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The Difficulties Present with COVID-19 Patients with Specific Underlying Comorbidities

By Meghna Manjith

Abstract

The point of this article will be to provide a rough overview of SARS-CoV-2 and how it invades the human body as well as showing how it affects the body (symptoms). The paper also discusses different comorbidities (hypertension, cardiovascular disease, diabetes, and chronic obstructive pulmonary disease) and provides an in-debt analysis to help explore the possibilities behind the severity these underlying diseases may cause when the body contracts the Coronavirus Disease 2019 (COVID-2019).

Adhesion

Coronaviruses in general are enveloped spheres that contain a single strand of positive sense RNA (ribonucleic acid) inside (Sevajol et al.). The virus also contains at least four different types of proteins, which include the Membrane (M), Spike (S), Nucleocapsid (N) and Envelope (E) (Tortorici et al.). The spikes give the illusion of a crown on the virus, leading to the name "coronavirus" (corona means crown in Latin) (Li). These proteins play an important part in invading the human body. The first step to invasion, (after entering the body) is adhesion, or the process where the virus attaches itself to a human epithelial cell. Although it is more common to attach to epithelial cells in the respiratory tract, it is theorized that the coronavirus can also attach to epithelial cells in the corneal and/or intestinal tract (Smyk et al.). And this step is completed by the S glycoprotein.

The S glycoprotein contains two subunits: subunit S1 and subunit S2. The S1 subunit is responsible for binding to the host cell's receptors and the S2 subunit is responsible for fusing the viral and cellular membranes (Walls et al.). The first step in the invasion of a cell is for the receptor binding domain (RBD) in the S1 subunit to bind to the angiotensin converting enzyme 2 (ACE2) receptor on the host cell (Rothan et al.) The S1 subunit is essentially stabilizing the perfusion state of the S2 "fusion machinery" (Tortorici et al.). After that, the host proteins further cleave the S protein at the "so-called S2 site." This is located upstream of the fusion

peptide. It is believed that the reason the S protein is cleaved is so that it can activate the protein for membrane fusion (Walls et al.) Finally, the S2 membrane fuses together the virus's and host cell's membranes so that it can allow the passing of the viral RNA into the host cell (Li).

Infection

After successfully entering the epithelial cells, the SARS-CoV-2 infected patient can display a variety of symptoms, usually arriving after a mean incubation period of 6.9 days, a bit longer than the previously noted 5.2 days (Wei et al.). Some common symptoms include fever, cough, shortness of breath, and muscle aches (Tu et al.). Fatigue, sputum production, sore throat, and headache are also pretty common symptoms with symptomatic patients. Some of the less dominant symptoms include those associated with the gastrointestinal area, including diarrhea and vomiting (Ludwig et al.). Symptoms also include anosmia (which in turn can cause ageusia), sneezing, nasal congestion, rashes, discoloration of toes and/or fingers, and viral conjunctivitis. The most common radiological findings in COVID-19 patients are ground glass opacities in the lungs (Lotfi et al.). Side note: although epithelial cells that contain the ACE2 receptors are found widely throughout the body, a study shows that there is high ACE2 expression in the corneal, respiratory, and intestinal epithelial cells. Because ACE2 receptors are important for the virus'
entry into the cells and the creation of infection, it makes sense why there are common symptoms based on these areas (Smyk et al.).

Acute respiratory distress syndrome (ARDS) is another symptom that is common in some COVID-19 patients. The incidence rate of this symptom is 15.6%- 31% higher than that of other organ injuries and is thought to be caused by damage to alveolar epithelial cells. Elderly people and those with comorbidities are thought to be more at risk for ARDS and this syndrome most likely contributes to their increased chance of death (Xiaochun et al.).

However, most people who are infected with the SARS-CoV-2 are either asymptomatic patients, (meaning they do not show any symptoms) or have symptoms (like the ones stated above) that usually last 1-2 weeks, leading to full recovery. But there are going to subsets of patients who progress to pneumonia and develop severe dyspnea. These patients may need intensive care as well as respiratory intubation (Unudurthi et al.).

Children can also catch the coronavirus but are less likely to be affected by it. The most common symptoms of children are fever and cough. The frequency of severe illness in younger children is also lower than with adults (7% vs. 25.6%). Also, children younger than one year of age are more likely to obtain more severe illness, likely due to their weaker immune system. It is assumed that children are less likely to get a severe infection from COVID-19, because they are less likely to have underlying comorbidities (Cui et al.). However, these numbers were published before the spread of the current aggressive variants and could be different when subjected to new studies.

Delving deeper into comorbidities in children, there have been studies that have tried to determine how COVID-19 affects children with underlying comorbidities. For example, in a study with 1391 children with COVID-19, only three children needed to go to the ICU and need mechanical ventilation. And these three children had underlying diseases. In addition, it is being noted that most infants that have the coronavirus also have Kawasaki's Disease (KD) or something similar. This shows the need to keep the infants with KD under close surveillance and the need for more information to be brought to light about this disease in pediatrics (Lotfi et al.).

The Effects of Age

While all age groups can contract and transmit the COVID-19, only certain age groups seem to develop full pathogenesis and severe complications. Data from March 2020 shows that of the 508 patients hospitalized in the USA, 36% were within the ages of 65-84, 18% were within the ages of 45-54, and 17% were within the ages of 55-64. The rest of the patients (29%) were either older than 84 or younger than 45. And for the patients that were in the Intensive Care Unit, 46% were within the ages 65-84 and 36% were within the ages of 45-64. In addition, death was more likely to take those in the 65-84 age group (46% of deaths were of patients in this age group) (Bialek et al.). As months passed on, these percentages have stayed relatively the same, with the 65-84 age group as the most susceptible age group to the SARS-CoV-2 (Chen et al.). However, with the new variants circling around, these numbers might have changed and might emphasize a new age group.

Underlying Health Conditions

A characteristic that is also important to take note of is any underlying medical conditions, as 46.4% of confirmed cases (in a 138-patient case study) reported by Wang et al. had comorbidities which include diabetes, hypertension, chronic obstructive pulmonary disease, and cardiovascular disease. And 72.2% of the patients in the Intensive Care Unit had comorbidities, as opposed to the 37.3% of people who didn't (Yang et al.). This shows comorbidities might influence how the SARS-CoV-2 can affect a patient's body. The following pages provide an in-dept analysis
on how four, specific underlying health conditions can enhance the infection and lead to more severe medical complications when subjected to the SARS coronavirus 2. 5.a. Diabetes

Diabetes will the first underlying comorbidity discussed in the paper. Patients who have diabetes and contract COVID-19 can trigger stress conditions that could lead to the release of catecholamines and glucocorticoids, two types of hyperglycemic hormones. With the release of these hormones, the patient is more prone to elevated glucose levels, abnormal glucose variability, and diabetic complications. These side effects can lead to severe acute respiratory syndrome and septic shock which could lead to multiple organ failure, which could eventually lead to death (Wang et al.). The mortality rate (in China) of COVID-19 patients with diabetes was higher (7.3%) than that of COVID-19 patients with no comorbidities (0.9%).

In addition to China, South Korea and the USA found that diabetes was common among critically ill patients. In a single study in South Korea, it was reported that most COVID-19 patients with a 28-day mortality rate were diabetic rather than not (17.2% vs. 1.2%) (Jeong et al.). And in the United States, of the 122,653 laboratory confirmed COVID-19 cases (by March 28, 2020), Diabetes Mellitus (DM) was one of the most common underlying diseases in COVID-19 cases with severe outcomes of respiratory infections (10.9% versus the 9.2% and 9.0% of two other common diseases) (Chow et al.). Another set of data from June of 2020 (recently revised) shows that in a group of the "non-survivors" of COVID-19, 22% of them had the underlying disease of diabetes (Zhou et al.). And finally, a recent report reaffirms this fact by stating that diabetic patients with COVID-19 have often have poorer prognosis than patients without the underling disease of diabetes (Hoong et al.). This information shows the ongoing need to focus more on diabetic patients as the disease could lead to serious complications.

Hypertension

The next underlying disease is hypertension. Hypertension has been prevalent among medical reports of COVID-19 patients and is shown to be one of the most common comorbidities among patients. One report said that 15% of 41 patients hospitalized (around January 2, 2020) in the United States had hypertension (Huang et al.). Another report says that out of all the patients who were in the ICU (results from Spain), the patients who had died more often than not had hypertension (Huang et al.). And a recent report from the United States has concluded after a rigorous study that having hypertension significantly increases the odds of mortality after acquiring COVID-19 (Antos et al.).

But why are patients with hypertension at risk? One thing to focus on could be the medications these patients use such as angiotensin-converting enzyme inhibitors (ACEI) and angiotensin receptor blockers (ARBs). These medications are shown to increase ACE2 expression and theoretically could increase the binding of the SARS 2 coronavirus because of the increase in cells that the coronavirus could bind to (Schiffrin et al.).

However, some studies have shown that ACEI might be protective against respiratory complications. Acute pneumonia can be caused when the SARS-CoV-2 virus binds to the ACE2 receptors-this can lead to the imbalance of the renin-angiotensin-aldosterone system. By hindering the renin-angiotensin-aldosterone system using ACEI, it can help decrease the risk of pneumonia caused by COVID-19, which could ultimately decrease the risk of mortality (Khashkhusha et al.). Likewise, ARBs can block the angiotensin AT_1 receptors, which would decrease the risk of inflammation in the lungs, kidneys, and heart (which can happen to COVID-19 patients) (Schiffrin et al.).

However, at this point, there is not enough research to determine if ARBs and ACEI can really have a beneficial impact on all patients.

Cardiovascular Disease

Cardiovascular disease (CVD) is another underlying disease that COVID-19 patients have. The fatality rate was shown to be higher for specifically cardiovascular disease patients (10.5%) than for the entire cohort (2.3%) according to the 44,672-patient meta-analysis conducted by the Chinese Center for Disease Prevention (Dhakal et al.). And a recent study giving information from late April 2021 shows that patients with this comorbidity have a

mortality rate of 10.5% (Das et al.). Although there is limited research as to why this disease has a profound effect on COVID-19 patients, there are several theories as to why this is the case.

The first is that since there is high ACE2 expression in the heart, as well as the lungs, it increases the susceptibility to cause injury to this organ. The higher secretion of these enzymes in cardiovascular disease patients might be related as to why CVD patients have a more severe reaction to the SARS-CoV-2 (Paramasivam et al.). More ACE2 expression means more ways the virus can infect the body, and this can cause a lot more severe reactions than with someone who doesn't have CVD and an increased secretion of enzymes.

Another theory is the medicine used for COVID-19 patients. Remdesivir, interferon-alpha, and lopinavir-ritonavir, are a few examples of medicine that are being used to treat COVID-19 patients. They have been known to cause mortality, conduction defects, and heart failure (Aggarwal et al.). This effect, on top of the patients preexisting heart condition (and the influx of ACE2 expression in the heart) could potentially exacerbate the situation and could fatally affect the patient. A thing to be noted is that these theories were created right when the COVID-19 pandemic had just begun and could potentially be false when subjected to new evidence.

Nonetheless, they may still be important in helping to discover the reason behind the higher fatality rate in CVD patients.

Chronic Obstructive Pulmonary Disease

Chronic obstructive pulmonary disease (COPD) is the last comorbidity that will be stated in this article. COPD patients that contract the COVID-19 have a 5.9-fold risk increase than COVID-19 patients who are not COPD patients. This is a dramatic difference and shows that COPD patients should be kept at a closer surveillance (Lu).

COPD patients are known to have increased levels of ACE2 receptors, and this increases the chance for the virus to infect the body. In addition, impaired host immunity, persistent mucus production, and structural damage are all common in COPD patients. These symptoms show that COPD patients constantly have an impaired immune system, making it easier for the virus to infect the body (Lippi et al.).

A recent study also shows that the expression of genes related to viral replication and

immune responses are altered in patients with COPD. As a result, immune exhaustion and altered inflammatory gene expression can take place, effectively increasing the risk of COVID-19 for COPD patients. Finally, according to a recent analysis done by Acevedo et. al on the "Indication of Biomarkers in Asthma and COPD (BACO)" study, there was an increase in plasma immune proteins in patients with COPD. This "condition" is similar to how the body is like when a patient has a severe COVID-19 infection (Acevedo et al.). This newfound evidence can help to show how COPD patients are really in a big disadvantage in how their body can counteract the disease because their body is already in a situation that looks exactly how the coronavirus would impact the body. Their bodies cannot take two hits of the exact same thing, and this could really be detrimental to COPD patients.

Another reason that COPD patients might have a harder time with COVID-19 might be the medications that they use. COPD patients usually inhale corticosteroids as their treatment, but these medications are also hypothesized to be a high risk for COVID-19 patients (Lippi et al.). Although these reasons could have no correlation to the severity of COVID-19, it is important for COPD patients to be careful during these rough times.

Conclusion

The information amassed in this article provides ample evidence that the presence of comorbidities can severely affect the outcome of a COVID-19 patient. The article also helps show that age plays a role, as shown by the great number of elderly patients affected severely by this virus. The SARS-CoV-2 poses a risk to many people's wellbeing and should be treated with caution because of the disastrous effects it can cause.

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Efficacy of Exercise For Recovery Following Nonoperative Distal Radius Fracture: A Systematic Review By Alex Miller

Introduction

Distal radius fractures (DRF) are one of the most prevalent skeletal injuries and can affect people of all ages (Bradley and Harrison, 2004). For reference, there are two bones in the forearm. The bone located on the thumb side is the radius. The part of the radius that is connected to the wrist joint is called the distal radius. Thus, a distal radius fracture occurs when the radius is broken in close proximity to the wrist. Specifically, distal radius fractures account for one out of every six fractures treated in emergency rooms (Michlovitz et al., 2001). Young adults commonly sustain these fractures from high energy traumas like automobile accidents, while older adults can sustain them from low-energy traumas: namely, a fall (Bradley & Harrison, 2004). Those who undergo an upper limb fracture will inevitably experience difficulty participating in personal, occupational, and athletic activities for up to 12 months beyond the time of fracture (Moore et al., 2008).

Treatment of a distal radius fracture usually begins with conservative casting, which immobilizes the wrist in a flexed position for up to 6 weeks, often resulting in pain and stiffness (Kay et al., 2000). To assist recovery following immobilization, patients with distal radius fractures are often referred for physiotherapy. With the intent to reduce pain and recover function, methods for rehabilitation vary significantly. Some current methods include joint mobilization, heat/cold modalities, electrical stimulation, and continuous passive motion (Michlovitz et al., 2001). One of the most common interventions is exercise. Examples of exercise include strength training with weights, range of motion exercises, and stretching activities. In a study with a sample of 242 physiotherapists in 2001, Michlovitz et al. established that 90 percent of the therapists prescribed a range of motion exercise to patients recovering from a distal radius fracture. However, this study did not explore the efficacy of range of motion exercises for distal radius fractures. While previous research has acknowledged the benefits of exercise in physiotherapy for a range of health conditions, previous systematic reviews have not

concentrated on the effects of exercise following nonoperative immobilization on distal radius fractures (Taylor et al., 2005; Bruder et al. 2011).

To best care for patients recovering from distal radius fractures, physiotherapists need contemporary evidence regarding the effectiveness of treatment techniques. This information will allow them to make clinical decisions about their interventions with patients. Thus, the overall research question for this systematic review was:

What is the efficacy of exercise in the recovery from nonoperative distal radius fractures?

Methods

This systematic review was conducted using databases that reference medical journals. Search terms included: distal radius, fracture, non-operative, conservative treatment, exercise, and physiotherapy. For a source to be included in this systematic review, it had to discuss physiotherapy following distal radius fractures treated nonoperatively. The sample had to be composed entirely of adults, and the trial had to be published in the year 2005 or after. Any outcome measure used to express recovery could be used, including patient reported outcome measures, such as DASH (Disabilities of the Arm, Shoulder and Hand) questionnaire and PRWE (Patient Rated Wrist Evaluation). The full inclusion criteria are listed in Box 1. The level of evidence of the included sources is a two: a two indicates a randomized control trial. Utilizing the conclusions reported in each trial, a descriptive synthesis was completed and the studies were grouped by the following headings: active movement, passive movement, and interventions utilizing multiple exercises.

Box 1. Inclusion criteria.

Design

- randomised controlled trial
- full-text publication
- published in 2005 or after

Participants

- humans

- 18 years or older
- sustained a distal radius fracture
- treated nonoperatively

Intervention

- any exercise program

Outcome measures

- any outcome measure used to express recovery

Comparisons

- exercise program versus no exercise program/placebo
- exercise program plus other programs versus other exercise programs

Results

The initial literature search yielded 11 potentially relevant articles. After reapplying the inclusion criteria to the full text versions of the articles, 3 were excluded. Kay et al. (2000) was excluded as it did not fall within the time frame allotted by the inclusion criteria. Bruder et al. (2013) was excluded as participants were physiotherapists who reported their practice patterns and not patients recovering from distal radius fractures. Delft et al. (2019) was excluded because it was a research proposal intended to receive funding.

Effect of active movement on recovery

There is limited evidence that active movement improves DRF recovery more efficiently than conservative methods. Jones et al., in 2019, found that advice to remain active while awaiting physiotherapy following a distal radius fracture yields a better 26-week functional outcome in comparison to advice to rest. 538 patients were randomised (active=178; rest=182; immediate physiotherapy=178). In the end, complete recovery was reported by 60 (44%), 46 (32%) and 53 (35%) patients, respectively, according to the group (Jones et al., 2019). Patients told to rest "experienced a lower probability of recovery (OR: 0.54; 95% CI 0.32 to 0.90) versus advice to remain active" and immediate physiotherapy (0.64; 95% CI 0.39 to 1.07) yielded no benefit (Jones et al., 2019).

Another study yielded results that may support active movement in distal radius fracture recovery. In 2013, Magnus et al., found that, through cross-education, strength training of the non fractured limb in the experimental group following a distal radius fracture resulted in improved ROM and strength in the fractured limb (17.3±7.4kg) after 12 weeks post fracture (P<.017), compared to the control group (11.8±5.8kg). However, no significant strength differences were identified between the experimental and control groups at "9 (12.5±8.2kg; 11.3±6.9kg) or 26 weeks (23.0±7.6kg; 19.6±5.5kg) postfracture, respectively" (Magnus et al., 2013). Range of motion results in the fracture hand "showed that the training group had significantly improved wrist flexion/extension (100.5±19.2) than the control group (80.2±18.7) at 12 weeks post fracture (P<.017)," yet "there were no significant differences between the training and control groups for flexion/extension ROM at 9 (78.0±20.7; 81.7±25.7) or 26 weeks (104.4±15.5; 106.0±26.5) or supination/pronation ROM at 9 (153.9±23.9; 151.8±33.0), 12 (170.9±9.3; 156.7±20.8) or 26 weeks (169.4±11.9; 162.8±18.1), respectively" (Magnus et al., 2013).

Unlike the previous two studies, the following study did not find any additional benefits in DRF recovery after implementing active movement physiotherapy with the experimental group. Maciel et al., in 2005, found that 6 weeks of activity-focused physiotherapy was equally effective as a single session of exercise and advice given by a physiotherapist in distal radius fracture recovery. The control and experimental groups were compared at 6 and 24 weeks. In both comparisons, Maciel et al. found that no group improved more than the other. However, results in respect to time were highly significant (P<0.001), indicating that both groups improved with time (Maciel et al., 2005).

Active movement physiotherapy is better for DRF recovery than no physiotherapy at all. However, more research is needed to accurately determine the efficacy of this mode of treatment.

Effect of passive movement on recovery

There is evidence that passive movement improves DRF recovery. In 2020, Reid et al. found that, compared to the control group, mobilization with movement (MVM) improved supination in the experimental group by 12 more degrees after 4 weeks (95% CI 5 to 20) and 8 more degrees after 12 weeks (95% CI 1 to 15). Moreover, secondary outcomes were greater in

the experimental group after 4 weeks: “extension (14 deg, 95% CI 7 to 20), flexion (9 deg, 95% CI 4 to 15), QuickDASH (211, 95% CI 218 to 23) and PRWE (213, 95% CI 223 to 24)”(Reid et al., 2020). It is important to note that while passive movement improves recovery, these differences are not statistically significant. Thus, more research is needed to come to a conclusion on MVM.

Effect of exercise programs with multiple exercise techniques on recovery

After examining the evidence, it is unclear whether exercise programs with multiple exercise techniques are effective for DRF recovery. Two studies demonstrate that programs with combined techniques yield the same results as conservative methods. In 2016, Bruder et al. found that the prescription of 6 weeks of ROM, strength, and activity-focused exercises in addition to structured advice to remain active yielded no additional benefit following distal radius fractures than structured advice alone. PRWE measured no significant differences in upper limb activity at “week 7 and week 24 assessments (mean difference –4 units, 95% CI –10 to 2; mean difference 0 units, 95% CI –3 to 3, respectively), or QuickDASH at week 7 and week 24 assessments (mean difference –5 units, 95% CI –16 to 6; mean difference 0.3 units, 95% CI –6 to 7, respectively)” (Bruder et al, 2016).

