences in political and social attitudes between these sides don't only show how lasting the effects of a divided Germany has been, it also shows a deep discontent within East Germany. While there's such a perceived sense of injustice from the East, it will be impossible for Germany to truly become reunified. The physical split between East and West Germany makes it a particularly notable case study of the divides between European political and social attitudes, for even after over 30 years of being reunified, Germany is still not reunified in the minds of its people. Divides of political and social attitudes can be seen in many other European countries. France is another notable example, for the legacy of the socioeconomic divide between the upper and lower classes lives on today, along with extreme political and racial divisions.

French Social and Political Views

Other than Germany, most European countries did not undergo such long, stark separations into two different countries. However, political and social polarization is present in many other countries in Europe. Divisions in these countries are sometimes based in specific regions like in Germany, but they can also be more widespread. This is the case in France. Survey data from one study found that the most stark differences in French social views lay in what they thought of mobility, both in class and region. Due to this data, they split the French into four categories. The first was the 'emancipated French' who looked upon mobility favorably. This was diametrically opposed to the 'rooted French', who preferred to remain in their region and in the same lifestyle as their ancestors. The next was the 'French on the edge' who may want to be mobile but have a hard time doing so. A trademark of this group is the

hardships they endure due to this lack of mobility, whether those hardships lie in prejudice in their region, poverty, or other factors. The final group is the 'assigned French', who want to be mobile like the 'emancipated French' but are restricted from doing so because of harsh economic realities (Cautrès). These categories show stark social divides in France that are not often recognized due to how spread out they are regionally.

In terms of social mobility, France has a higher proportion of people who have a higher income than their parents than Germany or even the United States ("Centrists Alarmed as Poll"). However, this change in social status is generally small, such as going from the bottom 20% to the bottom 40% (Dehrbécourt). There is also an enhanced sense of injustice because of the complete disconnect between the lives and incomes of the French wealthy elite and the average

French person (even if said person is well-off). One study found that the wealthiest 370 families in France pay only 2% of taxes in France, when this group includes 40 billionaires, including the richest man in the world Bernard Arnault, with a net worth of 206 billion American dollars (Rey-Lefebvre). The massive divide between the French elite and the rest of the French creates unrest and a social divide not unlike the divide between the people in former East and West Germany. The lower classes in France strongly resent the upper classes, and this leads to political attitudes including a dislike of the current government and a tendency to lean towards extremist parties.

The current president of France is Emmanuel Macron. He's known for being a rational politician and is unique because when he ran he was neither to the Left or the Right, which is practically unheard of in Europe. His refusal to lean towards the Left or the Right could make people believe that France would be less politically polarized, but it is rather polarized in a different way. Class divides and opinions on mobility are a large part of this polarization. Macron is extremely pro social mobility (although he did recently reduce the levy on capital gains and get rid of the wealth tax) so many people in the 'emancipated French' are very pro-Macron. The 'assigned French' resent the mobility of the 'emancipated French', so they tend to gravitate towards other parties, particularly extremist, far right parties such as the National Front, led by the controversial Marine le Pen (Rey-Lefebvre) (Cautrès).

The ongoing resentment of the high proportion of French people who would like to be upwardly mobile but cannot be for a variety of factors has a ripple effect of other political and social views. One example is opinions on France's relationship with the European Union and the rest of the world, which leads into their stances on immigration. In France, those of a higher socioeconomic status tend to have a more positive attitude towards the European Union and be more in favor of immigration. Meanwhile, those of a lower socioeconomic status, especially the 'assigned French', tend to view the European Union in a more negative light and be less in favor of immigration (Sorman). This is similar to Germany, with West Germans (who tend to be more financially well-off than East Germans) favoring the European Union and immigration more than East Germans.