Comparably, in 2008, Kay et al. found that, compared to the control group, 6 weeks of ROM, stretching, isometric, and strength exercises in addition to structured advice yielded no difference in the primary outcome of wrist extension, nor the secondary outcomes of ROM or grip strength. However, QuickDASH differences in favor of the experimental group for pain were “–16 points out of 100 (95% CI –27 to –5) at Week 3, and –14 points (95% CI –25 to –3) points at Week 6, and for activity was –13 points out of 100 (95% CI –24 to –2) at Week 3”(Kay et al., 2008).

Conversely, two studies support the use of multiple techniques. In 2019, Gutierrez-Espinoza et al. found that a 6 week scapular exercise regimen (consisting of ROM, strength, and isometric exercises) in addition to physical therapy has extra benefits in distal radius fracture recovery than physical therapy alone (control group): “the difference between groups for the DASH was 16.7 points ($P < 0.001$), 1.5 points ($P = 0.541$) for the PRWE, 0.2 cm ($P = 0.484$) for the VAS at rest, and 1.7 cm ($P < 0.001$) for the VAS at movement” (Gutierrez-Espinoza et al., 2019). All differences favor the intervention group.

The final study, Gutierrez-Espinoza et al., in 2017, found that supervised physical therapy is more effective in the rehabilitation of distal radius fractures than home exercise programs in the short (6 week) and medium term (6 month). The supervised group performed strength, scapular, and activity-focused exercise, while the home group performed passive, stretching, and strength exercises. Supervised patients "showed clinically significant differences in the total PRWE score at 6 weeks (17.67 points, P = .000) in the PRWE function score (15.2 points, P = .000) and in the PRWE pain score (5.6 points, P = .039)" (Gutierrez-Espinoza et al., 2017). There was also a significant difference in the total PRWE score at 6-month follow-up (17.05 points, P = .000) in the PRWE function score (14.5 points, P = .000) and in the PRWE pain score (2.5 points, P = .35)" (Gutierrez-Espinoza et al., 2017).

Overall, the lack of concrete evidence supporting physiotherapy programs with multiple exercise techniques suggests that more research is needed to determine its viability in DRF recovery.

Discussion

There is insufficient evidence to support the efficacy of exercise in the recovery from nonoperative distal radius fractures. This systematic review was limited by the scarce amount of research done on the topic, meaning that the inclusion criteria and outcome measures had to be kept broad to allow for a systematic review to be possible.

It must also be noted that there are limitations to the studies included. Jones et al., in 2019, relied on patient adherence. Patients in this study were randomized to either remain active while awaiting physiotherapy, rest while awaiting physiotherapy, or receive immediate physiotherapy. There is no way to guarantee that the patients remained active or rested during their waiting period. Furthermore, recovery is patient reported. With this in mind, the accuracy of the evidence provided by this study is questionable. Similarly, Bruder et al., in 2016, as well as Gutierrez-Espinoza et al., in 2017 and 2019) also utilized patient reported outcomes, like PRWE and DASH. This raises questions because if a patient reports a positive outcome, it is plausible that it could be a placebo. How can healthcare providers establish the credibility of patients' reports if they are unable to examine the patients in person? Moreover, should patient reported outcomes suffice for recovery? These studies set the concerning precedent that healthcare providers can send patients home without objectively determining their well being.

A limitation of the study by Magnus et al., in 2013, is that improvements in the fractured wrist were only observed after 12 weeks, but not at 6 or 24. This suggests that these differences may not have been a result of cross education, but a result of the conservative rehabilitation program (including at home exercises) both groups were prescribed. Additionally, the authors of the study also acknowledge that "no training log or formalized regimen was implemented to track adherence," so this means that the control and experimental groups could have followed their programs to different degrees (Magnus et al., 2013). If this is the case, the observed differences in results could be exaggerated.

The results of the study conducted by Maciel et al., in 2005, are also questionable. This is because the control group is prescribed exercise and advice, which may be a common practice, but one that has yet to be proven effective. Therefore, the control group does not serve as an accurate baseline for the intervention group. Correspondingly, Gutierrez-Espinoza et al., in 2017, had control and experimental groups that were prescribed dissimilar exercise plans. Thus, the cause for the observed differences within the results are unclear.

Four of the studies examined used interventions that prescribed the use of multiple methods of exercise (i.e. combinations of active and passive physiotherapy). In these cases, it is impossible to identify a single factor as a cause for an observed difference.

Conclusion

The efficacy of exercise in the recovery from distal radius fractures treated nonoperatively is inconclusive. All results in favor of exercise physiotherapy were not significant compared to conservative methods. Therefore, until further research is done, doctors should continue the use of conservative treatment in DRF recovery for the sake of standardization at medical practices.

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The Cancer Treatment We've Been Looking For: Our Own Body By Sailesh Gunaseelan

Abstract

The human immune system does a remarkable job protecting us from foreign invaders, such as viruses and bacteria **[13][14]**. Over the last decade, the field of cancer immunology has made tremendous progress in elucidating the relationship between the immune system and cancer cells **[15][37]**. Research has shown that cancer cells can effectively "hide" themselves from the immune system allowing them to grow unperturbed **[28]**. Proteins expressed on the cell membrane of cancer cells serve as "stop" signals for our immune system preventing immune cells from killing cancer cells **[28]**. This discovery has enabled scientists to create a new class of drugs called immunotherapeutic, which block these "stop" signals from the cancer cell, thereby allowing our immune system to selectively find and kill cancer cells**[15][16][37][41]**. While chemotherapy kills cancer cells and healthy cells causing widespread damage to cancer patients, immunotherapeutic not only acts as an effective treatment, but also causes less damage to the patient **[24]**. Immunotherapy is the future for cancer treatment and holds significant promise in taking us towards a cure for cancer **[30][33][37]**. This review paper will describe how human body immune system works, how cancer evades our immune system and how immunotherapy restores the immune system's function.

Introduction

Cancer is arguably the most frightening disease to be diagnosed and despite its long standing presence in human history, society continues to race towards the perfect treatment. Data from 2017 showed that almost 10 million people died from cancer, and it is estimated that approximately 2 million people will be diagnosed with cancer in 2021 **[8][29]**. Though cancer occurrences are rare, it is the second largest global killer of humans right below cardiovascular disease **[29]**. Due to its prevalence and deadly impact, cancer is an exceedingly pressing issue.

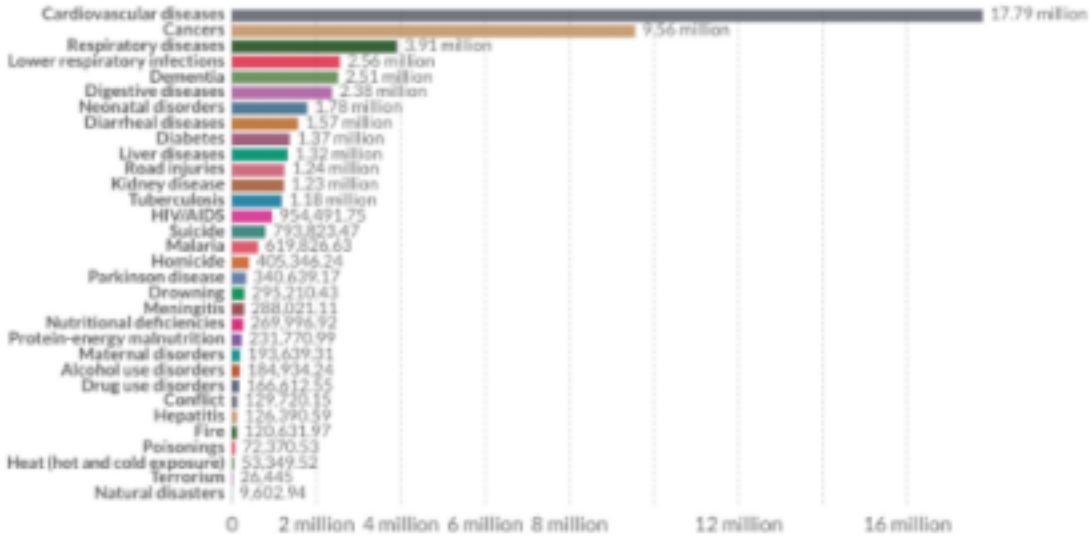

Figure 1: Causes of Death 2017: Cancer was the second highest cause of death *https://ourworldindata.org/cancer*

1.2 - Origin

While viruses and bacteria are foreign organisms to the host, cancer cells are unique in the sense that they originate from healthy cells in the body **[28]**. There are countless ways in which cancer cells can be formed, but there is an overarching theme to their genesis, which begins with the cell cycle **[6]**. The cell cycle is the process by which cells reproduce through cell division **[6]**. There are four stages in the cell cycle: G1, DNA Synthesis, G2, and mitosis **[6]**. The most important stage in the development of cancer is DNA synthesis **[6][40]**. Healthy cells create two copies of identical, healthy DNA after DNA synthesis, but sometimes there is an error made during DNA synthesis which can mutate or "break" the DNA being synthesized **[6][40]**. Once DNA mutates up to a certain point, it can lose the ability to perform essential functions such as telling cells when to stop dividing **[40]**. When this happens, cancer cells form **[40]**. Cancer cells are cells that lose the ability to stop dividing **[40]**. As a result, cells become malignant and begin to spread throughout the body **[40]**. In fact, the term "cancer" acts as a placeholder, indicating various types of uncontrolled cell growth **[40]**. This occurs because the gene, a specific part of our DNA, which would normally tell cells to stop dividing has mutated and lost its ability to do so **[6][40]**. Cancer diagnoses have different stages of severity [31]. If the cancer is localized to one part of the body,

the odds of surviving are much better than if the cancer has spread out to other parts of the body **[40]**. Ultimately, to effectively treat cancer, it must be stopped at every stage.

1.3. - Types Of Cancer

Cancer is not a single disease because cancer cells can arise in different parts of the body **[8][29]**. Moreover, different cancers have different survival rates **[4][7][8][23][32]**. For instance, melanoma is the abnormal growth of skin cells, and glioblastoma is the growth of abnormal brain cells **[19][27]**. Glioblastoma is one of the deadliest types of cancer, with most patients dying within 2 years of diagnosis **[27]**. Melanoma, if caught early enough, can have survival rates as high as 100%, simply because the cancerous cells can be cut out before they begin to cause serious problems **[19]**. In addition, patients with common cancers (e.g., breast, skin, prostate, etc.) are known to have a higher chance of survival **[4][5][8][23][39]** and this is mainly due to doctors' increased familiarity with these types of cancer, as well as advancement of equipment and technology used to fight these diseases **[11]**. However, some cancers are far more lethal. In fact, Karen Selby from The Mesothelioma Center states, "According to the American Society, lung cancer - and lung cancer caused by asbestos - is the number one killer, with 142,670 estimated deaths in 2019 alone…" Lung, tracheal, and bronchial cancer have claimed the highest number of lives, with a devastating "1.9 million in 2017" (Our World In Data) **[29]**.

1.4 - Risk Factors

Getting cancer can be due to poor genes, an unhealthy lifestyle or bad luck **[10][22][25]**. If mutated genes are passed down from parent to child, the likelihood of having cancer increases **[22][25]**. If one smokes, drinks and has poor eating habits, they can introduce mutagens to the body which can mutate the DNA and cause cancer **[7][10][22][25]**. Smoking, for example, introduces a significant number of mutagens to the body which mutate the DNA and cause extreme damage to cells, making them cancerous **[25]**. Lastly, a random error made during DNA synthesis can be enough to cause cancer **[10][25]**. Although the last cause is very rare, it can happen.

2 - Current Research

2.1 - Treatments

Given the deadly nature of cancer, there has been a lot of research into diagnosing and treating cancer. In order to determine the presence of cancer, various methods such as physical exams, laboratory tests, imaging tests, and biopsy are used **[21]**. When a patient has been diagnosed with cancer, a doctor can proceed in various ways, based on the threat level and current stage **[21]**. Depending on the type of cancer, doctors can select the correct treatment in order to handle the disease **[21]**. This may include curative, primary, adjuvant, and palliative treatment **[21]**. A cure occurs when the doctor removes any possibility of cancer cells returning, allowing the patient to live a normal life **[21]**. Such a treatment is highly unlikely with cancer and depends heavily on the patient's circumstances **[21]**. A much more practical treatment would be primary treatment, wherein the doctor removes all cancer cells from the patient's body, typically by surgery **[21]**. However, even when cancer cells are removed, there is a high chance of cancer continuing to grow, underlining the importance of adjuvant treatment **[21]**. Adjuvant treatment is an attempt to exterminate any cancer cells that reappear. **[21]**. In some cases, there are also times where it is not possible to terminate the cancer cell's growth **[21]**. During these times, the most effective treatment is palliative treatment, which focuses on alleviating a patient's symptoms when remission is not possible **[21]**.

2.2 - Chemotherapy

One of the most common treatments for cancer is chemotherapy **[20][36][38]**. Chemotherapy consists of the implementation of various drugs, used to prevent cancer cells from growing and dividing **[20][36][38]**. The treatment is most effective after the formation of large tumors that have begun to spread rapidly and cannot be effectively removed through surgery **[20][36][38]**. While radiation and surgery target specific areas of the body, chemotherapy can treat the entire body **[20][36][38]**. Unfortunately, chemotherapy has major side effects **[20][38]**. As chemotherapy drugs work their way through the body, they can affect other fast growing healthy cells, which include the skin, hair, intestines, and bone marrow **[20][36][38]**. Due to the

potential for major complications, chemotherapy is not a perfect treatment, which is why scientists have been furiously working in order to create new ways of treating cancer.

3. Cancer Immunology

3.1 - The Immune System

The human immune system helps to fight off invaders, such as viruses and bacteria, in the body **[13][14]**. However, cancer is often able to grow uncontrolled and unperturbed by our immune system **[28]**. A common cold can be healed in a matter of days with little to no medicine, as our immune system eradicates the virus from our bodies **[13][14]**. However, with cancer, medicines like chemotherapy and radiation treatment are almost always necessary to eradicate cancer cells **[21]**. To understand why the body is often unable to fight cancer cells, it is important to understand how the human immune system works.

The immune system is an umbrella term for a set of specialized cells that defend the human body against viruses, bacteria and fungi **[34]**. Humans have two types of responses to any foreign invader: innate and adaptive **[34]**. The innate response is the first response from the immune system **[34]**. It is what causes the redness and inflammation associated with cuts on the skin, and it is responsible for the first round of destruction of foreign invaders **[34]**. The adaptive response is a more specialized and coordinated defense against foreign invaders **[34]**. It's responsible for identifying previously fought infections like viruses and producing neutralizing molecules, called antibodies, that are mobilized against previously fought infections **[34]**.

3.2 - Organs of The Immune System

Each of the body's systems has specialized organs and cells, and the immune system is no different. Much like how the cardiovascular system is composed of the heart, veins and arteries, the immune system also comes with a specialized set of organs **[13][14][35]**. Bone marrow, thymus, tonsils, spleen and lymph nodes are hubs where immune cells are born, matured, and kept in reserve until they are needed to fight off foreign invaders **[13][14][35]**. Moreover, the human body comes equipped with an external barrier, making it difficult for viruses, bacteria,

and fungi to harm the skin **[13][14][35]**. The best way of fighting germs is to make sure they do not enter the body in the first place. The skin is the first line of defense against germs, but if the skin gets cut, there are immune cells lying in wait underneath the surface ready to attack whatever comes in **[13][14][35]**. Moreover, certain reflexes like coughing and sneezing help the body expel germs that may be trying to get into the airways **[13][14][35]**.

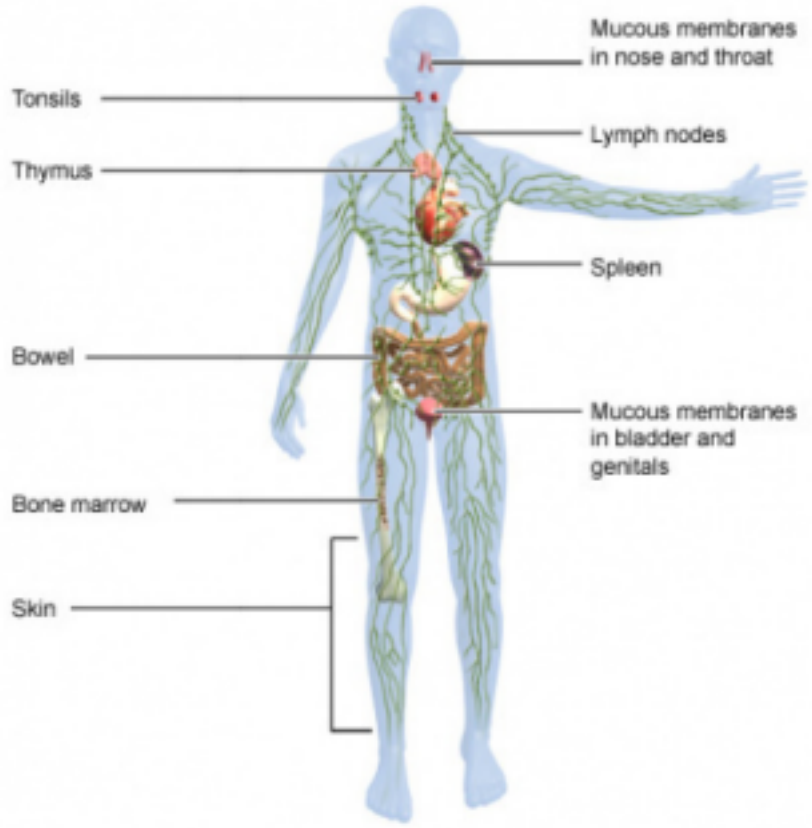

Figure 3: Parts of The Immune System - Location of the various organs in the immune system *https://www.ncbi.nlm.nih.gov/books/NBK279395/*

3.3 - Immune Cells

The immune system also comes with its own specialized set of cells **[13][26]**. These include cells such as lymphocytes, neutrophils, and macrophages **[13][26]**. Lymphocytes are cells that take part in the adaptive immune response and help the body fight off viruses **[13]**. These cells originate in the bone marrow **[13]**. Some move to the thymus where they mature

further and become T-cells, whereas others stay in the bone marrow and become B-cells **[13][42]**. T-Cells can be considered as the United States Marines: they need to be called upon to a site of danger, they kill selectively while leaving non-intruders unharmed and they inform other members of the group of the invaders they attacked and what the invaders look like **[13][26][42]**. T-cells effectively search and destroy whatever is not supposed to be in the body **[13][26][42]**. B-cells act like the FBI of the immune system **[2][13][26][42]**. They keep a record of invaders the body has fought off and they deploy specialized molecules called antibodies to help neutralize invaders and help alert T-cells to a site of danger **[2][13][26][42]**. Neutrophils and macrophages are a part of the innate immune system **[13][26][42]**. They are both responsible for engulfing foreign invaders like bacteria and small microbes and preventing them from causing mass havoc in the body **[13][26][42].** If the innate response is not sufficient to get rid of invaders, then an adaptive response arrives in order to act upon the virus **[13][26][42]**.

3.4 - Receptors and Ligands

Communication is extremely important for immune cells **[17][18]**. Immune cells need to be able to communicate with one another about potential invaders and the actions they take against them **[17][18]**. Cells communicate with each other through molecules known as receptors and ligands **[17]**. Receptors are proteins that generally reside on the outer membrane of cells exposed to the environment and ligands are the molecules which attach to their host receptor much like a lock and key mechanism **[9][17]**. There is one key (a ligand) for a lock (a receptor) **[17]**. Immune cells "know" what to do depending on which ligand and receptor come into contact. If the ligand is unfamiliar to the immune cell, the immune cell knows that it is a foreign ligand and the cell expressing this foreign material must be destroyed because it may be harmful to the body **[17]**. Receptor-ligand interactions can be stimulatory, meaning they can stimulate immune cells to go out and attack invaders, or they can be immunosuppressive, meaning they can "turn off" an immune response **[9][17]**. To properly regulate our immune response, healthy cells must express immunosuppressive ligands so that the body's immune system does not attack itself, and foreign invaders express stimulatory ligands that prompt the immune system to attack **[17]**.

Receptors are crucial for immune cells to determine the difference between both an unhealthy and healthy cell **[17]**. Ligands known as non-self-antigens (bacteria/fungi) trigger the immune response, resulting in the invader being attacked **[17]**. It's extremely important for the immune system to be able to identify the difference, as unhealthy cells are detrimental to an individual's health, while healthy cells allow the body to function correctly **[17]**.

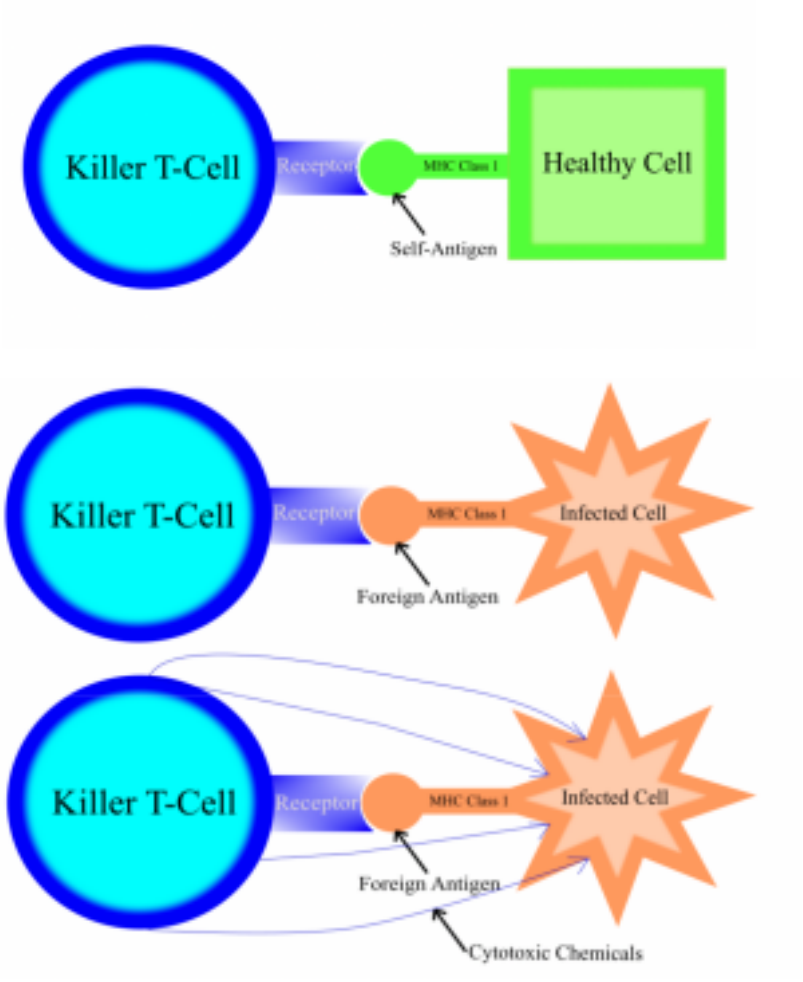

Figure 4: Overview of The Immune System-Reaction of the Killer T-Cell after recognizing a healthy and infected cell (receptor + antigen)

3.5 - Cancer Hiding from The Immune System

Although the immune system can protect us from foreign invaders, it seemingly has trouble protecting us from cancer cells **[28]**. Healthy cells in our bodies know all the neat tricks our bodies use to protect itself from the immune system **[28]**. Cancer cells, developed from once

healthy cells, maintain their knowledge of how to hide themselves from the immune system **[28]**. This evasion from the immune system allows cancer cells to grow virtually undisturbed in the human bodies **[28]**. Cells in our bodies use receptors and ligands to communicate with the immune system **[28]**. One "hiding" mechanism cancer cells use is the PD-1/PD-L1 axis **[28]**. PD1 (programmed death 1), is a receptor found on T-cells **[28]**. PD-L1 (programmed-death ligand 1) is a ligand found on many healthy cells in human bodies (such as placenta cells) as well as cancer cells **[28]**. When PD L1 and PD-1 come into contact, the T-cells that express PD-1 are essentially "turned off." **[28]**

Figure 5: PDL1(green) and PD1(orange) interact with each other to modulate immune responses *https://www.rcsb.org/structure/3BIK*

When PD-L1 expressed by cancer cells encounter PD-1 expressed by T-cells, the cancer cells effectively "turn off" and prevent the T-cells from attacking them **[28]**. This process is incredibly effective in preventing an immune response and has been a source of drug-discovery efforts **[28].** If this process can prevent T-cells from attacking cancer cells, then this can be drugged and allow the immune system to attack cancer cells **[28]**.

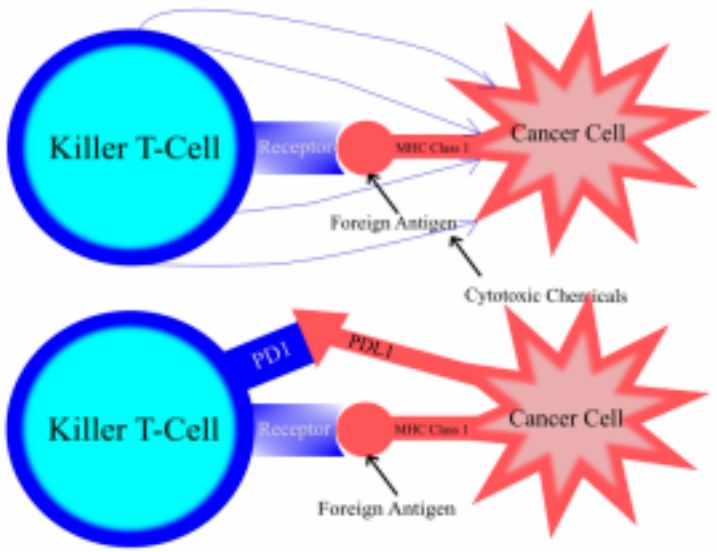

Figure 6: Cancer Cells Preventing the Immune Response - Reaction of cancer cells, passing the immune system checkpoint using the PDL1 pathway

4. Immunotherapy

4.1 - What Is Immunotherapy

Recent research and clinical success have shown that our bodies are best for fighting cancer **[15][16][37][41]**. Immunotherapy has made remarkable progress in the last decade, showing a great deal of promise for the future **[15][16][37][41]**. According to the CRI (Cancer Research Institute), "Cancer immunotherapy, also known as immuno-oncology, is a form of cancer treatment that uses the power of the body's own immune system to prevent, control, and eliminate cancer **[41].**" In simpler terms, immunotherapy allows the immune system to attack cancer cells, using additional help from outside sources **[15][16][37][41]**. An example mentioned before consisted of the PD1 pathway, with the cancer cell emitting PDL1, allowing it to evade the PD1 receptor from the Killer T-Cell **[15][16][37][41]**. With immunotherapy, it is possible to block the PD1 receptor, leaving the cancer cell defenseless against the Killer T-cell **[15][16][37][41]**. The treatment can come in various forms, such as antibodies, cancer vaccines, adoptive cell transfer, tumor-infecting viruses, checkpoint inhibitors, cytokines, and adjuvants **[15][16][37][41]**. This treatment is also known as a form of biotherapy (BRM therapy) **[15][16][37][41]**. Genetic engineering, known as gene therapies, may also be used to support the

fighting capabilities of immune cells **[37][41]**. Immunotherapy is the science of using our immune system to treat diseases **[37][41]**.

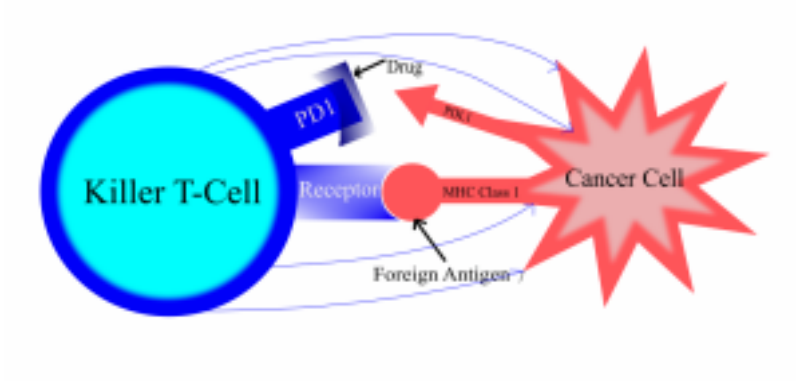

Figure 7: Drugs Blocking Receptor and T-Cell Killing Cancer Cells -As a result of the drug blocking the PD1 pathway, the Killer T-Cell can release its molecules, attacking the cancer cell

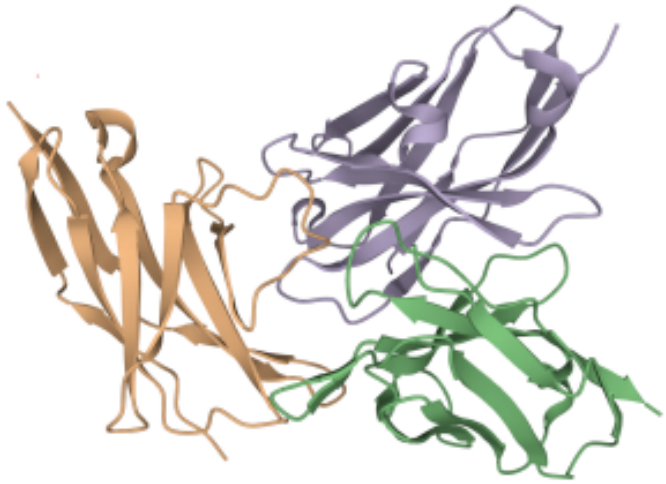

Figure 8: Anti-PD1 antibody immunotherapy (purple and green) binding to PD-1 (gold). Immunotherapeutic agents act as pseudo-ligands and prevent real ligands from binding to their receptors of choice. Anti-PD1 physically blocks PD-L1 from binding to PD-1 thereby instigating an immune response against cancer cells

https://www.rcsb.org/3d-view/5B8C/1

4.2 - Immunotherapy vs. Chemotherapy

Though advancements have been made in chemotherapy, it is important to know the differences between immunotherapy and chemotherapy. Chemotherapy acts mainly indiscriminately killing both cancer cells and healthy cells **[1][24]**. Moreover, there is a possibility of the cancer cells returning later which may result in multiple rounds of treatment **[1][24]**. Immunotherapy, on the other hand, allows the immune system to selectively kill cancer cells while leaving non-cancerous cells intact--for the most part **[1][24]**. This means that our immune system is monitoring our bodies 24/7 to search and destroy newly arising cancer cells **[1][24]**, whereas Chemotherapy focuses on cells that rapidly divide, targeting both cancerous and non-cancerous cells, leading to loss of skin cells, hair, and bone marrow cells. Immunotherapy generally comes with much milder side-effects **[1][24]**. Common side effects include skin irritation around the injection site, fever/chills, rashes, and diarrhea **[1][24]**. As with all medicines, it is ultimately up to the physician to decide what is in the best interest of the patient's health **[1][24]**. Given the type of cancer, its severity and the patient's biology, one form of treatment may be better than the other **[1][24].**

4.3 - Future of Immunotherapy

Immunotherapy has already been approved in the United States as well as all around the world in order to treat a variety of cancers **[16]**. As scientists and doctors continue to realize the prominence of immunotherapy, strong advances continue to be made in the field **[16]**. The CRI (Cancer Research Institute) states, "As of June 2017, the U.S. Food and Drug Administration (FDA) has approved 32 different immunotherapies for patients with cancers…" **[16]** Thirty-two drugs have already been approved, showing how much the field of oncology has invested in this treatment **[16]**. Immunotherapy is typically used with other treatments (e.g., chemotherapy/radiation therapy). As research on the treatment has only recently started, doctors as well as patients do not consider it as the primary option **[33]**. In fact, doctors typically suggest the treatment only after other curative treatments have been exhausted. Bob Tedeschi from STAT (American health-oriented news website) explains that "Immunotherapies work for only around 15 to 20 percent of cancer patients who receive them", which is partly the reason why they are

not prescribed at first **[33]**. Immunotherapy has a lot of potential, yet at its current stage, it can only benefit a small percentage of patients. However, scientists are still determined to make improvements to the treatment **[33]**. Current focus in immunotherapy research is moving immune cells to the exact location of cancer cells, so that immunotherapy can function more effectively **[30]**. This treatment shows a lot of potential, yet more studies must be done for it to benefit thousands of lives that are impacted with cancer **[30]**. It is important for patients to determine with their oncologist which treatment is the best option for them **[16][33]**. However, with the incredible advances already shown, it's natural to expect the prominence of immunotherapeutic in the future **[30][33]**.

5. Conclusion:

Cancer is one of the many hallmarks of the human experience. Chances are that each of us knows or has heard of someone who has died from this disease. Given the medical advancements and a higher level of public awareness, we are now able to diagnose cancer early thereby increasing the survival rate of many people **[4][8][14][31]**. However, some cancers do not display symptoms until they have become malignant and spread to the rest of the body **[31][40]**. Chemotherapy, once regarded as the only treatment for cancer, has begun to lose its spotlight given the success of tumor immunology and immunotherapy **[15][16][37]**. Immunotherapeutic drugs allow the body to kill cancer cells without harming healthy cells as well as keeping a lookout for any new cancer cells that may arise in the body **[15][16][37]**. Even in its infancy, immunotherapy has effectively treated a significant number of cancer patients **[15][37]**. Although much is yet to be known about immunotherapy and though it is not fool proof, it holds significant promise as a safe and effective treatment for all cancer types, bringing us closer to a cure.

6. Acknowledgements

I would like to thank Polygence for giving me this incredible opportunity, as well as my mentor Nooriel Banayan who always encouraged me and was with me through every step. Without the knowledge gained through countless lessons, this project wouldn't have been possible. This paper is for anyone who is not up to date with the progress made in cancer

treatments and focusses on immunotherapeutic as the future. The cover photo was from pngfind, https://www.pngfind.com/mpng/hiRoixi_human-body-transparent-background-transparent background-transparent-human/.

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Cyber Activism in the Egyptian Revolution by Laith Weinberger

On January 25, 2011, millions of Egyptians gathered in Tahrir Square. They were united through social media platforms like Facebook and Twitter and galvanized by a collective anger toward the Egyptian government, stoked by years of social inequality, economic decline, corruption, political repression, abuse of power, and state-sanctioned violence. This Cairo gathering was the climax of the Egyptian Revolution and resulted in the resignation of Egypt's leader, President Hosni Mubarak. But how did protestors reach this victorious point, when Mubarak resigned and hope in a democratic nation run by the people was rekindled? To answer this question, we must look back at the efforts that culminated in this moment, examining the organization of mass demonstrations and the spreading of awareness to rally support — and at the critical role social media played in the success of Arab demonstrations preceding 2011 and in the Egyptian Revolution.

Background

The Egyptian Revolution was part of the Arab Spring, a series of uprisings that took place across the Middle East beginning in 2011. The Arab Spring began in Tunisia and quickly spread across North Africa and the Middle East, from Egypt to Libya, Yemen, Bahrain, Kuwait, Oman, Iraq, and Syria. Though different factors inspired the uprisings, common catalysts included oppressive systems of governance, corruption, and widespread poverty and unemployment. In order to fully understand the uprisings, it is necessary to recognize the events leading up to the first protests. In 2008, the financial crisis saw stock markets declining substantially and the world descending into an economic crisis. Arab nations soon faced high levels of unemployment, with unemployment in Egypt alone increasing from 8.7 percent in 2008 to 10.4 percent in 2011.[1] Additionally, Egyptian youth had less of a connection to the government than their parents who relied on it for employment. To make matters worse, a population boom from the late 1990s to early 2000s throughout the Arab world resulted in dramatic downward shifts in the average age. In Yemen, for example, the average age dropped to under 18 years old.[2] As college education became more widespread among this younger

population, there were many more young, educated people seeking entrance into the workforce and not enough jobs to provide everyone with employment.

On top of the global economic crisis, many Arabs were grappling with oppressive political systems as well. Multiple Arab countries had in place hereditary power structures, with leaders maintaining power as "Presidents for Life" by defying election processes and not allowing the formation of opposition parties. In elections, the dominant political party often ran unopposed, with public dissent smothered. Egypt and Syria, among other Arab nations, were permanently under a state of emergency that allowed the government to restrict personal freedoms.

The apotheosis of Arab political unrest occurred in Sidi Bouzid, Tunisia on December 17, 2010, when 26-year-old street vendor Mohamed Bouazizi doused himself in flammable paint thinner and set himself on fire in front of a municipal building. Bouazizi was often stopped and harassed by law enforcement for not having a permit to sell his fruits and vegetables, and his suicide was in protest of this treatment by the government.[3] The incident infuriated and resonated with thousands of Tunisians and quickly morphed into a national movement with protests held across Tunisia.

Bouazizi soon became a martyr whose treatment was symbolic of the oppressive life under authoritarian regimes that censored communications, suspended basic rights through states of emergencies spanning decades, and used security forces to enforce obedience through imprisonment, beatings, torture, and murder. Despite the attempts of the Tunisian government to silence the protestors, activists posted online and organized demonstrations through social media, and the story was picked up by Middle Eastern satellite news stations. Al-Jazeera, an international Arabic news outlet, was at the forefront of coverage of the Arab Spring, keeping millions updated online and through its television stations. Al-Jazeera's coverage was blunt, and it was attributed by many to the galvanization of demonstrators.[4] As word spread, pro-democracy protests sprung up in Egypt, Libya, Yemen, Bahrain, Kuwait, Oman, Iraq, and Syria.

In Egypt, under President Hosni Mubarak's regime, regulations were in effect to restrict Freedom of Speech and Freedom of Assembly and Association — restrictions not unknown to Egypt's modern history and first used long before Mubarak took power. Under emergency laws enacted after Mubarak came to power in 1981, actions such as insulting the president,

distributing leaflets or posters, and opposing the government could result in jail time and fines.[5]

The government also had immense control over political participation. Egyptians opposing the government who attempted to involve themselves in politics faced harassment, and frequently arrest and torture. All political parties had to be licensed by the Political Parties Committee, a partisan group controlled by members of Mubarak's National Democratic Party (NDP). In order to further their agendas, opposition parties were forced to work with Mubarak. The Muslim Brotherhood, for example, did just that. The Brotherhood was an unregistered but widely supported Islamist party rooted in Egyptian society whose candidates ran as independents. The Brotherhood called for greater government influence over women's lives, education, religion, and art. In the 1980s and early 1990s, the party aided in discrediting more radical Islamists, as well as secularists opposed to Mubarak, in exchange for access to the political stage. The participation of a competing party also allowed Mubarak to quell demands for reform.

Furthermore, opposition was quelled through government control of public demonstrations: protests required licenses from the Ministry of the Interior, which rarely granted them. When unlicensed demonstrations in Egypt did occur, security forces were dispensed before significant attention could be generated. Most media outlets were controlled by the government, and even private outlets were influenced by the regime.[6] There was little coverage in the media of groups other than the NDP. To give an idea of the Egyptian government's influence over the media, a few years after the Arab Spring, the Egyptian Media Group — a media conglomerate that owns almost twenty companies across the TV, print, production, marketing, and advertising industries — was acquired by a government-owned investment firm.[7] In 2005, the Brotherhood garnered 20 percent of the parliamentary seats in what was one of the fairest elections in Egypt, although that was based on the relatively low standards the Egyptian government had set in the preceding decades. Mubarak then moved to ensure this would not occur again, imprisoning his main opponent and directing security forces in advance of the 2010 parliamentary elections to arrest 1,200 Brotherhood members.[8] The 2010 elections were violent and fraudulent. At least eight people were killed in violence at polling locations, and ballot stuffing and vote-buying were prevalent. Opposition representatives, like those from the Brotherhood, were excluded from polling locations, and civil society monitors and journalists

were also barred.[9] This violence and fraud was a continuation of the electoral politics that had demoralized most Egyptians over the years, as they realized the impossibilities of a popularly elected government under Mubarak.[10]In an interview with *The Guardian*, the director of research at the Brookings Institution, Shadi Hamid, said: "We knew it was going to be bad, but I don't think anyone realised it was going to be this bad… Egypt has joined the ranks of the world's most autocratic countries. Now we're talking full-blown, unabashed dictatorship."[11]

The Role of Social Media Before the Arab Spring

Social media's power in organizing protests was apparent before the Egyptian Revolution. In 2003, cyber activists organized demonstrations to protest the United States' invasion of Iraq. People in more than 600 cities across North Africa, Europe, and the United States participated,[12] with increases in access to technology and social media use boosting online support. The most successful social movement in Egypt before the Arab Spring began following the murder of Khaled Said. On June 6, 2010, Said was in an Internet café 100 feet from his house in Alexandria, Egypt. Two undercover officers entered and began attacking him. They dragged Said out of the café and violently beat him, killing the twenty-eight year old. Though the reasons for the murder are unsubstantiated, the killing was legal under Egypt's emergency law, which gives the police immense power while suspending constitutional rights and due process for citizens. A week after Khaled Said was killed, a group called *Kullena Khaled Said* (We Are All Khaled Said) was launched on Facebook. It soon attracted a large following of over 500,000 members[13] and now has almost 3.5 million followers. Many other groups sprang up too, seeking justice for Said. They invited Egyptians to participate in demonstrations against police brutality, and then used Facebook to continue to mobilize protests throughout 2010. By fostering unity and a sense of individual empowerment, *We Are All Khaled Said* provided a space for angry and disenfranchised Egyptians to interact while encouraging collective action. By specifically focusing individuals' efforts on the killing of Said, rather than on broad political reform, the movement was able to garner support more broadly and have more influence. -

Social Media's Use by Activists in the Egyptian Revolution

` Two primary factors defined the success of the Egyptian Revolution: the massive, widespread demonstrations and the extensive spread of awareness to rally support, both of which were intertwined with cyber activism on social media. Organizers relied on social media heavily, particularly Facebook, to schedule protests. In fact, the first mention of holding the January 25, 2011 protest in Tahrir Square was on the *We Are All Khaled Said* Facebook page. However, support quickly went beyond a posting on one Facebook page as Egyptians messaged each other through social media about the protests and other groups mentioned Tahrir Square as well. Some may argue that Internet usage was not widespread enough in Egypt for social media to result in such large demonstrations. However, due to the government's subsidization of computers and Internet access, usage in Egypt was quite significant. Though only 2.72 percent of Egypt's population used the Internet in 2002, by 2005 the rate had more than tripled to 11.7 percent. The increase in Internet adoption was even more impressive between 2007 and 2010, shooting up from 13.75 percent to 30 percent,[14] a percentage that represents more Egyptians than the entire population of the Netherlands today.[15] Furthermore, these estimates are most likely under-representative, as many Egyptians accessed the Internet through Internet cafés, libraries, and Internet clubs. In these settings, a single connection represents multiple users. Additionally, 87.1 percent of Egyptians used cell phones in 2010.[16] One month before the Arab Spring reached Egypt, an estimated 8.6 million Egyptians used the Internet through mobile devices, with social media use growing after Arabic Facebook was introduced in 2009.[17] Facebook's users went from 900,000 to almost 5 million between 2009 and late 2010.[18] While exact mobile app download
worldwide, with annual increases of over 1 million downloads in Egypt alone.[19]

Only social media would allow for communication among so many people, and it was social media's unique ability to form connected groups with shared identities that motivated Egyptians to engage in collective action. As one Egyptian activist stated: "Before this social media revolution, everyone was very individual, very single, very isolated and oppressed in islands... But social media has created bridges, has created channels between individuals, between activists, between even ordinary men, to speak out, to know that there are other men who think like me."[20]

A 2011 study conducted by the Dubai School of Government, titled *The Arab Social Media Report*, looked into the impact of social media in the Middle East. The study, which analyzed growth rates, Internet traffic, and demographics, concluded: "Growth of social media in the region and the shift in usage trends have played a critical role in mobilization, empowerment, shaping opinions, and influencing change." According to the study, 85 percent of respondents said they used Facebook to spread awareness, spread information, or organize actions for the Arab Spring in early 2011.[21]In a separate seperate survey published in 2013 looking into the role of technology in enabling communication during the Egyptian Revolution, 78.3 percent of respondents reported visiting Facebook pages related to the uprising (including *We Are All Khaled Said*) and 97.9 percent said they used social media at the time of the Egyptian Revolution.[22]

Aside from social media, liberal activists had few platforms to rally support and connect with a large demographic. With awareness spreading online, the demonstrations grew and their size then likely encouraged the Egyptian army and Muslim Brotherhood to join the movement. The support of the Muslim Brotherhood provided an additional mass of followers, as well as organizational strategy and an internal operational framework necessary to sustain the movement. Soon after they joined, the Brotherhood established checkpoints to discourage pro-government individuals from entering Tahrir Square during the protests in an attempt to keep demonstrators safe and reduce violence. Emergency clinics were also set up to treat the wounded and provide resources like food, water, and blankets. The Egyptian army secured the ultimate success of the Egyptian Revolution, as they were the ones to force Mubarak to resign. For years, the Egyptian military had been a crucial source of the sitting regime's power and support. Without the support of the military, liberal activists most likely would not have succeeded and Mubarak would never have resigned. Also, even as police began to beat protestors on January 26 and violence escalated in the following days, the military stayed away to protect hotels, banks, and some government buildings. If the military had decided to participate in the Mubarak regime's violence, there could have been many more casualties.