Overall, although the social divides in France are not due to the country being severed for decades like Germany was, there are definitive divisions in France, even if they are often

unseen. Like Germany, socioeconomic divides are felt strongly, and someone's socioeconomic status is better predictor of what party they'll support than it is in countries such as the United States. In Germany and France, people of lower socioeconomic statuses tend to support extremist, far right parties more than the other people in these countries. These parties are the Alternative for Germany and the National Front respectively, and they share similar principles, often built on xenophobia. Resentment of people of a higher socioeconomic status and of the government as a whole is also strong within the middle and lower classes in these countries, which is another reason they are drawn to alternative parties. The striking similarities between France and Germany may show that social and political divides are just as prevalent in other countries in Europe as they are in Germany. However, they are more visible in Germany due to the repercussions of the past physical divide between East and West. France and Germany are both known for their political polarization. However, other European countries undergo polarization of their own that is more under the surface. One such country is the Netherlands. It is widely regarded to be stable, but has social and political tensions that will be discussed in the next section.

Dutch Social and Political Views

The Netherlands is another example of a European country that did not undergo a divide like Germany did, but still suffers from social and political polarization. It is generally thought to be politically stable with very little political and social unrest, and this is largely true. For decades the Netherlands has been governed by a coalition of parties that form a centrist government that caters to the majority of people's needs. However, since the beginning of the 21st century, levels of unrest and dissatisfaction have been growing (Pas). Like France, there are distinct divides between people of different socioeconomic statuses. Those of a lower socioeconomic status are more likely to feel slighted or forgotten by the government, which is similar to the attitudes of many East Germans.

A lot of the stability in the Netherlands in the past was due to its largely homogeneous population. In 1972, over 90% of the population of the Netherlands was racially Dutch. Most of the country shared the same background and views, so political stability was high. Now, 22% of the country is made up of residents with a migrant background (Framont). Due to this, the government has to cater to people with far more diverse backgrounds and perspectives than it ever has. It has found it impossible to please the entire population, which has led to unrest with both migrants and native Dutch people.

As with most cases of unrest, some people turn to extremist parties due to dissatisfaction with the current government. The ingrained xenophobia of many people in the Netherlands has caused them to turn to far right parties with anti-foreign, Islamophobic, and anti-EU beliefs and policies. The main far right party in the Netherlands is the Party for Freedom, or PVV (Pas). Unlike far right parties in many other countries in Europe, the PVV was not taken seriously for years, being considered a fringe group of people who were too extreme to lead (Jennison). However, due to the wariness some Dutch people have had over their growing migrant

population, the PVV has grown in recent years. In fact, in 2021 it got 11% of the Dutch vote and obtained 17 seats in the Dutch House of Representatives, making it the party with the third largest number of seats (Damhuis). The PVV having such a high amount of support is particularly concerning as it's in the Netherlands, which is generally thought to be a very open and accepting country. It is so outspokenly anti-Islam and anti-immigration that, even without a majority, the PVV has potential to do a significant amount of damage to the progressive policies the Netherlands is known for.

High amounts of immigration is not the only thing that is causing discontent. In many cases, people of a lower socioeconomic status or simply working class people feel as if the Dutch government does not think about their needs and interests before making decisions for the country. A key example of this is the Dutch agricultural protests in 2020. In October 2019, the Dutch government placed various reforms on the agricultural sector to combat climate change, but those who worked in agriculture believed that those reforms would be detrimental to their livelihoods. An example of one of these reforms is the initiative to cut the amount of livestock in the Netherlands in half, which could make many people lose their livelihood. In addition to hundreds of protests, many farmers founded the Farmers Defense Force to organize these protests against the agricultural reforms and a perceived lack of respect for their profession along with other working class professions among the government and the rest of the Dutch population. These agricultural protests resulted in high levels of polarization as the Farmers Defense Force and various animal rights and climate activism groups clashed, with the Dutch population taking sides (Satre *et al.*). This also caused Dutch farmers to lean towards far right parties who told them they would look after their interests as they feel that the current government does not.