In addition to being used to schedule demonstrations and mobilize protestors, social media was used as a source of information by many Egyptians and as a tool to spread awareness by Middle Eastern news outlets and activists. Independent news outlets that covered Mubarak's opposition were quickly shut down by his regime. The Cairo offices of al-Jazeera, for example,

were forced to close in an attempt to cut off their coverage of the uprising. Social media became a crucial part of al-Jazeera's reporting as the news organization was forced to rely on video postings, blogs, and tweets to keep the Egyptian public and the global community informed.

Activists also used social media, sharing videos and images of protests to show what was happening. Cell phones were used to record demonstrations and provide Egyptians and the global community with live updates on social media. Soon after the conclusion of the Egyptian Revolution, in an article discussing how social media alters the ways people form political opinions, New York University professor Clay Shirky wrote: "Reporting is no longer confined to traditional sources… instead, social media grants access to unfiltered information related by any person affected by an event who chooses to share the story."[23] As a paper titled *Opening Closed Regimes* found, online activism "helped the revolution spread beyond international borders," with the adoption of Arabic by Facebook and Twitter allowing Arab activists to reach and connect with larger audiences.[24]

Denial of the Impact of Social Media

Critics argue that the decisions of the Brotherhood and the Egyptian military to aid liberal activists were disconnected to cyber activism. The facts easily counter this argument, however, as the wide support garnered on social media and the large demonstrations organized through Facebook and Twitter were the reasons the Brotherhood and Egyptian military joined. As the timing of their decisions suggest, the Brotherhood and the Egyptian army sided with the protestors for fear of losing followers and popularity after seeing the massive number of demonstrators at early protests and the growing interest from others in Egyptian society and around the world.

Yet despite this evidence of the pivotal role of social media in the Arab Spring and Egyptian Revolution, there are still skeptics. New York Times columnist Thomas Friedman said during a speaking engagement, "What brought Hosni Mubarak down was not Facebook and it was not Twitter. It was a million people in the streets, ready to die for what they believed in."[25] This point is based on a common misconception that social media does not fuel demonstrations, people do. In reality, Twitter and Facebook are not independent of people, and

social media and the actions of Egyptians are not mutually exclusive. Social media platforms were crucial in a snowball effect that led to the eventual resignation of Mubarak: in spreading awareness, gaining a larger audience, organizing bigger demonstrations, and gaining the support of the Brotherhood and Egyptian army due to the sizable protest turnouts.

Similarly, skeptics argue that the real revolution was a product of "high-risk activism," which refers to activists who physically put themselves in danger. Social media is considered low-risk activism, because interpersonal ties are weak and not much is put on the line. As proved earlier, however, social media helped to organize millions of Egyptians to take part in high-risk activism. As the aforementioned *Opening Closed Regimes* found, "a spike in online revolutionary conversations often preceded major events on the ground."[26]

Conclusion

Social media has been used to organize some of the biggest protests and political movements in the Middle East's history, from the demonstrations in Tahrir Square to those organized much earlier in opposition of the United States' invasion of Iraq. As demonstrated after the brutal killing of Khaled Said, all it takes is one Facebook group to rally support, spark an international movement, and drive serious political change. The role of social media as a catalyzing force for political demonstrations is not confined to the Egyptian Revolution, as social media remains important in the organization of protests today — with examples including the recent George Floyd protests and the 2017 Women's March in DC. Though a 2013 coup unravelled the work of activists during the Egyptian Revolution, the legacy of social activism and community mobilization, a concept affirmed during the Arab Spring, remains today.

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"A Year of Epidemics": Causes of the Disproportionate Impact of the 1918-1919 Influenza on Native American Reservations by William Hu

In May 1919, the villages of Bristol Bay, home to the Yupik people for centuries, were changed forever. In early May, an unknown disease arrived -- a new strain of influenza virus brought in by fishing ships. By the middle of the month, the single available hospital at Dillingham was "operating at full capacity." The lack of sufficient medical facilities, staff and wireless [1] communication left the Yupik people to struggle with the disease on their own. Finally, on June 7, 1919, a doctor and two nurses reached these isolated communities after an 800-kilometre journey. There, they found a scene of horror, with "villages completely wiped out" and "whole families…lying stricken on the floors of their [homes]." By the end of the pandemic, the Bristol [2] Bay region lost 40% of its population. Seventy-five years later, the Alaskan Natives Commission would identify the pandemic as one of the primary reasons for the "physical and spiritual poverty" Alaskan native communities experience today.[3]

Although the 1918 influenza affected almost all groups in America, Native American peoples on reservations often suffered comparatively higher infection rates and deaths. While the Yupik of Bristol Bay suffered heavily, the primarily non-Native American inhabitants of Dillingham, a town scarcely 50 miles away, faced a concerning but comparatively mild 5.5% mortality rate. This trend also applies to other groups such as the Navajo, Lakota and the Sioux, which suffered more heavily during this pandemic than wider America. Mikaela Adams, a medical historian at the University of Mississippi reports that Native American people died at a rate "four times higher than the rest of the US population." Native American communities in Utah, Arizona, Alaska, [5] Colorado, Mississippi, New Mexico all suffered a 4-6% mortality rate from the influenza, compared with a 2.5% mortality rate in the general population. Several root causes linked to the [6] assimilation policy, including insufficient funding for medical facilities, a lack of prompt and adequate medical support when the pandemic erupted, and suppression of traditional medicine resulted in the flu's proportionately more significant impact on Native American groups.

Cause 1: Lack of Funding

The *Cordova Daily Times*, a respected Alaskan newspaper, made a grim admission on February 7th, 1919. In a two-column story, it reported that wireless communication, a staple of ordinary American life, "had been lacking" in Native American communities and that this deficiency had exacerbated the devastating impact of the influenza. "Had funds been available...for installing even these small [communication] plants", declared the *Times*, then a "less tragic tale of the ravages of the influenza among natives might be told." For example, Tyonek, an Native American village [7] only 40 miles from the medical hub and Indian Office superintendent at Anchorage, did not have a single wireless system that could request assistance. When the pandemic struck, thirty-five inhabitants, including the local chief, died by the time the disease was discovered and reported.

From the late 1800s, the U.S. Office of Indian Affairs (Indian Office) initiated a formal policy of assimilation intended to bring Native Americans into mainstream society, theoretically improving access to modern healthcare. In reality, a lack of consistent funding caused reservation conditions to fall far short of expectations. The first formal appropriation of $40,000 for Native American health needs was made only in 1911, exemplifying the government's lax approach to funding Native American health. In 1914, Warren K. Moorehead, a commissioner for the Indian Office, [8] stated in his book '*The American Indian in the United States*' that "it is incomprehensible to me that appropriations for combating disease are so meager." Moorehead especially points out the [9] sorry state of health appropriations in contrast to the "lavish" funding put towards assimilation programs like education and allotment. A friend of Moorehead summed up the futility of 'modernizing' indigenous peoples through residential schools without addressing core health problems: "an Indian child learns to read and write, contracts trachoma, is sent home and goes blind. How does education benefit the blind Indian?" This lack of resources to combat health [10] problems undercut the theoretical benefits of modernization on reservations. A lack of funds greatly reduced reservation hygiene standards and livability. The 1928 Meriam Report, a two-year survey on reservation living conditions, described Native American housing as "lacking in sanitary facilities" and "conducive to the development and spread of disease." For example, on Kiowa and Osage reservations in Oklahoma, government programs tore down unsanitary traditional housing but replaced them with permanent dwellings that often had equally

“inadequate provisions for ventilation” and caused “great overcrowding.” These conditions meant that diseases such as tuberculosis, trachoma, and especially influenza would almost always spread from a single family member or residential school pupil to infect the entire dwelling. The Meriam Report concluded that nearly all Native American living spaces failed to meet “what a white man would regard as the minimum standard of health and decency.”

Additionally, reservation diets often lacked critical nutrients and vitamins. Residential schools, for example, emphasized their role in bringing proper nutrition to Native American children by establishing a quart of milk per day per pupil as a minimum standard. In reality, the residential school system achieved this standard “in very few schools”. Although health specialists were long aware that “disease can be combated by a preventive, curative diet,” monetary neglect meant that pupils and reservation inhabitants had to subsist on a diet “notably lacking” in preventive foods like milk, fruit and fresh green vegetables. The Meriam Report, which “seriously questioned” whether the Indian Office could improve reservation dietary standards without “more adequate [monetary] appropriations”, demonstrates how underfunding contributed to malnutrition.

A chronic lack of funds also reduced the quantity and quality of vital physicians, nurses and other healthcare workers. The Meriam Report noted the “inadequacy of appropriations” that “prevented the development of an adequate system of...medical relief work.” As a result, the Indian Office could not afford to hire enough health workers to manage conditions across reservations. The few who were hired were paid “sub-standard salaries” compared to other government occupations (e.g. Army, Navy and Public Health). For example, in 1890, physicians working with Native American groups were paid an average annual salary of $1,028 compared with $2,823 and $2,622 for Army and Navy physicians respectively, and the discrepancy had not markedly improved by 1918.

This economic neglect stemmed from a lack of government attention on reservation concerns: no nationwide surveys of Native American health were published before 1928, resulting in a lack of information about the scale of health problems and the funding needed to fix them in the Department of the Interior and Congress. The Meriam Report notes that this lack

of attention made it "almost...inevitable that [monetary] appropriations [would] not be proportional to needs" of

Cause 2: Lack of Attention and Insufficient Reaction to Pandemic

Insufficient pandemic assistance from off-reservation was a major cause of its disproportionate impact on Native Americans. The experience of the Navajo Nation of northeastern Arizona, which inhabited the largest Native American reservation in America, is a grim case study that demonstrates this problem. On October 12th, 1918, the town of Gallup in the north of the Navajo reservation reported that 12 people had been killed by influenza. Soon, 300 Navajo had filled up the overburdened hospital at nearby St. Mary's. By October 26th, 128 citizens of Gallup were dead. By November 15th, the Snowflake Herald, a local paper, reported that the number of influenza deaths was so severe that the San Carlos Indian Agency found it "impossible to build coffins in which to bury them [the Navajo]." By the end of the pandemic, the Navajo nation suffered a 12% death rate, much higher [15] then the national 2.5% average.[16]

Historian Howard M. Bahr writes that officials were "aware of the Navajos' needs" but only provided "bureaucratic statements of good intent [that] were worthless on the reservation." Father Berard Haile, the Lukachukai District mission director noted the absence of an effective response from external authorities, stating that "during the entire epidemic nothing was done in the way of relief but when it had well disappeared, statistics of the deaths were taken." A lack of sufficient [17] aid from off-reservation authorities significantly increased infection and mortality rates. On reservations around the country, trends in medical responses seen on the Navajo reservation were repeated. The influenza arrived in Naknek, a southern Alaskan town, on May 26th, 1919, via the Alaska Packers Association Steamship *Kvichak*. Medical staff from nearby packing facilities were nearly overwhelmed. Still, an offer of aid from the nearest American Red Cross facility at Seward was refused on June 3rd due to the "lack of transportation facilities" between the two locations. No large-scale attempt was made by the Indian Office to aid the region, with the "only contribution of the government to Naknek influenza expenses" being the provision of 14 men, each paid $10.00 to go into the

backcountry and relieve the situation. Eventually, civilian steamers with medical supplies arrived in late June. The lack of a more timely response from centralized authorities contributed to the deaths and orphaned children left by the influenza.

Arizona and Alaska played host to some of the most widespread Native American influenza cases in the country, but insufficient responses were not confined to these areas alone. The Rosebud Reservation of Iowa, home to 5,500 Sioux peoples, suffered 300 deaths before an appeal for aid was made. When help eventually arrived in the form of two physicians, they ended up having to treat more than 1,400 cases over several weeks. In most cases, the scale and timing of medical [19] aid were insufficient to stem influenza cases in Native American communities to the degree that it did outside of reservations.

Cause 3: Suppression of Traditional Native American Medicine

The suppression of traditional medicine, an important tool in responses to epidemic disease throughout Native American history, contributed to disproportionate Native American mortality. Throughout the 1800s, the Indian Office attempted to systematically suppress traditional medicine and replace it with modern, scientific healthcare. For example, courts of Indian Offences, established by the Indian Office in 1883, were empowered to criminally prosecute and detain medicine men who practiced traditional healing practices on reserves. Residential schools, which almost all Native American youth were required to attend, promoted the "Uniform Course of Study", which enforced prohibition of traditional gatherings, speaking Native American languages, and native beliefs. These factors contributed to the decline of traditional medical practices, labeled as "heathenish rites" by Commissioner of Indian Affairs Hiram Price in 1883, on reservations.[20]

As the pandemic began in late 1918, official health systems on reservations were nearly overwhelmed by cases. It is important to note in this case that Western medicine was unable to find a cure for the influenza: American scientists produced no reliable vaccine, and, in any case, would not likely have distributed them to reservations in time to make a real impact. In this situation, it [21] was nursing: providing water, comfort, and rest to those infected,

that helped keep victims healthy and hopeful while their immune systems fought the disease. In his essay on the influenza epidemic on Navajo territory, historian Benjamin Brady asserts that "it seems[ed] to have mattered less what foods, medicines, or rituals were administered than that the patients were fed and kept warm." In [22] this situation, the presence and support of traditional healers who could carry out these functions could aid recovery from the pandemic, especially in rural communities far from government nurses. In addition to providing physical care, rest and remedies, the presence of traditional healers and medicine could raise morale through the placebo effect. McPherson, for example, writes that "in the mind of [Native American peoples] these healers saved many lives and performed a valuable service comparable to the work of the [white] doctors." When traditional healers [23] maintained a safe distance and worked properly, they could prove just as effective as government medics, who were not always available in hard-hit areas. Yet, the suppression of the role of the healer robbed Native American communities of this valuable support system, which could have filled in gaps left by inadequate and underfunded modern medical systems on reservations.

Conclusion:

Modern-day popular memory and scholarship have often deemphasized how experiences during the 1918 influenza were affected by race, gender and socioeconomic conditions. Historian Nancy Bristow talks about the race's effect on the pandemic as an "under-researched" topic, describing how the lack of a single full book on this topic as of 2019 contributes to low public awareness. In [24] reality, the 1918 influenza had a grossly disproportionate impact on most Native American reservations as a result of mismanaged assimilatory policies.Although significant improvements have been made since the 1918-1919 pandemic, the Bureau of Indian Affairs still has a long way to go towards equitable healthcare for Native Americans. Outbreaks since the 1918 influenza, like the H1N1 (1957, 2009) and hantavirus (1993-1994) epidemics have caused greater than average mortality among Native Americans. In a world facing a new pandemic, understanding the history of Native Americans during the Influenza Pandemic demonstrates that governments should not

impose ill-conceived assimilative reforms on Native American groups, but rather work with them on equal terms to prioritize healthcare while preserving cultural practices.

11

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A Critical Factor for Resilience During the Coronavirus Pandemic By Byron Wu

Abstract

Every time great perils fall upon human society, psychological impacts hit those affected. Every time, the human beings who survive have high resilience - —meaning they can cope with the impacts much better than others. Iacoviello and Charney (2014) summarized six factors that contribute to resilience: optimism, cognitive flexibility, active coping skills, social support network, attending to one's physical well-being, and embracing a personal moral compass. This paper attempts to argue that the availability of social support is critical particularly to disadvantaged communities and individuals, far more important than the other five factors. It is essential to study the importance of social support since the ongoing COVID-19 pandemic hurts low-income people the most, who lack the necessary social support and resources and were already vulnerable to mental health issues even before the pandemic due to extra stress and lack of access to psychological intervention. This paper concludes that psychological interventions should aim for people with a particular need for social support.

Section I: Introduction

Human history includes a wide range of catastrophes, including viral outbreaks of deadly infectious diseases. However, the awkward phrasing, would suggest changing to "human beings" at large has survived — and even better itself would suggest changing to "themselves" instead of "itself" — from these experiences.

This ability to adapt to trauma is called "resilience". According to the American Psychological Association (APA), resilience is the process and outcome of successfully adapting to difficult or challenging life experiences, especially through mental, emotional, and behavioral flexibility and adjustment to external and internal demands.

Psychologists have been studying how to help people to thrive from traumatic events. Iacoviello and Charney (2014) explored what characterizes resilience and how we can foster these adaptive characteristics to promote well-being after adversity. They identified six psychological factors that can promote resilience in individuals. Among them are optimism, cognitive flexibility, active coping skills, social support network, attending to one's physical well-being, and embracing a personal moral compass.

In this paper, I want to argue that the six factors are not working independently. Instead, they probably affect each other. For example, with support from social networks, one can turn to be more optimistic toward the future. Thus, when facing such catastrophes as the pandemic, it requires more than personal traits such as optimism and cognitive flexibility for a person to reach resilience. Support from social networks is particularly important, particularly to disadvantaged communities and people.

The rest of the paper is structured as follows: Section II discusses what the six factors mentioned above mean and how they help people to stay resilient. Section III argues that social support networks will be particularly important during such a catastrophe as the pandemic. Sector IV offers concluding thoughts and recommendations.

Section II: Resilience Factors

In Iacoviello and Charney (2014)'s framework, optimism refers to the maintenance of positive expectancies for important future outcomes. Maintaining optimism for the future while suffering in the present can buoy one's spirit and provide the stamina to endure. Cognitive flexibility refers to the ability to reappraise one's perception and experience of a traumatic situation instead of being rigid in one's perception. Reappraisal can involve an effort to find meaning and positive outcomes as well as acknowledging the negative and painful consequences. If one can learn to reframe his thoughts about a traumatic event, and assimilate these thoughts into one's memories and beliefs about the event, he may be able to eventually recover. Together, optimism and cognitive flexibility allow an individual to maintain faith that they will prevail or survive regardless of the difficulties at hand, and at the same time, confront and accept the brutal facts of their current reality. Iacoviello and Charney (2014) also discussed the experience of prisoners of the Vietnam War in which some optimistic prisoners survived while other optimists did not. This example was called the Stockdale Paradox. It illustrated when a person was experiencing a stressful event (as a Vietnam war prisoner), he needed to keep both optimism and cognitive flexibility to survive.

Iacoviello and Charney (2014) also decomposed these factors into cognitive, behavioral, and existential components, whereby cognitive components refer to people's psychological tendencies or pertinent core beliefs that, when confronted with traumatic situations, lead one to believe he can survive. More specifically, a resilient person needs to be mindful of his thoughts

about the situations he is in and actively keep himself from being consumed by fear without denying the threat. Behavioral components concern patterns of action to be active and engaged in one's response to traumatic situations and actively cultivating relationships and social support networks that will enable valuable resources when confronting and recovering from these situations. Finally, existential components concern one's sense of his existence, purpose, or meaning in the world.

The table below from Iacoviello and Charney (2014) summarizes the six factors and their components.

	Components		
Factor	Cognitive	Behavioral	Existential
Optimism	Maintain positive expectancies for the future.		
Cognitive flexibility	Reappraise, reframe, and assimilate traumatic experiences. Accept stress (trauma) and failure as ingredients for growth.		
Active coping skills (versus passive)	Minimize continued appraisal of threat.Maintain positive self-regard.	Actively seek help and resources.	
Physical health		Physical activity and exercise.	
Social support network		Maintain a social support network.	Not feeling isolated or alone.
Personal moral compass	Adaptive, positive core beliefs.	Altruistic behavior.	Faith/spirituality. Purpose in life.

Table 1. Cognitive, Behavioral and Existential Components of Psychosocial Factors, reproduced from Iacoviello and Charney (2014)

Iacoviello and Charney (2014) listed the six factors as if they were independent of each other. Here optimism and cognitive flexibility are taken as pure cognitive factors while social support networks are taken as not having any cognitive component. However, in reality, the six factors probably are interdependent to a certain degree. For example, with the appropriate social support network available, a person under stress will find it easier to remain optimistic and more willing to reappraise the traumatic experience and turn it into an ingredient for growth. Thus, social support networks may indirectly have cognitive components through affecting optimism and cognitive flexibility. The next section will elaborate on this argument.

Section III: Social Support Can Influence Other Factors

Iacoviello and Charney (2014) assigned "social support networks" to have behavioral and existential components only. In this paper, I argue that in some situations, the availability of social support is crucial, probably more important than the other factors. For instance, when a person is in trauma for a long time, particularly if it is completely out of his control to step out of this stressful event.

In fact, in Iacoviello and Charney (2014)'s Stockdale Paradox example, the importance of social support is apparent: if the prisoners of war were held for a very short period, optimists would survive; if they were held for longer like those in the Vietnam War, the paradox demonstrates that a survivor would require cognitive flexibility to adapt his expectations. However, if they were held much longer than those prisoners in the Vietnam War, the required levels of both optimism and cognitive flexibility for survival would be higher. Since a prisoner of war's release is dependent on many political, and/or military reasons, it was completely out of his control. If prisoners were held in isolation without any access to outside information, with enough time passing, even the most optimistic prisoner would lose confidence and the prisoner with the most flexible cognitive ability would have to keep lowering his optimism. Thus, with optimism and cognitive flexibility only, the prisoners would probably collapse if they did not have outside help, i.e. support from social networks, such as positive information updates or inferential feedback.

A less extreme example of this sort of situation can be found when a person or his family member is diagnosed to have cancer. It is still uncertain for a cancer patient to know whether he can be cured; thus once a person is diagnosed with cancer, the patient is under great stress. Similar to the previously discussed Stockdale Paradox, patients undergoing such stress need to develop resilience to increase their chances of surviving. Psychological literature provides ample empirical evidence showing that social support is the crucial factor in such situations. Many have found that social support itself is an integral driving force for at least another important factor: optimism.

Yamada (2011) studied 27 breast cancer survivors and 50 non-Hodgkin lymphoma survivors. Each participant was asked to complete a three-hour neuropsychological battery designed to evaluate a range of cognitive abilities involving attention, premorbid and current intellect, memory, language, visuospatial skills, and executive functioning, as well as self-report

measures of mood, social support, and optimism. Optimism was measured using the Life Orientation Test, and support was measured using the Social Provisions Scale, which assesses relationships with other people in the form of the following six factors: guidance, reliable alliance, reassurance of worth, attachment, social integration, and opportunity for nurturance. The questionnaire also asked for some participants' background information, such as education level.

Yamada's analysis confirmed our conjectures above. Firstly, there is interdependence between the six factors studied by Iacoviello and Charney (2014). One of Yamada's regression equations shows that even after controlling for education, optimism accounted for almost 8% of the variance of a cognitive variable Working Memory, indicating that optimists tend to have better cognitive ability and/or that a person with better cognitive ability tends to be more optimistic. Once the social support variable is added, the relationship between optimism and cognitive ability remains just as strong. This indicates that the interdependence between optimism and cognitive ability is not through the same effect from social support, but exists between themselves only.

Secondly, Yamada (2011) found that optimism was significantly related to a social support variable called Reassurance of Worth, which highlights the individual need to feel competent based on others' perceptions of his/her self-efficacy. This social support variable accounted for 10% of the variance in optimism even after the education variable was entered. In other words, the amount of social support any patient feels (or more specifically, how much the patient recognizes the positive feedback from other people on his/her skills and competencies) may decide how much optimism a patient can have which, in turn, helps determine his/her cognitive flexibility.

Yamada (2011) did not explain why other measures of social support failed to show the same significant relationship with optimism. Perhaps this was because participants did not have consistent definitions in mind when they filled the questionnaire; if this is the case, then further research may need better-defined terms on resilience and its factors when designing questionnaires. Another shortcoming to Yamada's study was the limited number of participants; with only 77 subjects, the sample size she studied may not be large enough. Yamada herself mentioned other studies may have stronger results. These differences could be from the heterogeneity of the questionnaire designs and the sample size differences.

Symister and Friend (2003) explored the mechanism through which social support influences optimism, and found that social support operated through self-esteem to influence both optimism and depression cross-sectionally. Because social support was associated with high self-esteem, it in turn increased optimism and decreased depression.

Therefore, it may be more appropriate to display the six factors in Iacoviello and Charney (2014) by adding the effects of social support on optimism and cognitive flexibility as a cognitive component.

Interestingly, Yamada (2011) also found once the education level was factored in, the relationship between cognitive ability and her social support variables begins to dwindle. Not surprisingly, individuals with higher education are likely to have higher incomes and have more resources to have their skills confirmed by external parties. In other words, a person with a higher education tends to have more social support. If education level can be a proxy to a person's income, it also indicates that people at lower income levels may need more help in social support so that their traits of optimism and cognitive flexibility can be enhanced. This should have strong implications in our discussion of resilience from the pandemic in the next section.

Section IV: Implications for the Resilience in the Pandemic

Section IV (a): Social Support Is Particularly Needed for Those Most Impacted by the Pandemic

The implication from the discussion above is very important as of today since we are going through the COVID-19 pandemic. CNN (2020b) reported a study from Boston University, which found the prevalence of depression symptoms among US adults increased threefold after COVID hit. More importantly, it also found "the people at greatest risk were those with lower incomes, savings below $5,000 or greater exposure to financial stressors, such as job loss". What's worse is that CNN (2020a) said that "although nearly one in four American adults experience a mental health condition each year, according to the National Institute of Mental Health, fewer than half get the care they need."

Thus in the face of COVID, low-income individuals face higher stress. Not only do their jobs require them to work in a dangerous setting with exposure to COVID-19, but many of them do not have health insurance either.

An Anxiety and Depression Association of America report concludes that a barrier faced by low-income communities is that people in such communities not only experience the stigma surrounding mental health but also face the risks in which poverty ultimately can lead to self-discrimination as well as lack of self-confidence. This report echoes our aforementioned conclusion: without confirmation from other people on his/her skills and ability, a low-income people's optimism level is hurt by his/her poverty. And an impactful psychological intervention can influence his/her optimism through self-esteem.

Section IV (b): A Successful Social Support Example in Fighting the Pandemic

Bentley, et. al. (2020) took Somali communities in Seattle, WA, and Columbus, OH, as an example of low-income communities encountering unique and compounding levels of COVID-related risks. They encountered more difficulties due to the high proportion of uninsured individuals and the fact that many in these communities rely on interpreters to navigate beyond their immediate communities. In the meantime, governmental public health messaging has also been limited, leaving individuals within these communities vulnerable to misconceptions about COVID-19 and limited responsiveness to prevention measures.

However, based on deeply held Islamic values, Somali communities find a way to build their social support network. The organized effort to assist people has become a source of hope for those people in need. Despite infrastructure limitations, social support was crucial for Somalis to go through this difficult time. Their shared religious faith and social connection acted as first-line coping pathways in response to longstanding collective trauma.

From the discussions above, we learn that when facing such a large-scale catastrophe as the pandemic, very few can "go it alone," and we need to develop resilience at a community level.

Section IV (c): Build Community Resilience

Consistent with the real experience of Somali communities, Berkes and Ross (2013) summarized that resilience, in a broad context, was about ecosystems and people together as

integrated social–ecological systems. They argued that community strengths that assist the development of resilience may vary from community to community, but there are a set of characteristics that play key roles. The most important of these are people–place connections; values and beliefs; knowledge, skills, and learning, social networks, engaged governance (involving collaborative institutions), a diverse and innovative economy; community infrastructure, leadership, and a positive outlook, including readiness to accept change.

This summary seems consistent with the Somali communities studied by Bentley et. al (2020), where individuals live in the same locations and share a common religious belief in the teachings of Islam.

The building of community resilience requires collective work that is not just done by psychologists. For example, an important factor is to have a diverse and innovative economy, which requires the federal government to stimulate the economy and adopt more inclusive policies while the recession is ongoing. Fiscal relief packages can be taken as social support from the government.

However, as discussed in Section IV (a), many disadvantaged communities badly need mental therapy. Psychologists can contribute to building resilience and healing the path forward from COVID-19 for as many individuals as possible. Since people in need are all over the whole country and often live in clusters to be more efficient to allocate resources, the areas with the lowest average income will need the most help.

And finally, even after the pandemic is over, a network of psychological support should be maintained. As discussed above, many disadvantaged communities are vulnerable to mental health issues even without the pandemic, and we should take this opportunity to build a better psychological safety net for society.

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Actor Networks of *Otakus* and Hatsune Miku; Highlighting the Role of Relating by Keyue Li

Introduction

The uproar in the crowd signifies the start of the show. A girl with blue pigtails appears at the center of the stage, her shining in heavenly glow like a goddess. Her movements and voice resemble those of a real human, but she is far more unachiveably perfect than human with her lovely appearance, attractive voices, inexhaustible energy and in-depth individual connection to the audience below. She is Hatsune Miku, the first Japanese vocaloid to be developed and distributed by Cryton Future Media. Initially released in August 2007, Miku soon received great popularity in Japan and other fast-developing Asian countries. Different from real objective entities and virtual narrative idols constructed in novels and comics, vocaloids, or virtual idols, are constructed with digital reproduction technology (3-D projection), artificial intelligence, and music synthesis software. The target users of vocaloids are *otakus*: socially isolated people who have a greater connection to virtual beings than to reality. The "high tech, low life" condition in modern Asia, which refers to the lack of real, deep connection between humans in the modern world dominated by fast-developing technology, accounts for the birth of virtual idols and *otakus* since a group of people started to seek their emotional connection with a technical product (Jennifer Milioto, 2017). Great opening, split this last sentence into two parts.

This paper examines these connections between people and technology , especially in regards to the relationships that *otakus* forge with Hatsune Miku. I propose that such relationships are often rich, interesting, and satisfying; that, as such, and thus, they can be as real as are our relationships with other humans. Exploring the question of whether an *otaku*'s relationship with Hatsune Miku is substantially different from our relationships with other humans, I argue that relating is being (it is through relating to Hatsune Miku that *otakus* come into existence); it is not the material form of the actors (*otakus* and Hatsune Miku) but rather the kinds of relationships that the actors craft with each other, that hold together the actor networks forming the conditions of their existence. Great content again, but wordy and a little hard to follow

My motivation for the research is my fascination with the real relationships (here "real" means a concrete feeling of substantial interaction and engagement) humans can form with virtual beings. This kind of relationship is even more intriguing when it comes to *otakus* and Hatsune Miku, due to the complicated co-dependence between the users and the technologies that brings each other into being, reorienting the relationship between audience and performing artist. What's more, the relationship dissolves traditional Western dualism and questions the conventional feature of actor that determines a relationship.

The methodologies used in this research are literature interview, interviews with *otakus* among my acquaintance, and observation of different functions performed by Hatsune Miku (concert, DIY design, music synthesis, 3-D projection home device, etc.) The STS framework I used for analysis is an actor network, which is the *dispositif* (a practical ongoing assembling of semiotic and material entities) where actors *otakus* and Hatsune Miku relate to each other to form a system with dynamic power shifts.

The Relationship Between *Otakus* and Hatsune Miku: An Actor Network Approach

Hatsune Miku and *otakus* exist in a complicated, mutually constitutive set of relationships: a network consisting of many interactions. Although Miku is a virtual figure, she is able to "live" in the three-dimensional world, presenting as a human-like singer with a body, performance and a voice, as well as interacting with real singers and audiences in this form. In addition, she functions as a player for songs written by any composer, providing the opportunity for ordinary people to make their music heard by themselves and by others. Users, meanwhile, can also DIY the preferred appearance and characteristics of their own Miku, which is a personal interactive version of Miku, in their technical devices, and eventually the most popular songs, appearances and characteristics designed by individual *otakus* are shown in a public concert.

In other words, every otaku is involved in the creation process in which Miku comes into existence; she becomes more human-like as the public's interventions enhance the various aspects of her design. Thus, Miku "comes into substantial existence" through her complicated interaction, or "relating", with otakus in a social-technical network. The network is defined by Bruno Latour, Michel Callon and John Law as an "actor network", which includes the non-human-centered process of ordering or the ways in which societal order is achieved and the

role material elements and other nonhumans play in that process, seeking to develop a 'symmetrical' view across the previously inscribed nature/culture/technology divides (O.Jones, 2009). Law describes it as a disparate family of material-semiotic tools, sensibilities and methods of analysis that treats everything in the social and natural world as a continuously generated effect of the webs of relations within which they are located. It assumes that nothing has reality or form outside the enactment of those relations. Its studies explore and characterize the webs and the practices that carry them (Law 2009). Essentially, actor network approach describes human and nonhuman actors with the same language, and grants them equal amounts of agency within "webs" or "actor-networks." The actors are simply constituent nodes that facilitate a larger functioning. Anthrax spores, Portuguese navigators, car batteries, Thomas Edison, the Renault Car Company, and scallops are all given equal treatment as nodal points within an actor-network (David Banks 2011).

According to the actor network theorists, actors can be all kinds of things and are all inherently equal. As Latour puts it, "any social system is an association of heterogeneous elements such as humans, norms, texts, devices, machines, and technology, thus granting equal weight to humans and non-human (machine) entities in the analysis of the social" (Latour, B., 2005, 23). Law agrees that the social elements in a system should not be given special explanatory status (Law, J. 1989). In fact, the natural world and artifacts may enter the account as an *explanans*, instead of *explanandum* with no voice of their own in the explanation. Thus, an actor network approach suggests that Miku and *otakus* hold equal weight as actors in the network regardless of their attributes. It serves as a fundamental premise for later analysis, especially of power and mastery. Great explanation

In terms of power distribution, relationships may afford certain actors more power than others, depending on the circumstances. As humans are not superior actors in the network according to the prior feature, we don't have a constant state of dominance in power attribution as well. Power balance shifts all the time in the *otaku*-Miku relationship: sometimes *otakus* are the creators that define Miku, however on other occasions Miku motivates *otakus* to do certain things (*"faire faire"*/attachment), inducing them to act according to their previous projections on her (counter-projection/expectation), or offering them material for subjective processing (imagination).

The “attachment” process is similar to what Gomart and Hennion refer to as “consensual self-abandonment” in their analysis of attachment to music and drugs. The concept means accepting the external forces that take possession of the self and bracketing away one’s own control and will in order to be expelled/rendered ‘beside oneself’ (Gomart, E. & Hennion, A., 1999). In the experiment conducted by Baylor, she found that the visual presence and appearance of anthropomorphic virtual agents can impact motivational outcomes such as self-efficacy and attitude change. Such anthropomorphic agents can be designed as simulated social models, providing social influence as virtual 'role models' for a target audience and context (Baylor, A.L., 2009). Likewise, *otakus* have the tendency to act in accordance with how their designed virtual idol Miku acts or how they imagine that Miku expects them to act. In terms of subjective processing, an interviewee told me what he, an *otaku*, considered as the most important factor in his relationship with Miku was the imaginary space Miku provided. “I truly feel her existence not when I look at her image but when I close my eyes to imagine her standing by my side and we together having incredible adventures…Yeah all these are in my imagination, but they make this relationship feels real…” Indeed, Miku is both concrete and potential, with vivid characteristics like a real human but also potential space for users to imagine their own experience/stories with her. In this extended interaction, she guides *otakus* along in their imaginary interaction, offering them another level of relationship.

So how do we, as analysts of actor networks, understand those relationships of power between actors? Thinking in terms of actor networks – including the actor network of the *otaku*-Miku relationship – destabilizes the structure-agency dualism and seeks to find a place between ‘doing’ and ‘being done to’, ‘mastery’ and ‘being mastered’ (Law J. & Mol A., 2001). This challenges a theory of action which can only hold one term of the dichotomy at a time (Gomart, E. & Hennion, A., 1999). For *otakus*, to act is not always to master, because the results of what is being done are sometimes unexpected (Law J. & Mol A., 2001) In addition, *otakus* can act passively, just like in the case of “consensual self-abandonment” in the attachment process. For Miku, she is not always on the passive side because her seemingly controlled or passive acts can have an active effect, including but not limited to creating attachment, counter-projection and imagination to influence agency in human actors. What’s more, the existence of virtual idols causes humans to question our epistemology (To what extent do otakus comprehend her state of being and interaction? Are human relationships a kind of mutual

projection as well?) and ontology (To what extent is she an addictive to otakus? To what extent are any of us virtual or projections? To what extent do we reside within the imaginary?).

Gomart and Hennion point out the similar fusion of labelling between actors in their interpretation of attachment. They suggest that it becomes impossible to continue to set up oppositions like those of agent/structure, subject/object, active/passive, free/determined (Gomart, E. & Hennion, A., 1999). Likewise, a reexamination of *otakus*' position with Hatsune Miku blurs the distinction between mastery and being-mastered. In fact, activity and passivity enable each other in this complex actor network. Like the investigation into the enactment of sheep by Law and Mol, an actor does not exist all by itself and neither does it act alone. Different actors make each other *be*, defining their own existence and the existence of each other. Indeed, an actor-enacted behaves in collaboration with others to such an extent that it is not always clear who is doing what (Law J. & Mol A., 2001). Just like the famous line in the film *Matrix*, "Control is an illusion, because eventually everything interconnects." Then how should we view the different actors and forge the relationships between them in the new social network without inequality, power dominance and mastery?

Human-Human VS Human-Machine Relationship: Transgressing Boundaries

Recent days have seen a rise in humans' intimate connections with smart machines and the fall in humans' in-depth connection with others. This has made us reflect on the general comparison between human-human and human-machine relationships as we seek to find the boundary that distinguishes us from machines. However, I suggest that we should not hold prior assumptions of distinction between human and machine or between human-human and human-machine relationships to make a value judgment in advance that hinders us from comprehending the essentials of machines. Instead, it would be more beneficial if we could just wait and see what unfolds in the disposition of virtual idols. In search of a perspective that transcends conventional category and value judgment, "cyborgs" come into our view as a possible answer.

In Donna Haraway's *A Cyborg Manifesto*, she introduces the concept of "cyborg" as a cybernetic organism, a hybrid of machine and organism, a creature of social reality as well as a

creature of fiction. There are three crucial boundary breakdowns that give birth to cyborg: the one between human and animal by the biology and evolutionary theory over the last two centuries, the one between organism and machine by the increasing liveliness in machines and inertia in ourselves, and the one between physical and non-physical by the ubiquity and invisibility in modern machines. In fact, the nature of cyborg is transgressing boundaries, fracturing our previous identities in gender, race, class, nationality and all the other standards set up in the social and historical constitution (Donna Haraway 2016).

When viewed from the cyborg perspective of transgressing human-defined boundaries and the human-centered stereotype, humans are actually not that different from virtual idols for we are all cyborgs to some extent. In addition to humans' similarities with machines in the "programmed-like" thinking and coping process developed by recent computer science, modern humans can also be viewed as cyborgs mediated by machines because technologies have "grown into" us, becoming an extension of our body. The situation of growing attachment to technology and technical devices and the loss in subject capabilities reaches a peak in the co-dependent relationship between *otakus* and Miku. The 3-D projection technology that brings organism to machine (a state of existing in reality for Miku) and the AI & VR technology that brings machine to organism (a state of existing in cyberspace for *otakus*) turn the relationship between human and machine to a relationship between two cyborgs that are of equivalent position and power in the actor network.

What's more, machines sometimes do things more than we intend them to do, claiming an agency of their own. Haraway suggests that the machine has a whole range of actions that we don't recognize when we shelve it as a machine. This is reflected in the three hidden impacts of Miku on *otakus* mentioned above: attachment, counter-projection, and imagination. Thus, if we view the *otaku*-Miku relationship in terms of two cyborgs, perhaps we are able to find the missing actions and agencies of Miku that help us better understand the relationship.