The discontent in the agricultural sector of the Netherlands is representative of a widespread feeling that the government is not supporting the needs of the working class. It is reminiscent of how many East Germans feel as if the government is not working for them, only for their West German counterparts. Another important similarity is the general fear of immigration in East Germany and the Netherlands as a whole, and in both places this causes people to support far right parties, whether that is the AfD or the PVV. Although the social divides in the Netherlands are not as visible as the divide between former East and West Germany and the divide between socioeconomic classes in France, they definitely exist, as seen in the creation of the Farmers Defense Force. The Netherlands is often put on a pedestal as a utopia of acceptance and liberalism, and although this is the case in many situations, there are still a significant number of social and political divides that may be more subtle than in other countries, but are too large to ignore and are just growing larger as time goes on.

The Far Right in the United Kingdom

The case of the United Kingdom is considerably different from the other three countries. Rather than one major far right party, it has a disorganized network of far right parties, each lobbying for slightly different things. Out of all of these parties, only one has a seat in

parliament and none got a significant percentage of votes in the most recent election (Feldman). On the surface, it may seem like this means the UK leans much further to the left than these other countries, but that is not the case. The main right wing party, as well as the party with the most seats in parliament, in the UK is the Conservative Party. Although it's not considered extremist, many of its views are more extreme than the centrist governments of the other countries on this list. This means that people who hold right wing beliefs who would vote for extremist parties in the other countries may vote Conservative in the UK, making the interpretation of data about the other right wing parties skewed. This makes the politics in the UK closer to those of the United States than the rest of Europe.

   The UK has no need for a large, defined radical right party because the Conservative party in the UK supports a lot of the agendas that extremist parties in countries in continental Europe lobby for. However, right wing extremist parties in the UK are still able to have

influence. One prime example of this is the case of the UK Independence Party (UKIP). The leader of UKIP Nigel Farage pushed extremely hard for the passing of Brexit, and had a lot of influence on Boris Johnson, the British prime minister at the time. He was regarded as a kind of celebrity in the far right world (Damhuis). Because his party did not have seats in parliament, Farage used his celebrity and relative infamy to push his message supporting Brexit, along with utilizing Boris Johnson's power as prime minister. He used a lot of propaganda pushing an anti-EU agenda and empty promises that Brexit would impact the day to day lives of people in Britain in a positive way. For example, he said that more funding would go to the National Health Service when he had no authority to reallocate this money in the first place (D'Arcy). Overall, even though Nigel Farage and UKIP had no real political power in parliament, many people consider them one of the main factors in Brexit, which shows how strong the British far right actually is.

   These unconventional methods range from mild like the case of the Traditional Britain group and UKIP up to acts of terrorism, some which have resulted in arrests (Morillas). However, even the attacks that ended in arrests and significantly negative media attention were a net positive for many of the parties involved. They got their messages out there and even drew some supporters to their cause. The supporters of these parties, particularly the supporters that were drawn in by acts like terrorist attacks, were attracted to these parties for similar reasons that people were attracted to far right parties in Germany, France, and the Netherlands. These reasons include discontent with the current government or with one's quality of life in general, causing them to seek extremist strategies that will seemingly fix these issues. Distrust in the government in the UK is as high or even higher than the other countries in this paper: the majority of people in Great Britain believe that the political system is not working for them, and there is so much distrust in the government that many scholars believe that it is not possible to reach a point where the majority of the country trusts their government ("Radical Political Platforms"). There is not a centralized far right in the UK like in other countries, but right wing values still exist there in the form of the Conservative party and influence of fringe parties. However, compared

to other countries in Europe, the far right is not as much of a threat to the UK in terms of the impact it can have on democratic backsliding.

Comparison Methodology Across Countries

This section includes two tables in order to better understand the similarities and differences between the four countries that are looked at in this paper. Table 1 is a qualitative examination of the similarities between the three comparison countries (France, the Netherlands, and the United Kingdom) to the divisions in Germany, as well as the differences from both. Table 2 takes more of a quantitative approach. It looks at the amount of seats the main far right party (or parties, in the case of the UK) in each country have in parliament, also represented as the percentage of seats that the party obtained. It also looks at the percentage of votes each of these parties obtained in the most recent general election in each country respectively. All of this data is in order to quantitatively assess how much power in government each far right party has.