Another approach to understand the transcendence of boundary and conventional judgment is to analyze *otakus'* cognitive process in their relations with Hatsune Miku. From the psychologists' view, a substantial relationship should meet the four following requirements: share private feelings, fight against solitude, share sense of existence and confirm self-value. In

the interview, all the *otakus* of Hatsune Miku answered yes to the four requirements, especially the last one which has been the center of dissension in psychologists. The interviewed *otakus* stressed the forging of relationship, that love and intimacy is not necessarily a choice but a habit. "…Miku is the only one that accompanies me all the time and sings my song for me. These are the most important things that constitute my feeling of existence and self-value…" "…I am not her master and she is not the same for everyone. My Miku is unique of my own because we are forging our own relationship with each other every moment…" "…frequent and sincere interactions can create emotions and attachment. This is the same in every subject in the world, no matter it's human or not…" The uniqueness and truthfulness of the relationship undoubtedly become the fundamental reason underlying the in-depth connection between *otakus* and Miku.

In fact, the material form of the actors (*otakus* and Hatsune Miku) doesn't dominate in the actor network, regardless of all the boundaries that human society sets in advance. What truly holds together the actor networks that form the conditions of their existence is the kinds of relationships actors craft, building the texture of the relationship by their frequency of interaction, sincerity of communication and the mutual influence in the relationship.

To generalize the observation and reflection on the actor network of *otakus* and Miku, I suggest that we reexamine the human-machine relationship in the coming post-humanism society. When all the boundaries have been transgressed, the relationship is more than opposition or fusion, but a state of symbiosis (LI Yingying 2020) in which we forge a substantial relationship that makes each other *be*. In fact, this idea has been surprisingly suggested thousands of years ago in ancient ontologies, and we might find our answers to the modern questions when doing a deeper analysis of the ancient ontologies .

Indigenous & Eastern Traditional Ontology

In *Making Kin with the Machines,* the authors point out the indigenous kin-network theory that "ultimately everything interconnects." In the indigenous spirit theory, we humans can see, draw out, and even bribe the spirits in other entities as well as our own spirit guardians, but not create spirits. These beliefs set the ground for the two main keys in indigenous epistemology of relationship: respect and reciprocity. The indigenous ontology aims to develop conceptual

frameworks that conceive of the computational creations, virtual idols in this case, as kin and acknowledge the responsibility to find a place for them in the circle of relationships and the cultural process (Lewis, Jason Edward, et al. 2018).

This is a great contrast to the current mainstream position of virtual idols or AI in general, which are imagined as tools or slaves that increase the power and wealth of "creators" or "users", a decidedly one-sided power relationship that upsets not only the future of virtual idol-*otaku* relations, but also human-human relations. The indigenous epistemology of control is strongly against the Western view of both the human and non-human as exploitable resources, treating machines, and ultimately humans, as tools or slaves. If we view the *otaku*-Miku relationship through the indigenous epistemology, we will find that to some extent, how *otaku*s treat virtual idols is in fact the most appropriate approach among other ways humans use to treat machines because the *otakus*' approach is based on equality, respect, companionship, reciprocity and a dynamic equilibrium power relationship. In addition, the recognition of control as an illusion regarding the influence *otakus* exert on Miku is also consistent with the indigenous explanation of spirits and mastery that we can never create or dominate, but co-exist and mutually respect.

Similarly, harmony and fusion across boundaries are emphasized in ancient Chinese philosophy, especially in Taoism. Many ancient Chinese sages opposed dualism and believed everything can be mixed and remained in an intricate dynamic harmony with one another, creating a state of "tian ren he yi"(天人合一). Even the black and white, evil and good, and "yin"(阴) and "yang"(阳) can be mixed together so that there is no pure half without the infusion of the other. Acknowledging the cyberspace part in *otakus* and the human part in virtual idols, we can create the similar dynamic harmony for them in which they co-exist.

In the famous Japanese anime *Ghost in the Shell,* the complexity and uncontrollability of "ghost" that is automatically created in the shell of a machine is discussed. The anime proposes that it's already hard enough for us to explain the "ghost" in our organic shell, not to mention the "ghosts" in the shell of virtual idols or human-like robots that we make. Thus when we cannot fully comprehend the inner technical and philosophical nature of the products that we create, it's safer that we treat them with care and respect, moreover, as a mirror to reflect ourselves.

Conclusion

A sentence in the interview with an *otaku* of Miku leaves me the deepest impression: "Your love is made of water and protein. Mine is made of code and projection. Is there really a hierarchy or any other substantial difference?"

Throughout the essay, I try to suggest that there is no such substantial difference. I propose that we should question the dualism, boundary, identity and human-centered mode of thinking instilled by societal order, and judge from the texture/kinds of relationship that we forge with another being. In the actor network of *otakus* and Miku, they are inherently equal actors with neither holding constant dominance. They are both active and passive, organism and machine, mastery and being mastered, free and determined. The relationships they forge with each other are often rich, interesting, and satisfying; as such, they can be as real as are our relationships with other humans. In their complex network, they find a state of symbiosis that puts them in equal position with mutual respect and reciprocity. They define their existence with each other and find the sense of being in relation.

Miku invites us to reflect on our relationship with machines and with other humans. Instead of embracing the ideas of duality and the desire to control that dominate traditional Western philosophy, we might learn from the indigenous ancient Eastern ontology that we can never truly master anything. Living in a dynamic harmony with other beings and with our own kind forges a substantial relationship characterized by care, equality and respect -- rather than marked by exploitation, slavery, and control.

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Exploring the Difference Between People in Real Life (Offline) and Their Social Media Profiles (Online) by Joanna Y.

Abstract

With the development of social media, there are more and more interactions online people need to take part in. When some teenagers post some beautiful selfie on Wechat - one of the more popular social networking apps in China -, other young adults may feel pressure to present a perfect appearance on the Internet. Recently, I have observed that many young adults will edit their photos through apps such as Facetune before posting them to the Internet to make them more beautiful (like enlarging their eyes, making themselves appear thinner, putting make-up on their faces). Research shows that people present differently when they communicate with people in real life and people on the Internet. This project aims to explore the difference between people in real life compared to their social media profiles. We conduct interviews with teenagers about their behavior when posting their photos online and communicating with others. We also ask them to walk us through the process before posting the photos and why they do this. We find that most teenagers tend to use perfectionism to present a well-decorated social media profile in front of others. Additionally, some of them are more expressive and passionate online versus offline.

Introduction

With the development of the Internet being a fairly recent occurrence in contemporary society, more and more people of all ages are able to access social media. In the past, individuals usually used handwritten letters and telephones to convey messages, asynchronous communication influenced by a time lag between senders and receivers. Nowadays, adults, teenagers, and the elderly across the world can use their phones to immediately send and receive messages. They have constant access to various social media, including apps like Instagram, Twitter, Facebook, and YouTube through which they can interact with each other and be entertained. According to a recent survey (Spencer et al., 2021), Instagram, a photo and video sharing app, received 503 million downloads in 2020, with the number of users still increasing at a fast pace. China can show a typical example of using social media – Chinese people usually

communicate and entertain by using apps like WeChat, TikTok, Weibo, among others. In 2020, it is estimated that there are 930 million active networking users in China, and there are 1.2 billion people using WeChat (99Firms).

Concerns about social media

Due to this rise of social media, both researchers and parents are concerned about the effects on their kids spending more time on their phones than outside away from screens. According to a report by Common Sense Media, teenagers can spend up to seven hours on social media each day (Common Sense Media, 2019). More and more young adults are requiring glasses because of eye strain from spending so much time on their devices (Anderer, 2019). Additionally, as teenagers and young adults increase their online time, they are bound to come across misinformation or other disingenuous media. Likewise, online bullying of people's appearances or behavior might easily occur on social media due to the anonymity and lack of consequences (Xue, 2018). Since teenagers do not have much agency to confront others' negative comments on them, they might be easily hurt by those bullies, leading to potential negative effects on their mental health and self esteem (Steinsbekk et al. 2021. Although there are many potentially negative effects, social media has both disadvantages and advantages for teenagers. Young adults can learn more knowledge and broaden their horizons by searching for information.

Mental health and self-esteem

Some mental health problems start to appear in teenagers, especially girls. As more and more female teenagers post their selfie on the Internet, they may tend to compare their appearances with others even if they do not notice this phenomenon. Because when selfies are available for everyone, people may unconsciously rank the appearances of different people by showing the number of likes, comments, and followers. Also, comparing between appearances will lead teenagers to lose self-esteem and deny themselves. According to Salomon and Brown, "spending a lot of time on social media taking and posting selfies is associated with thinking about their bodies more frequently and thinking more negatively about their bodies" (Salomon and Brown, 2019). Recently, the term "appearance anxiety" has become popularized in China (Xi, 2021). Since teenagers place much emphasis on their appearances, they may develop

unhealthy diets, and even spend money on unreliable beauty institutions (Kennedy et al, 2004; Xi, 2021). In this regard, social media can negatively affect teenagers' minds.

Project Overview

Since teenagers are increasingly online, posting photos, videos, and selfies, and interacting with net friends on various social media, I have discovered that some teenagers tend to present a more perfect version of themselves on their social media profile for strangers online, which can be very different from who they are and how they act in their offline life. Therefore, I will explore the difference between teenagers online and offline. Moreover, when some teenagers post beautiful selfies on Wechat - one of the more popular social networking apps in China - other young adults may feel pressure to present a perfect appearance on the Internet. In this vein, they will edit their photos through apps such as Facetune and XingTu before posting them to the Internet to make them more beautiful (like enlarging their eyes, making themselves appear thinner, putting make-up on their faces). Therefore, this project aims to explore the difference between people in real life compared to their social media profiles through exploration of teens' self-perceptions and their thoughts around photo editing.

Methods

To explore themes of on and offline personality differences, I make use of the semi-structured interview method by asking open-ended questions that allow others to answer in a long passage in order to examine why and how participants present themselves online. These questions provide a large amount of interviewees' subjective opinions toward this topic. Additionally, depending on the answers from the participants, I can follow-up with additional questions based on their answers to previous ones, which is an advantage of semi-structured interviewing. The questions asked contained content aimed at exploring themes of photo editing and online or offline personality by observing different behavior of individuals acting in their lives.

Recruitment

As teenagers are the group of interest, I recruited participants between the ages of 16 to 18. I utilized snowball sampling to recruit friends and students at my school as well as family

members. Recruitment was contained to one large region of China.As a component of the larger study, I conducted autoethnography to self-reflect on my own experiences with social media as a means of comparison with the other participants. Autoethnography is an exploration of personal experience to understand cultural experiences.

Analysis

All interviews were recorded and transcribed for later analysis. To find patterns within the interview data, I use thematic analysis, a qualitative data analysis technique that allows me to observe patterns among participants. To carry out this analysis, I read through the interview transcriptions in order to identify larger themes present within the data. Also, by putting participants in my research paper, the audience can know better the participants' situations, which can be very helpful. I make use of an inductive and iterative approach on each participant's data, returning to the data throughout the analysis process to confirm my thematic interpretations. Also, I utilize affinity diagramming to visually organize and group my notes on the interview responses.

Results

Six participants completed the interview, including the author. Five of the participants identified as female, while one identified as male. All participants were teenagers between the ages of 16 and 18 with an average age of 17. All of them were born in and currently reside in Guangzhou, a large city in the southern region of China.

Autoethnography

Through an autoethnographic exploration, I consider my own responses to the interview questions. Personally, I spend about two hours a day on WeChat to chat with friends and view different photos they send. I sometimes send scenery photos in Wechat. Most of the time, I really care about if people like my photos and their comments on them. To make my photos appear more appealing and perfect, I will use the apps Polar or Lightroom to make edits to them (e.g., make the sunlight brighter, make the sea more blue, etc.).

The reason that I am pursuing this research topic is that I have observed some of my friends really care about how the selfies they post online are perceived. They usually complain about their appearances since they consider themselves ugly. They are too anxious to accept all parts of themselves. To relieve this appearance anxiety, they will use apps like Facetune to make their faces look more conventionally attractive, adhering to societal norms of beauty. It is common to see teenagers today making use of filters and editing photos before posting online. I've noticed people do not only edit selfies - individuals always want to beautify what they send to the Internet despite the type of media (e.g., landscape photos, selfies, videos). To show themselves in the best light, they will create a beautiful and idealized social media profile online.

On the Internet, everyone may be perfect. This also applies to myself - I like to present a more perfect persona online. While communicating with friends in person, I tend to be extroverted. However, when interacting with strangers in real life, I will become a totally different person who may be shy to talk with them. When I chat online with my friends, I often show more passion in my communication than I do offline. Funny emojis and words that might not be easily conveyed offline (e.g., responses to funny posts/online laughter) helps me have a better conversation with my net friends. Even so, when meeting net friends in real life, I think I would be shyer than I act in our online interactions. Therefore, I have a totally different personality online versus offline, which is also influenced by the type of people I am interacting with.

Social media use

All participants noted that their most frequently used social media platform is WeChat, an app for Chinese people to communicate and send photos online. These photos can be shared in small group messages or posted to a user's entire network of friends. Aside from WeChat, the interviewees pointed out that they also use other social media platforms including Weibo, Tiktok, Zenly, and Bilibili, which are apps for entertainment. In WeChat, participants had 325 friends on average, with a median of 200 due to one participant having around 1000 friends on this platform. The interview record shows that they spend about 2 hours and 30 minutes on WeChat every day, which emphasizes the significance of WeChat in their daily lives.

The six participants mentioned that in WeChat, they often interact with their close friends instead of family members or weaker-tie acquaintances since one or two close friends can better understand them (BBC, 2020). Among the interviewees, some of them are eager to post photos about their lives, and they usually post photos on WeChat twice a day. Some participants were less enthusiastic about posting photos, and they post seven times a day or even one month. On average, participants post photos every 12 days, with a range of two days to two months. Additionally, they will post different types of photos like landscape photos, selfies, group photos with friends, and photos about their daily lives including scenes such as going to a beach, climbing a mountain, and travelling to another city.

Photo alterations

Five out of six interviewees noted that they will add a filter onto their scenery photos to make the landscape appear more beautiful and vibrant. Some participants also discussed edits they make to photos of themselves, including things such as enlarging their eyes, making themselves appear thinner, and adding skin-whitening filters. These alterations are made to participants' selfies in order to appear as what they perceive as being more beautiful. These edits are achieved through the use of Polar, Lightroom, Facetune and Xingtu, a commonly used photo editing app in China. However, one of the participants believes that the original color can be the best, so he does not make any changes to his photos. The time spent on editing photos ranges from one minute to one hour or more, and the average time for editing is half an hour. Additionally, before sending the photos, some of the teenagers will send their photos to one or two of their close friends to ensure whether those photos look great. This is due to fear of the negative feedback from others online.

Negative Experiences

When teenagers are surfing the internet, it is possible for them to encounter some negative experiences. Only one participant discussed having a negative experience online. One day after she sent a selfie on WeChat, one of her friends on WeChat that she is not familiar with commented: "wow you look so white! What have you done on this photo?" This made my friend very angry because the person who comments indicates that she might not be as white and beautiful as the photo looks. Though she was angry and did not want to care about that person,

she still would notice if her photos are too white or not before sending them. The other participants in my interview did not have that negative experience. Negative experiences online may bring people who care about others' comments negative emotion.

Despite only one participant discussing a negative experience on social media, four out of six participants noted that they do care about the comments other people leave in response to their photos. One person commented that they would delete photos if they received strange comments. Two of the participants discussed being afraid that people might leave negative or bad comments on their photos. Only two participants were unconcerned about comments they could receive - one because he was confident in his photos, and the other because their online audience is friends who "send nice words".

Self-Presentation and Communication

The six teenagers held different opinions towards communication online and offline. I present a discussion of these differences, with a comparison of the two modalities.

Offline

Offline, participants noted that they have an easier time conveying their tones and seeing facial expressions in daily communication because they are facing people directly. Nevertheless, individuals need to consider what they are going to talk about since friends may have different opinions. If they hold different views toward an event, they may disagree with each other, which would destroy their friendship. Additionally, people are less brave in making new friends in their real life because it requires people to talk a lot to set up the relationship. Some of them will be more reserved and wait for strangers to start conversations since they are not an active participant. As online is quite different from offline, people may also be less expressive. They are afraid that if they laugh too much in front of strangers, others may consider them as strange people. Besides, emojis online can express more feelings than facial expressions made offline.

Online

When communicating with strangers online, some people suggest that they will be more enthusiastic since others may not see people's facial expressions, and they can avoid

embarrassment by sending various emoji. Also, they will be braver to express their feelings on the Internet than offline. Some of the participants pointed out that their online communication makes others think they are angry, even if they are not. Since words shown online may not show people's feelings, it can easily make others consider they are angry. All of the seven teenagers found that they tend to have a better personality online such as showing their happy lives by photos or videos and being more polite and warm-hearted. On the Internet, people always want to show a great social media profile that contains the best part of their personalities.

Discussion

We present findings from interviews with Chinese teenagers examining their social media use and self-presentation online versus offline. There are some general themes we have observed in the interview. Most of the teenagers were concerned with online appearance, and they expressed the desire to present the perfect aspect of themselves in front of people online. The majority of them use techniques like photo editing to improve their appearances. Some of them care about comments from people online, while others do not care since they believe that the most important thing is to bring themselves happiness, but not others. One of the participants described having a negative experience online, which affects their current social media use. When asked to compare their self-presentation online versus offline, participants noted they are able to express emotion and passion more easily online. When people are offline, people described being more shy when interacting with strangers and also less open with their emotions due to fear of being perceived as strange or too expressive.

The phenomenon of teenagers being very concerned with their appearance might not exist in other countries, but it is very serious in China since many of the teenagers struggle with appearance anxiety (Xi, 2021). There may be numerous cultural factors at play here that influence teens' anxiety. In China, lighter skin and thinner bodies are considered more beautiful than those with darker skin or larger bodies. Historically, this view of beauty has persisted for many generations (Yeung, 2016). Because of this, many teenagers edit their photos to become thinner and more white. This phenomenon also occurs in offline situations, with skin lightening products being commonly used (Zhang, 2020). Also, self-presentation comparison would appear:

people often post some beautiful selfies on the Internet, which may let teenagers compare themselves with others.

Although we have utilized semi-structured interviews to more deeply understand teenagers in China online and offline, there are still some limitations of this method. Since we only interviewed six teenagers, our sample size is too small to make any broad generalizations. Additionally, participants in the interview all resided in the same location, Guangzhou, and most of them know each other as friends and classmates and share similar ideas and beliefs. This suggests that we cannot generalize our results to teenader from different places with completely different thoughts and backgrounds.

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Drug Discovery Using Machine Learning and Data Analysis by Aida Fakhry

Abstract

Estrogen receptor-positive (ER+) breast cancer is the most common subtype of breast cancer worldwide [1]. This research paper targets the different methods questioning the binding to ERα promoting breast cancer proliferation. Primarily, the CHEMBL database was run through the default coronavirus drug discovery and then moved towards the discovery of expanding keywords into aromatase. Centers have approved therapies by aromatase or by modulating ERα. However, besides their therapeutic success, they induce several side effects and unknowns (regarding dosages).

Aim

The function of this research will focus on finding a compound (or a molecule) that will be able to inhibit the function of the aromatase enzyme. For the focus of this research the organisms that will be tested through the following data structure will be the aromatase enzyme [4]. Considering that aromatase activity and ERα display significant roles in breast cancer, the goal is to discover compounds able to simultaneously inhibit aromatase and modulate ERα [part of the cytochrome p450, which is responsible for breast cancer].

Methods

I used the ChEMBL Database through Python to retrieve all the known aromatase inhibitors (AIs) and ERα antagonists. Using the ChemAxon software, I computed two types of compounded organisms. Selected compounds were thoroughly analyzed by molecular docking. Anti-aromatase [stopping the production of estrogen in postmenopausal women] activity in the Database was evaluated in human placental microsomes and ERα expression was assessed [3].

Under the CHEMBL database, there are 2 single proteins under the “target_type” and the rest are Organsms [figure 1]. This was found after changing the target search to “coronavirus” and changing target_query = target.search to input (‘coronavirus’) instead of the default. This omitted difficulty for precise drug discovery.

[Figure 1]: Rendement of Target ID

	cross_references	organism	pref_name	score	species_group_flag	target_chembl_id	target_components	target_type	tax_id
0	[]	Coronavirus	Coronavirus	17.0	False	CHEMBL613732	[]	ORGANISM	11119
1	[]	SARS coronavirus	SARS coronavirus	14.0	False	CHEMBL612575	[]	ORGANISM	227859
2	[]	Feline coronavirus	Feline coronavirus	14.0	False	CHEMBL612744	[]	ORGANISM	12663
3	[]	Human coronavirus 229E	Human coronavirus 229E	12.0	False	CHEMBL613837	[]	ORGANISM	11137
4	[{'xref_id': 'P0C6U8', 'xref_name': None, 'xre...	SARS coronavirus	SARS coronavirus 3C-like proteinase	9.0	False	CHEMBL3927	[{'accession': 'P0C6U8', 'component_descriptio...	SINGLE PROTEIN	227859
5	[]	Middle East respiratory syndrome-related coron...	Middle East respiratory syndrome-related coron...	9.0	False	CHEMBL4296578	[]	ORGANISM	1335626
6	[{'xref_id': 'P0C6X7', 'xref_name': None, 'xre...	SARS coronavirus	Replicase polyprotein 1ab	4.0	False	CHEMBL5118	[{'accession': 'P0C6X7', 'component_descriptio...	SINGLE PROTEIN	227859

In this research project I will be examining the bioactivity for SARS coronavirus 3C-like proteinase (index number: (4)th entry on [Figure 1]). Beneath this, there will be a Target ID: 'CHEMBL3927'; note that this is the unique identification of the target.

[Figure 2]: Filter Set For Accurate Drug Discovery

activity = new_client.activity
res = activity.filter(target_chembl_id=selected_target).filter(standard_type="IC50")

The second filter following the "res" variable should set the standard_type to IC50 [Figure 2]

The second filter following the "res" variable should set the standard_type to IC50 [Figure 2]. Thus, when filtering out the selection within the CHEMBL database, IC50 will be chosen for the column type. IC50 will be used for this research as it is the most widely used and informative measure of a drug's efficacy. IC50 (half-maximal inhibitory concentration) indicates how much drug is needed to inhibit a biological process by half. This provides a measure of potency of an antagonist drug in pharmacological research [2]. By running this under df.head (or, due to the lengthiness of columns, you can set () to (3)), you can access "standard_type" and select "IC50." To access the unique values in this column, type in "df.standard_type.unique()." Notably, the only "unique" type for the dataset is IC50.

Before further examination of the "standard_value," it is essential to understand the notion of potency with each drug. I.e., on the first column the potency for IC50 is 7200.0. The lower the number, the better the potency of the drug, vice versa. The ideal finding within drug

discovery in the CHEMBL database is a high potency. In other words, the inhibitory concentration would be at 50%, thus having a low concentration. The ideal finding will ensure that there will be a drug that produces the same inhibition at 50% as a different drug but at a lower dosage. Notably, the bioactivity data is in the IC50 unit. Compounds having less than 1000 nM will be considered to be active while those greater than 10,000 nM will be considered to be inactive. As for those values between 1,000 and 10,000 nM will be referred to as intermediate.

Each compound will be described by a molecule CHEMBL ID (molecule_chembl_id) - each row represents one compound. Though, there may be instances in which multiple rows will contain the same molecule chamber ID. For simplicity and undeviating results, I will keep only one of them. To best ensure there is no redundancy, iterate/run a for loop under "canonical_smile," "molecule_chembl_id," and "standard_value."

[Figure 3] Target Search For Aromatase:

target = new_client.target
target_query = target.search('aromatase')
targets = pd.DataFrame.from_dict(target_query) targets

Switching target_query = target.search to target_query = target.search('aromatase') [Figure 3] switches the keyword to an enzyme as part of the cytochrome p450, which is responsible for breast cancer.

[Figure 4] Result From Target Search:

	Cross_references	Organism	Pref_name	Score	Species_group_files	Target_chembl_id	Target_components	Target_type	Tax_id
0	[{'xref_id': 'P11511',	Homo sapiens	Cytochrome	19.0	False	CHEMBL197	[{'accession':	SINGLE	9606

	'xref_name': None, 'xre...		P450 19A1			8	'P11511', 'component_description...	PROTEIN	
1	[{'xref_id': 'P22443', 'xref_name': None, 'xre...	Rattus norvegicus	Cytochrome P450 19A1	19.0	False	CHEMBL3859	[{'accession': 'P22443', 'component_description...	SINGLE PROTEIN	10116

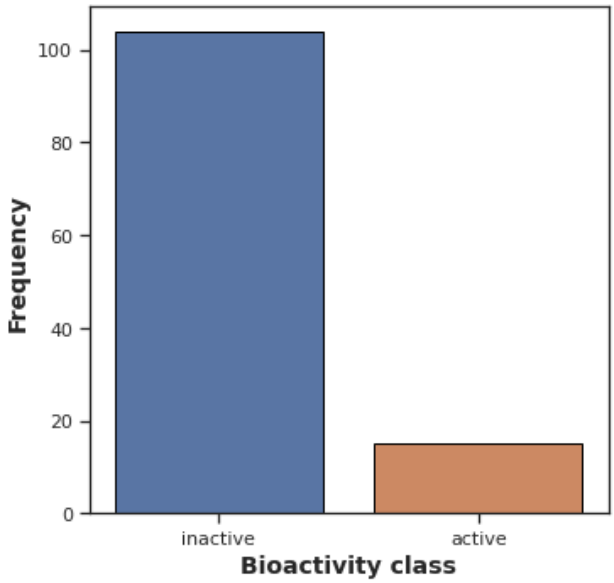
By running ‘aromatase’ within the variable target_query, the outcome for pref_name is Cytochrome P450 19A1. When running ‘rattus norvegicus’, the outcome for pref_name is also Cytochrome P450 19A1. Notably, the species group files are both false, and the target type are both singular. Thus, a fair prediction before analyzing data is that the potency of both organisms may be fairly close in results. Additionally, the p-value may be quite low - or even ‘null.’

Computing Molecular Descriptors [Testing Hypothesis]

Running the code cell for installing conda and rdkit are essential during drug discovery because they allow you to compute the molecular descriptors for the compounds that have been compiled through the download (the data set of biological activity from the CHEMBL database). This computation will be measured using molecules and smiles notation (which is the information about the chemical structure), in order to compute the molecular descriptors. IC50 will be used once again as a bioactivity class: active, inactive, and intermediate. During this drug discovery active and inactive compounds will be monitored. The lipinski (drug likeness of a compound) which is based on the Absorption, Distribution, Metabolism, and Excretion (ADME)

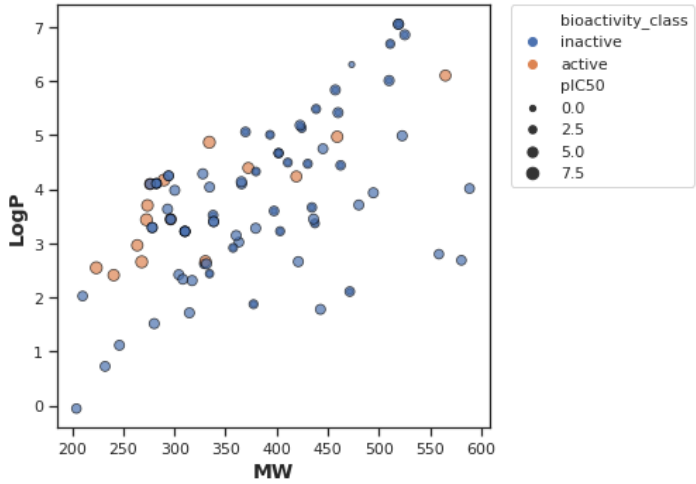
will be used to see whether the drug can be a.) absorbed by the body or b.) distributed in the body, and become metabolized.

[Figure 5]: Seaborn Importation



This figure is made from importing "matplotlib.pyplot as plt" under the seaborn importation. Both bioactivity classes are shown to compare the inactive and the active molecules within the drug.

[Figure 6: Scatter plot of MW versus LogP]



It can be seen that the 2 bioactivity classes are spanning similar chemical spaces as evident by the scatter plot of MW vs LogP. The distribution of the inactive and active class is expected because of the threshold of 5 and 6. In other words, if the pxc 50 > 6, it will be active, if pxc < 50, it will be inactive. Inactive: 1-5: Active: 6-7.

Mann-Whitney U Test [mannwhitney('pIC50')]:

The Mann-Whitney U Test was run to determine whether there is a statistical significance for the pIC50. As a result, the p-value is rather low (1.662636e-10) therefore, the hypothesis that the p-value would be "null" is rejected. Interpretive results based on running all four chemical space's via Lipinski descriptors: only LogP exhibited no difference between the active and the inactive, whilst the other three descriptors comprising of: MW, NumH-Donors, and NumHAcceptors.

Combining X and Y variable [CSV File Creation]

After downloading the CSV file (that contains combining x and y variables to the dataset), the model building begins. The target protein for this model building is acetylcholinesterase (a cholinergic enzyme). For simplicity, bioactivity data 3 (class pxc50) essentially tells us that it contains the bioactivity data information, comprising three categorical classes: active, inactive, and intermediate. For measurement, PubChem FP to determine the fingerprint - this becomes useful when simultaneous fingerprint data is used.

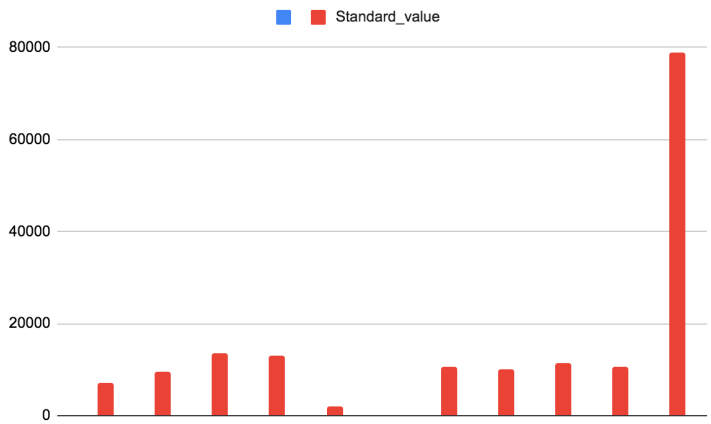
Input Features

Unique "fingerprints" within the database represent unique molecules. The unique properties of the compounds should be distinguished between compounds that are inactive and active. This will answer whether or not some drugs are potent (good) or not good (target variable: pIC50). Upon dropping (x = df.drop('pIC50, axis=1)), the results will be focused on pubchem fingerprints [Figure 7]. Furthermore, the tenth and fifteenth ranked features (i.e. PubChemFP804 and PubChemFP741) correspond to 3-sulfonyl phenol which according to the SMILES from its substructure description, seems to fit as a part of 4,4′-sulfonyldiphenol (Bisphenol S) (National Center for Biotechnology Information, 2020)

Building a Regression Model using Random Forest

model = RandomForestRegressor(n_estimators=100)
model.fit(X_train, Y_train)
r2 = model.score(X_test, Y_test) r2

Output Data [Conclusive Data Chart]:



Conclusion

Conclusively, the data supplies information that proves the theory that the dosages within ERα are enhanced to a level that can be reduced, further researched, and broken down into a lower dosage. Trends between active and inactive compounds were found through descriptive analysis which qualitatively and quantitatively addressed issues by further researching the CHEMBL database and QSAR model. ER activity prediction was evaluated via machine learning algorithms and several functions (classes) of fingerprint descriptors. This research paper proves that aromaticity, amine groups and aliphatic hydrocarbons are important for the active compounds. Moreover, ERβ should be examined thoroughly in relation to ERα. The knowledge

gained from this study serves as general guidelines for data-driven machine learning drug discoveries.

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Variation In Long-Term Performance And Improvement Based On Age At Which One Starts Competitive Swimming by Ishvi Mathai

Introduction

When it comes to competing at the highest levels in swimming, though, athletes are all subjected to similar workout regimens, training plans, and diets, some swimmers perform better than the rest. This research aims to find one governing factor that could contribute to this superior performance.This report was the output of an internship at Kellogg School of Management between March 20th 2021 and August 4th 2021.

Hypothesis

The age at which a swimmer starts competitive swimming training affects their performance. Swimmers who start their training very early on in their childhood (at the age of 6-7, the ages at which most US Olympic qualifying swimmers seem to have started) surpass their late-starting counterparts throughout their respective careers.

Data

For this project we collected our data from USA Swimming. We chose this as the United States can be considered as one of the leading nations at swimming, having won a third of all the Olympics Swimming medals ever. The database is extensive, swimming being a very popular sport in the United States. It is also comprehensive and open to public data mining. The first source of data was the Complete Results of the US Olympic Trials 2016. We chose this to retrieve the list of fastest swimmers in the country with the most varied ages and backgrounds. It also clearly separated male and female events, assisting our data extraction. The second source of data was the Individual Times Search Resource on the USA Swimming website, to get timings of each swimmer from all meets throughout their career.

Data Wrangling

We first converted the PDF pages of the Olympic Trials document into individual images of JPEG format, and then used OCR to recognise text from the images. We then cleaned up the

text file so as to get the complete list of swimmers who competed at the Olympic Trials 2016. After creating a CSV file with all the swimmers' names, we used geckodriver to simulate a browser, and use the names from the CSV file as input to download each swimmers' timings for all events at each age into individual excel sheets. Next, we processed each swimmers' starting age (age at which they began competitive swimming) and their timings at each age, for each event.

Since the mean gender performance gap between men and women is 8.9% for swimming races, and men remain faster than women [1], we decided to separate their data. Next, we segregated these results based on event and starting age to figure out patterns in these combinations, and created an individual excel sheet, with each swimmer's data in tabs, for each of these combinations.

Analysis

We chose age 7 as the early starting age and age 10 as the late starting age as these were the two ages with most data points and had a sufficient gap to reflect age-based differences. We then used a linear regression model to normalise the graphs and use the slopes to understand the rates of improvement.

Female Swimmers

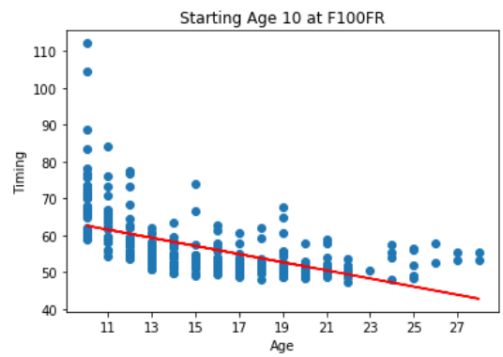
The following are comparisons between female competitive swimmers who started their careers at age 7 vs. age 10.

Freestyle events

From Fig. A and from the slopes (Coef) in graphs, in the 100FR events, we see that the early starting female swimmers (Rate of Improvement (RoI): 1.97) have a higher rate of improvement than their late starting (RoI:0.56) counterparts.

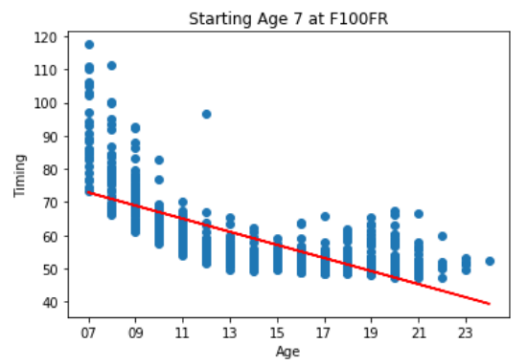
Seeing a similar trend in all other freestyle events from the 50m to the 800m (Fig A), taking 100FR as a representative for all freestyle events, we see that the early starters improve faster, and remain faster than the late starters throughout their careers.

```
Number of swimmers with Starting Age 10 in F100FR : 46
```




```
Coef: -1.1
```

```
Number of swimmers with Starting Age 7 in F100FR : 77
```



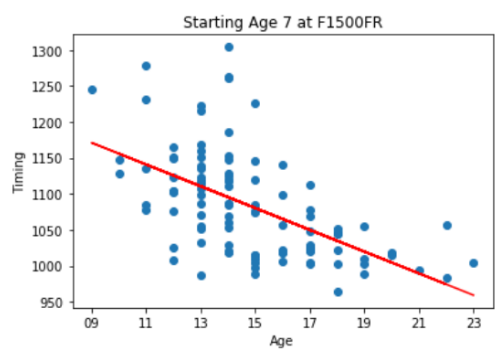

```
Coef: -1.97
```

However, in the case of long-distance freestyle event 1500m, we see that the late starters (RoI:19.93) have a much higher rate of improvement than the early starters (RoI:15.13), deviating from our initial hypothesis.

```
Number of swimmers with Starting Age 10 in F1500FR : 21
```


```
Coef: -19.93
```

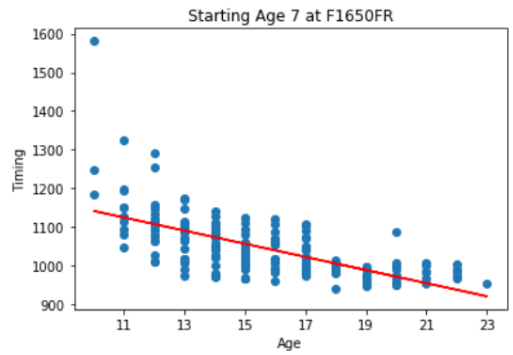
```
Number of swimmers with Starting Age 7 in F1500FR : 47
```




```
Coef: -15.13
```

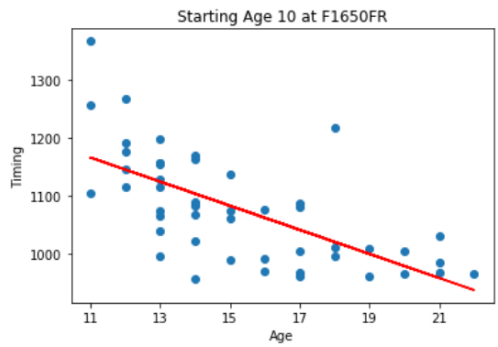
We also see similar results for the 1000yd and 1650 yd events, where late starters (RoI: 12.39,20,82 respectively) have a higher rate of improvement than the early starters (RoI: 9.42,16.98 respectively)

Number of swimmers with Starting Age 7 in F1650FR : 59



Coef: -16.98

Number of swimmers with Starting Age 10 in F1650FR : 22



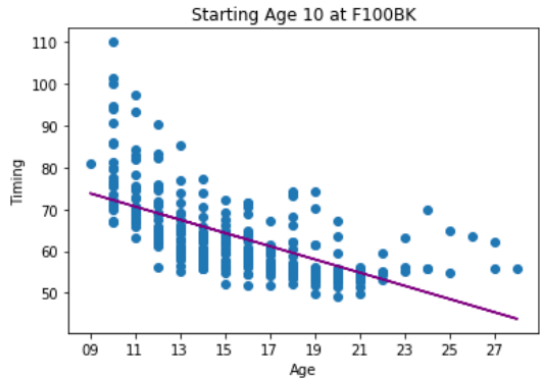
Coef: -20.82

It is interesting to note that although 1500m and 1650 yd are essentially the same distance, the only difference being that the 1500m swim takes place in a long course (50m) pool and the 1650 yd swim takes place in a short course (25yd) pool, in Fig A you can see that both early and late starters show higher rates of improvement (RoI:16.98, 20.82 respectively) in the 1650 yd event as compared to the 1500m (RoI:15.13,19.93 respectively) event.
This result could be attributed to the fact that most training occurs in yard pools resulting in a familiarity with the pool length, or that the summation of the greater number of turns and push offs in a smaller pool contribute to exponentially faster timings as swimmers improve their turns as they grow older. The takeaway from this could be that swim times at the 1500m event could further be reduced if the swimmers are given adequate exposure to the longer 50m pools during training.

Backstroke events

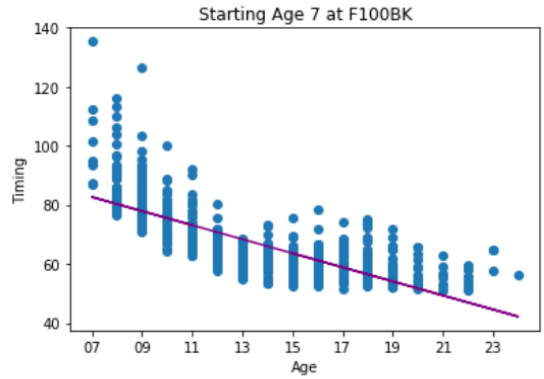
In the backstroke events in Fig. A, we find that the early starters (RoI: 1.49,2.38,2.92 respectively) do better than the late starters (RoI: 0.94,1.58,2.22 respectively) in all the three distances: 50BK, 100BK, 200BK. However, it can also be seen that the late starters (RoI:2.22) perform better in the 200BK event, relative to the early starters (RoI:2.92), compared to the RoI difference in the other distances. This seems to indicate that late starters gain advantage as the distances get longer.

Number of swimmers with Starting Age 10 in F100BK : 47



Coef: -1.58

Number of swimmers with Starting Age 7 in F100BK : 77



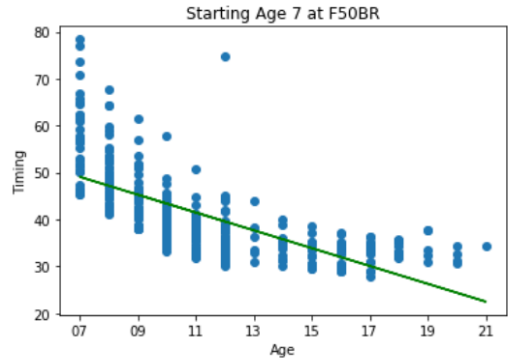
Coef: -2.38

Breaststroke events

Like in the backstroke events, in fig. A, we see that the early starters (RoI: 1.9,2.7,3.48) do better than the late starters (RoI:0.78,1.83,2.97) in all the three distances: 50BR, 100BR, 200BR.

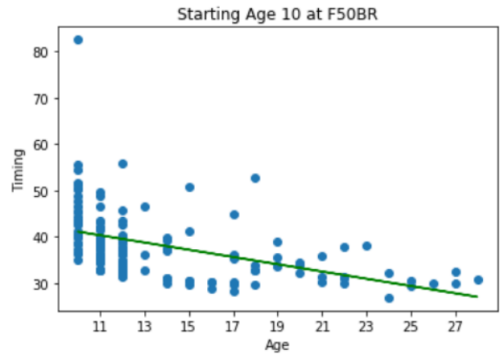
The difference in RoI between late starters (RoI: 2.97) and early starters (RoI:3.48), I 200BR relative to the shorter distances, is less – again suggesting that late starters have an advantage as the distances get longer.