Table 1: Political & Social Divides in Germany Compared to France, the Netherlands, and the United Kingdom

	France	**The Netherlands**	**The United Kingdom**
Similarities to Divisions within Germany	- A general feeling of inequality among people of a lower socioeconomic status leads to discontentment with the current government and a tendency to lean towards far-right parties. - The far right party most of these people support is anti-immigration and against the European Union. - Resentment is felt from those of a lower socioeconomic status towards those of a higher socioeconomic	- People who feel marginalized and slighted by the government are more likely to support far right extremist parties. - The far right is built on xenophobic and Islamophobic principles, as well as being anti-immigration. - Relatively stable overall due to economic success. - The far right party and supporters of it are looked down upon by those of a higher socioeconomic status.	- A general distrust of the government is prevalent. - Far right groups take stances built on xenophobia and being against the European Union. They often take these stances to prey on existing fears of the public. - Relative economic growth, but leaves some people behind despite these successes.

	status. - Those of a higher socioeconomic statu shave more positive views of the European Union and immigration.		
Differences	- Differences in social and political views are not mainly geographical like in Germany, they are rather based on mainly socioeconomic status.	- More homogenous views than in Germany (mostly due to the largely homogenous population). - Differences in social and political views are not geographical like in Germany, they are rather based on a number of factors including socioeconomic status and race.	- The far right is made up of a disorganized mass of smaller parties rather than one main party. - Young people in the UK tend to lean further left than young people in Germany (and most other European countries). - The percentage of votes for the far right is much more in the minority than Germany or the other countries on this list (however, the government overall leans further right than these other countries). - No longer in the European Union and the divide between leavers and remainers is prevalent.

Table 2: Support of Far Right Parties in Germany, France, the Netherlands, and the United Kingdom

	Alternative for Germany (Germany)	The National Front (France) Party for	Freedom The Netherlands) National	Action, Britain First, the British Democrats, the English Defense League, the Reclaim Party, the British National Party, and UKIP (The UK)
Seats in Parliament/ Parliament equivalent	78 out of 736	89 out of 577	17 out of 50	1 out of 650
Percentage of Seats in Parliament/ Parliament equivalent	11%	15%	11%	0%
Percentage of Votes	18%	23%	12%	0%

As it can be seen in Table 2, the National Front in France has both the highest percentage of seats in parliament and the highest percentage of votes. This indicates that there is a high amount of discontent with the government in France, which rings true given that there are noticeable class divides there, along with high amounts of xenophobia and racial divides that push people to the National Front. The PVV in the Netherlands and the AfD in Germany have the same percentage of seats in their parliaments, but the AfD got a larger percentage of

votes in the most recent election, showing that there are higher levels of discontent with the current government in Germany than there are in the Netherlands. However, they have the same percentage of seats in Parliament, giving them seemingly equal pull in their countries' governments. However, this may be negated by the fact that the PVV is still extremely looked down upon by other political parties in the Netherlands and considered more of a fringe party than the AfD is in Germany. The data for the United Kingdom is quite skewed because there is not one large far right party and the country as a whole leans more towards the right than most of the countries in continental Europe, so many people who would otherwise support far right parties simply vote for the leading Conservative party.

Conclusion

  Social and political divisions are present in all the countries that this paper looked at, for they exist in every country to some extent. They are especially visible in Germany due to the former divide between East and West leaving a distinct geographical rift that pushed the political and social views of the country apart. This divide is felt over thirty years after the country reunified after being pushed apart for just under thirty years. Even though often times they are less apparent than what's present in Germany, other countries also have significant social and political divisions. No country can escape them: even places like the Netherlands that are regarded as extraordinarily stable still have rifts that they need to deal with. Whether these divisions are primarily due to economic circumstances, concerns surrounding immigration, feelings of injustice, or a number of other reasons, they always have a serious impact on the country and can cause high amounts of unrest.

  When people are faced with these divisions, many people on the end that feel slighted tend to turn towards extremist parties. In many cases, these parties are far right groups that villainize the current government, immigrants, and many other groups in order to garner support. Many countries, such as Germany, France, and the Netherlands have one major far right group, while others like the UK have many smaller ones, but all can make an impact politically and socially. These parties represent people who feel left out of politics and tend to have extreme views, and many times a strong extremist far right party is a sign that there are high amounts of discontent in that country.

  This paper mainly focuses on Europe, but this is a global issue. The United States is a prime example of this. Like the UK, the US does not have one main explicitly extremist far right party, but the Republican party pushes many extremist views in order to garner support from people who feel slighted by the current government. This phenomenon is often called democratic backsliding and is a global issue that is supported by many far right parties. When a mainstream party such as the Republican party supports these radical views, the backsliding worsens. Many people believe that social and political rifts are too ingrained in society to be fixed, but there are some ways they can be improved upon. An important way to improve upon this is economic equality and more political inclusion. When people feel as if their needs are being paid attention to by their current government, they are less likely to turn to fringe parties,

so deep social and political divisions are less likely to occur. These divisions are extremely harmful to democracy and overall quality of life, so it is imperative that measures are taken to lessen them. However, they will likely never go away completely due to how ingrained in our society division and resentment truly are.

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Simplifying Multimodal Composition: A Novel Zero-shot Framework for Visual Question Answering and Image Captioning By Ethan TS. Liu

Abstract

In this work, we perform zero-shot image captioning and visual question answering on images using a simple model composition framework, composing the dense image captioning capabilities of a visual language model with the powerful reasoning abilities of a large language model, ChatGPT. The proposed method utilizes zero-shot learning to enable cross-modal integration of vision and language in order to create a comprehensive visual language model. We achieve zero-shot state-of-the-art performance on VQAv2, demonstrating its effectiveness and high accuracy. The method's simplicity makes it highly scalable and adaptable to a wide range of applications, including integration from OpenAI's multimodal model, GPT-4, with audio language models in the future. The results demonstrate the vast potential of this simple zero-shot framework in improving the accuracy and relevance of vision and language applications, and constituting an effective approach to image captioning and visual question answering, as well as future multimodal composition.

1 - Introduction and Problem Background

Recent years have seen the rapid development of multimodal models [1, 2], due to numerous factors including improved network architecture [3, 4, 5, 6], large-scale model training [7, 8, 9], among numerous other factors. Numerous advances have been made in computer vision and object recognition which allow for more effective downstream tasks. Fine-tuning and training methods have been applied to counter the typical catastrophic forgetting by models like OpenAI's CLIP when fine-tuned [10, 11, 12]. The integration of vision and language models lead to vision language models, capable of responding to questions or captioning images. However, based on what vision-language task one looks to perform, the selection of model may often change, as different vision problems often require different types of models. Ultimately, this may require manual selection and composition of individual models for each use case.

One solution to this problem has been the end-to-end model, combining the vision modules and the language modules. This joint fine-tuning approach allows the user to use natural human language to interact with the vision-language model in the context of the image provided by the user to the model. Examples of this include PaLM-E [13] and Flamingo [14]. In essence, these two modules function as one, communicating in special tokens or signals in order to achieve visual understanding of the image. However, these methods utilize "hands-on" approaches towards improving models, in which models such as the aforementioned end-to-end models are fine-tuned and/or trained in order to specialize towards certain domains. These manual approaches are too intensive and costly, requiring large amounts of computing resources and enormous annotated datasets to finetune for specific capabilities. In recent years, model composition through guided prompt engineering has been able to achieve powerful results, such as the concept of Socratic Models [9], in which models are guided to engage each other in

dialogue in order to achieve satisfactory results. Therefore, in this work, we aim to further enhance model composition. We provide a novel framework with guided prompt engineering for composing a visual language model with a large language model, ChatGPT, in order to provide a more flexible and accurate network to enhance reasoning and action.

2 - Model Composition and Methodology

This is a zero-shot framework that leverages the zero-shot capabilities of pretrained models by guiding multimodal communication and dialogue amongst independent models to achieve collective inference on a task-specific output. We utilize multi-model, multimodal prompt engineering with pre-trained models in order to facilitate adequate and varied communication between models to achieve a flexible and effective framework for model composition. For instance, suppose we want to recreate an image. Let f_{VLM} be the function computed by a given visual language model, f_{LLM} be the function computed by a given large language model, f_{DM} be a function computed by a given diffusion model as DM, and img be the image input.

$$Recreate = f_{DM}(f_{LLM}(f_{VLM}(img)))$$

Initially, the visual language model works in tandem with the language model to produce an extensive caption of the image being inputted. This extensive caption then satisfies the diffusion model, and it now has enough material to recreate an image based on the output from the large language model. All of these models engage in thorough dialogue with each other, much like they are sitting together at a dinner table, as demonstrated by the Socratic Models concept [9]. In this work, we apply this novel framework to guide multimodal dialogue in order to more accurately perform visual downstream tasks, using a visual language model and a large language model - Bootstrapping Language-Image Pre-training 2 (BLIP-2) and ChatGPT, respectively. Both of these models were chosen for their powerful image and reasoning abilities [2, 15]. In order to achieve a versatile framework for simplifying model composition, we look to implement various principles. One principle we choose to use is to implement the sentence "Let's think step by step" to the end of many of our prompts. Previous work has found that by appending the phrase "Let's think step by step" to the end of a prompt for large language models, these models obtain a statistically significant increase in accuracy in responding to the prompt [16]. The study's authors state, "the versatility of this single prompt across very diverse reasoning tasks hints at untapped and understudied fundamental zero-shot capabilities of LLMs (large language models), suggesting high-level, multi-task broad cognitive capabilities may be extracted by simple prompting" [16].

Moreover, another study has shown the impact of "Let's work this out in a step by step way to be sure we have the right answer" [17], which also greatly increases the accuracy of large language models in answering questions. We also implement a modified version of this phrase, namely "Work this out in a step by step way to be sure you have the right answer."

These 3 essential phrases compose the majority of our framework. We implement these phrases in both the visual language models, BLIP-2 and BLIP-VQA (a derivative of BLIP-2), and the large language model, ChatGPT, in order to maximize accuracy and performance. What remains is instructing ChatGPT and adding context to allow it to function better with the prompt received from the visual language model. For example, for certain questions involving human-human interactions, we implement context prompts such as "Use your knowledge of human interactions, relationships, and commands to summarize the information in the photo". We name this framework "Simplifying Multimodal Composition", or SMMC for short. Following these principles, we implement the following system architecture using the SMMC framework.

In order to better understand what is occuring, refer to Figure 1. The prompt is passed to ChatGPT to generate some questions (Step 1: Question Generation). Then, these questions from ChatGPT are passed to the visual question-answering, or VQA, model of BLIP, known as BLIP_VQA (Step 2: Questions). BLIP_VQA uses the image given to answer the numerous questions generated from ChatGPT (Step 3: Responses). then captions the image (Step 3: Responses). With the original question, the image caption from BLIP-2, and the answers from BLIP_VQA, we are now able to combine the Step 3 Responses to prompt ChatGPT with the final user query answer prompt, Step 4. This user query answer prompt also comes with few-shot prompting in the form of examples for ChatGPT to better understand the question along with what text information is given. Ultimately, this generates our final answer from the system architecture.

3 - Results and Discussion–3.1 - SMMC Performance Evaluation

We can see the effect of this SMMC framework in simple image captioning. Consider this image of the Marina Bay Sands in Singapore.

A typical prompt of the model to constitute image captioning with regards to location would be: "'Question: Where was this photo taken specifically? Answer:".
The visual language model, BLIP-2, responds with "singapore" - nowhere near the level of detail that we want our answer to contain.

If we instead modify it with one of our essential phrases of the SMMC framework, the prompt becomes: "'Question: Where was this photo taken specifically? Work this out in a step by step way to make sure you have the right answer. Answer:"'

BLIP-2 now responds with "the marina bay sands in singapore". Through this free response, we can see the powerful detail and information that is contained by a slight increase in sentence length from using the SMMC framework to augment the visual language model.
We can see the powerful ability of the SMMC framework in evaluation on VQAv2, a dataset which contains open-ended questions about images which "require an understanding of vision, language and commonsense knowledge to answer" [19].

We access ChatGPT via the Azure "gpt-3.5-turbo" API that has a token length limit of 4,096. PNP-VQA (Plug-n-Play VQA) model achieves 63.3% accuracy for zero-shot on VQAv2.

In contrast, our SMMC framework achieves a state-of-the-art 73.7% accuracy on zero-shot tasks for VQAv2, a marked increase of 10.4% from the previous zero-shot state-of-the-art model. This increase is statistically significant, and bears much promise for the future of flexible zero-shot frameworks that excel in both simplicity and performance. Much of this success is undoubtedly due to the use of the phrases "Let's think step by step", and "Let's work this out in a step by step way to be sure we have the right answer". Through numerous batches of size 100, we found that when we removed these phrases from the prompt, the SMMC accuracy declined by an average of 34%. In fact, prompting ChatGPT to show its reasoning process has been shown to be beneficial in NLP studies [21] for increased accuracy and performance. Moreover, by instructing ChatGPT to remain in context while allowing it to interact and communicate with the BLIP-2 and BLIP_VQA models as ChatGPT creates its own questions based off extensive image captioning, we are able to maintain dialogue between these models to achieve the highest zero-shot performance level.

3.2 - Limitations

However, this SMMC framework does have some inherent limitations. For one, the vision capability of the framework is wholly dependent on the integrated vision models. That is to say, if one vision model fails, the system may fail. Moreover, if any form of mistake is made by one of the vision models, then the system's dependency on those vision models will cause it to produce inaccuracies.

As another limitation, visual signals such as image captions are converted to human text format from the visual language models for ChatGPT to understand, which may not be the best format of conversion for efficiency.

4 - Conclusion

We have presented SMMC, a framework designed to simplify multimodal composition through prompt engineering and engaging models in dialogue, utilizing both the impressive vision capabilities of a visual language model, and the powerful reasoning abilities of a large language model. SMMC demonstrates a simple way to empower a large language model, namely ChatGPT, with a pool of visual language models, namely BLIP-2 and BLIP-VQA, in order to enhance its reasoning ability for visual downstream tasks such as image captioning and visual question-answering. Given the flexibility of the SMMC framework, we anticipate that it can be further used to develop more complicated zero-shot frameworks in order to achieve higher performance on these visual question-answering tasks and extensive image captioning, and even extend to other domains such as audio language models and speech synthesis.

5 - Future Work

A possible example of audio language models being used in this SMMC framework could be using audio language models with GPT-4. We implement OpenAI's open-source model Whisper to transcribe the audio file we receive from the user on the front-end. This model was

chosen due to its high accuracy, as zero-shot Whisper models close the gap to human performance, with a confidence interval of 95% [22].

This framework is derived from our proposed SMMC framework, and incorporates an audio language model, Whisper, with the visual language models BLIP-2 and BLIP_VQA, as well as the large language model, GPT-4. These models are able to engage each other in dialogue as we facilitate conversation using the SMMC framework through guided prompt engineering with the 3 phrases described earlier and immersing GPT-4 in context.

In order to better understand what is occuring, refer to Figure 1. Whisper first transcribes the user-given audio prompt to text format, and this prompt is passed to GPT-4 to generate some questions (Step 1: Question Generation). Then, these questions from GPT-4 are passed to the visual question-answering, or VQA model of BLIP, known as BLIP_VQA (Step 2: Questions). BLIP_VQA uses the image given to answer the numerous questions generated from GPT-4 (Step

3: Responses).

Separately, we prompt BLIP-2 with the image from the user (Step 1: Image Caption). BLIP-2 then captions the image (Step 3: Responses). With the original question transcribed from Whisper, the image caption from BLIP-2, and the answers from BLIP_VQA, we are now able to combine the Step 3 Responses to prompt GPT-4 with the final user query answer prompt, Step 4. This user query answer prompt also comes with few-shot prompting in the form of examples for GPT-4 to better understand the question along with what text information is given. Ultimately, this generates our final answer from the proposed system architecture.

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