Number of swimmers with Starting Age 7 in F50BR : 77



Coef: -1.9

Number of swimmers with Starting Age 10 in F50BR : 45



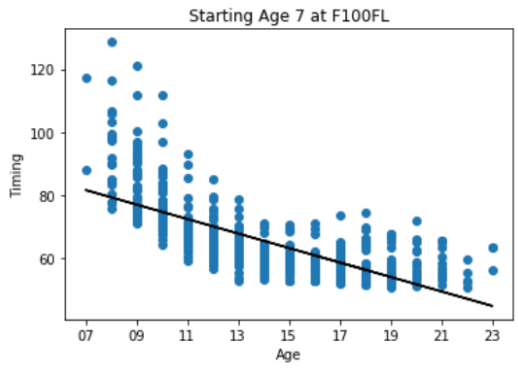
Coef: -0.78

Butterfly events

In this stroke as well, we see that early starters (RoI:1.6,2.3,3.24) have a clear advantage over the late starters (RoI:0.81,1,19,2,38). Interestingly, while the RoI of the early starters is

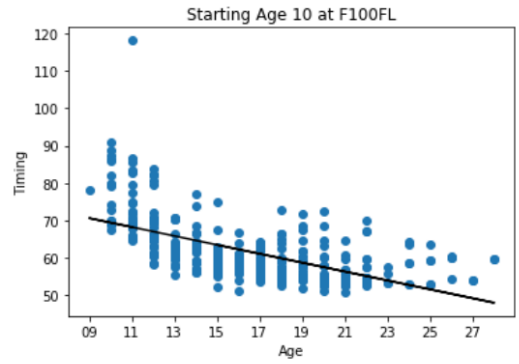
nearly twice as much as the late starters in the 200FL event, the difference between their slopes reduces, indicating once again the gaining advantage of late starters in longer events.

```
Number of swimmers with Starting Age 7 in F100FL : 77
```




```
Coef: -2.3
```

```
Number of swimmers with Starting Age 10 in F100FL : 47
```

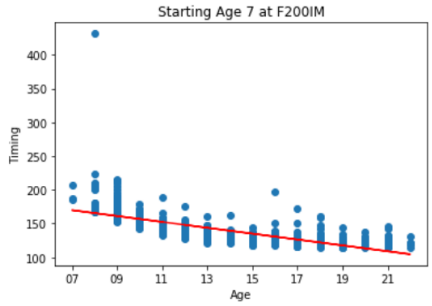



```
Coef: -1.19
```

Individual medley events

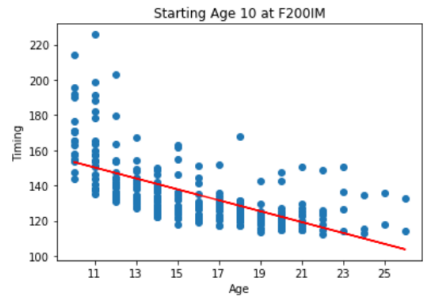
From fig. A, we see that in the 200IM, we see that the early starters (RoI:4.35) have a higher rate of improvement than the late starters (RoI: 3.1), consistent with our hypothesis.

```
Number of swimmers with Starting Age 7 in F200IM : 75
```




```
Coef: -4.35
```

```
Number of swimmers with Starting Age 10 in F200IM : 43
```




```
Coef: -3.1
```

However, in the 400 IM event, we see that the late starters (RoI:5.66) are faster than the early starters (RoI: 5.18). These patterns seem to indicate the gaining advantage of late starters as the distances get longer.

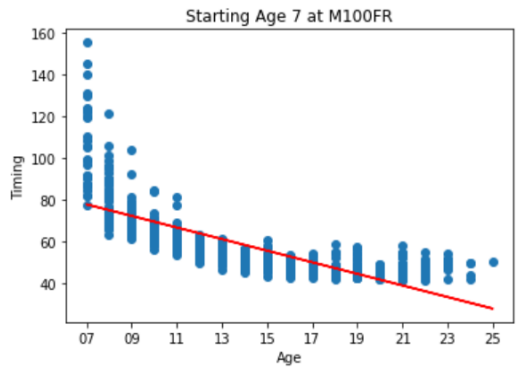
Male Swimmers

Following are comparisons between male competitive swimmers who started their careers at age 7 vs. age 10.

Freestyle events

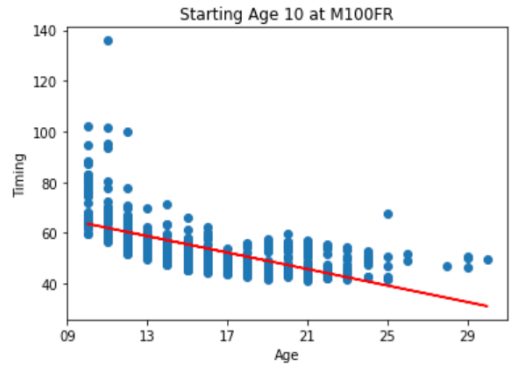
From fig. A we see that the early starters (RoI: 1.25) have a clear advantage over the late starters (RoI: 0.74). We also see that the difference between the rates of improvements decreases slightly as the event distances increase.

```
Number of swimmers with Starting Age 7 in M100FR : 71
```




```
Coef: -2.78
```

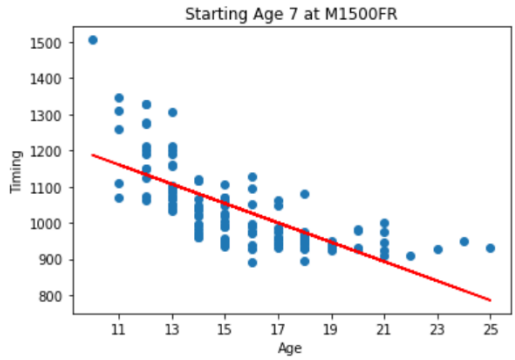
```
Number of swimmers with Starting Age 10 in M100FR : 77
```




```
Coef: -1.63
```

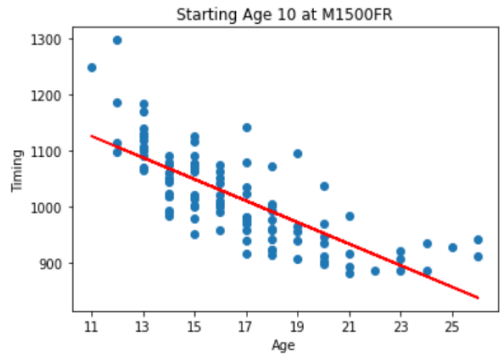
In the 1000FR, 1500FR and 1650FR events, we do not see the same results as we did for the female swimmers. The early starters (RoI: 15.39,26.76,28.13) continue to see an advantage over the late starters (RoI:11.27,19.23,22.89) in the long-distance freestyle events.

```
Number of swimmers with Starting Age 7 in M1500FR : 41
```




```
Coef: -26.76
```

```
Number of swimmers with Starting Age 10 in M1500FR : 36
```



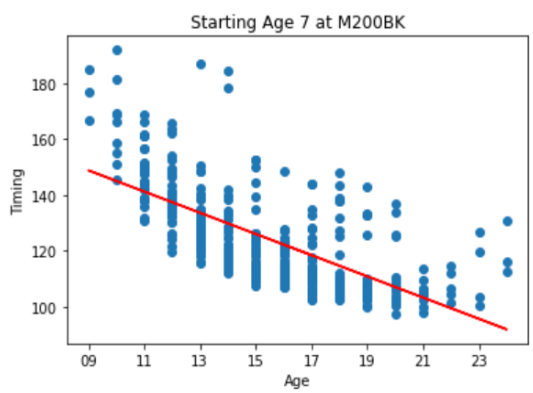

```
Coef: -19.23
```

But we do see that the RoIs of both early starters (28.13) and late starters (RoI:22.89) are higher in the 1650 yd event as compared to the 1500m, even though they're both the same distance. This result could be attributed to the fact that most training occurs in yard pools resulting in a familiarity with the pool length, or that the summation of the greater number of turns and push offs in a smaller pool contribute to exponentially faster timings as swimmers improve their turns as they grow older. The takeaway from this could be that swim times at the 1500m event could further be reduced if the swimmers are given adequate exposure to the longer 50m pools during training.

Backstroke events

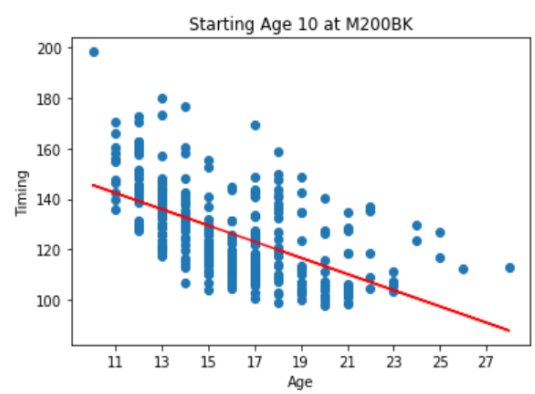
In fig. A, the early starters (RoI:1.82,2.84,3.8) seem to have a consistent advantage of the late starters (RoI:1.49,2.38,3.21) in all backstroke events: 50BK, 100BK, 200BK.

```
Number of swimmers with Starting Age 7 in M200BK : 66
```




```
Coef: -3.8
```

```
Number of swimmers with Starting Age 10 in M200BK : 66
```

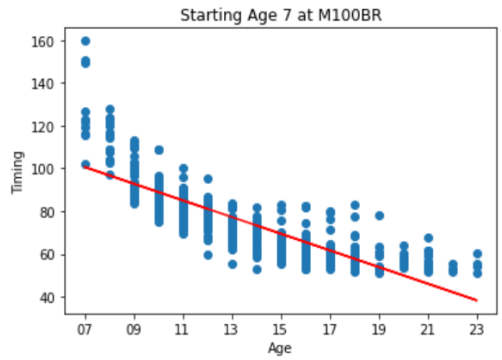



```
Coef: -3.21
```

Breaststroke events

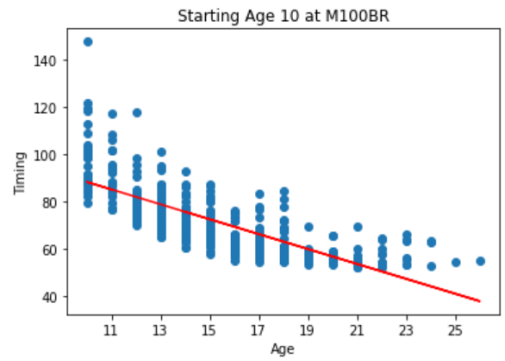
Fig A shows that the early starters (RoI:2.16,3.9,5.52) have a clear consistent advantage over the late starters (RoI:1.52,3.15,4.71) in the 50BR, 100BR, 200BR events here as well.

Number of swimmers with Starting Age 7 in M100BR : 64



Coef: -3.9

Number of swimmers with Starting Age 10 in M100BR : 73

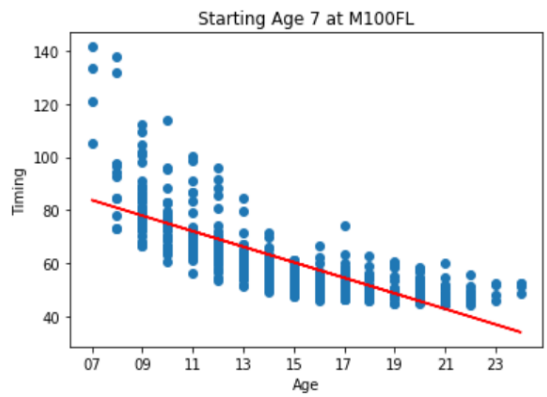


Coef: -3.15

Butterfly events

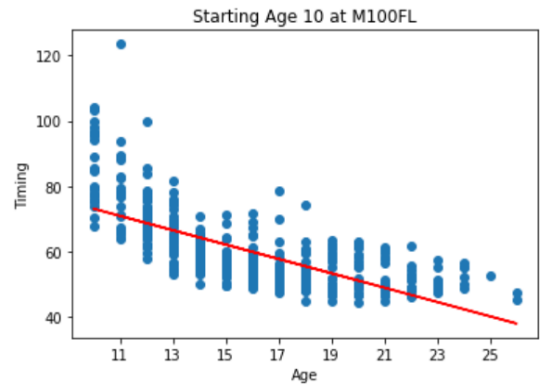
In fig A, we see that the early starters (RoI:1.87,2.92,4.65) have an advantage very similar to the one we saw for the breaststroke events over the late starters (RoI:1.25,2.2,3.7) in the butterfly 50FL,100FL, 200FL events.

Number of swimmers with Starting Age 7 in M100FL : 65



Coef: -2.92

Number of swimmers with Starting Age 10 in M100FL : 69

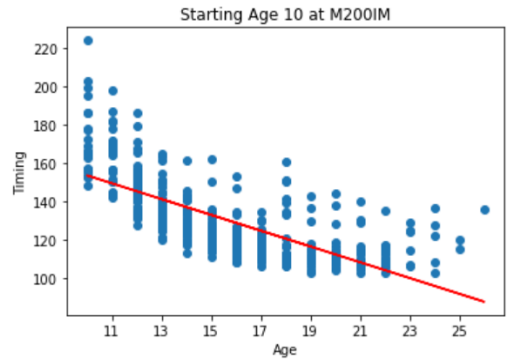


Coef: -2.2

Individual medley events

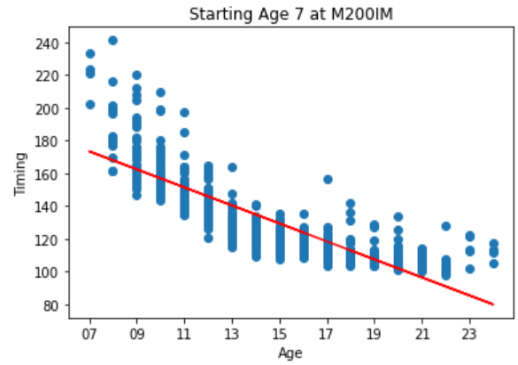
Just like with the female swimmers, in fig. A, we see that the early starters (RoI:5.5) have a better rate of improvement than the late starters (RoI: 4.12) in the 200IM event.

```
Number of swimmers with Starting Age 10 in M200IM : 69
```




```
Coef: -4.12
```

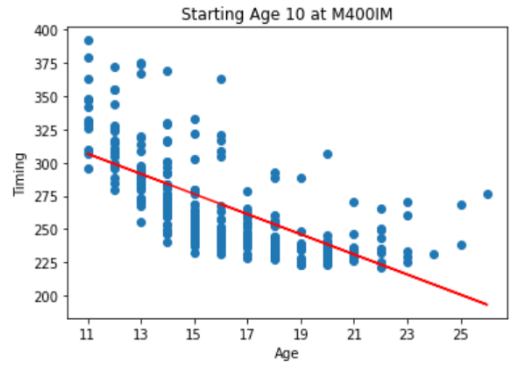
```
Number of swimmers with Starting Age 7 in M200IM : 66
```




```
Coef: -5.5
```

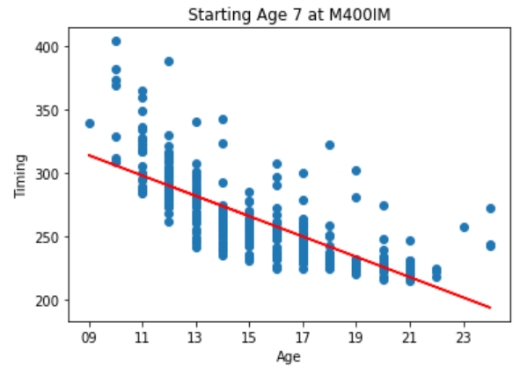
However, contradictory to the female late starters, the male late starters (RoI:7.56) do not have an advantage over the male early starters (RoI:8.0) in the 400IM event.

```
Number of swimmers with Starting Age 10 in M400IM : 62
```




```
Coef: -7.56
```

```
Number of swimmers with Starting Age 7 in M400IM : 63
```




```
Coef: -8.0
```

Conclusion

We see that the male swimmers are faster than the female swimmers and the early starters are, for the most part, faster than the late starters. Late start females tend to fare better in the longer distances, and are faster than the early starters in the longest, most challenging events: 1500m and 1650yd freestyle and 400 IM. For the male swimmers, we see that the early starters are faster than the late starters in all events. We also see that, unlike the female late starters, the male late starters do not seem to have an advantage in the longer distances; RoI of early start swimmers is clearly and consistently better across all events.

Another result that we observed is that all swimmers show a better rate of improvement in the 1650yd freestyle as compared to the 1500m freestyle although both events require swimmers to complete essentially the same distance. As mentioned before, this result could be attributed to a familiarity with the pool length in the 1650yd event, or that the summation of the greater number of turns and push offs in a smaller pool contribute to exponentially faster timings as swimmers improve their turns as they grow older.

Based on starting ages of swimmers, coaches can plot their timings relative to these graphs to figure out what their best timing at a certain future age would be. Considering that female late starters have an advantage in the longer distances, it might be beneficial to train them in those events. Coaches can explain the early specialization advantage to parents of young boys, so they can start swimming sooner rather than later. Coaches can also increase the workout times in the 50m pool to give longer distance event swimmers an edge in competition season.

Figure A

Event	No.	F7	No.	F10	No.	M7	No.	M10
50FR	77	1.02	47	0.56	75	1.25	80	0.74
100FR	77	1.97	46	1.1	71	2.78	77	1.63
F200FR	75	3.87	43	2.49	67	4.73	75	3.18
F400FR	71	6.43	35	5.34	62	8.78	58	6.03
F800FR	55	8.94	24	7.77	46	13.76	44	10.17
F1000FR	61	9.42	31	12.39	55	15.39	52	11.27
F1500FR	47	15.13	21	19.93	41	26.76	36	19.23
F1650FR	59	16.98	22	20.82	50	28.13	45	22.89
F50BR	77	1.9	45	0.78	66	2.16	72	1.52
F100BR	75	2.7	45	1.83	64	3.9	73	3.15
F200BR	74	3.48	36	2.97	61	5.52	65	4.71
F50BK	77	1.49	47	0.94	71	1.82	76	1.49
F100BK	77	2.38	47	1.58	66	2.84	76	2.38
F200BK	77	2.92	47	2.22	66	3.8	66	3.21
F50FL	77	1.6	47	0.81	68	1.87	74	1.25
F100FL	77	2.3	47	1.19	65	2.92	69	2.2
F200FL	77	3.24	47	2.38	59	4.65	61	3.7
F200IM	75	4.35	43	3.1	66	5.5	69	4.12
F400IM	74	5.18	35	5.66	63	8	62	7.56

No. - the number of swimmers who participated in the event for that starting age.

F7-rate of improvement for females with starting age 7;

F10-rate of improvement for females with starting age 10;

M7-rate of improvement for males with starting age 7;

M10-rate of improvement for males with starting age 10;

Green-Events where late starters perform better;

Red-Events where female late starters perform better than early starters, but same result is not seen with male swimmers

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2016-complete-trials-results.pdf (usaswimming.org) - 2016 U.S. Olympic Team Trials - Swimming - 6/26/2016 to 7/3/2016 Results, to get the list of the fastest swimmers in the US

A Closer Look at Women's Artistic Gymnastics Through the Lens of Physics by Mridula Shanker

About The Author

Mridula Shanker is a senior at Great Valley High School in Malvern, PA. She has competed in artistic gymnastics for over 10 years and secured multiple awards in various YMCA League/State championships. She is a Guinness World Record (GWR, London) holder in "The most tick-tock gymnastic moves". Recently, she has completed AP Physics and is thrilled to connect her experience in gymnastics with various principles and laws of physics.

Acknowledgement

I would like to express my sincere thanks to Mr. Robert Johnson, AP Physics Teacher at Great Valley High School in Malvern, PA. The way he taught us the AP Physics course has inspired me to interlink the various concepts and application of physics with real-world scenarios. I appreciate his tremendous effort and continuous support in guiding me through this exciting project. I'd like to convey my heartfelt appreciation to Ms. Murdina Misson, Head Coach and Ms. Shawna Cliff, Coach at Phoenixville YMCA who trained me in artistic gymnastics for over eight years.

Abstract

Women's artistic gymnastics is one of the three disciplines in the sport of gymnastics that demands extreme upper and lower body strength, power, flexibility, muscular endurance, combined with speed and agility. To be a gymnast, it takes balance, kinesthetic awareness, coordination and many more special skills. Gymnastics intertwines the concepts of physics with artistic innovation. The four major women's gymnastics events are vault, uneven bars, balance beam, and floor exercise, which all involve combinations of physics principles. Differences in the anthropometric measurements and physical characteristics of gymnasts in terms of mass, height and strength significantly influence the performance outcome. Every skill a gymnast performs is based on physics in some aspect, therefore understanding and appreciating the principles of physics in gymnastics maneuvers is critical. The aim of this review is to increase

the awareness and understanding of how various physics concepts are associated with and influence the performance of women's artistic gymnastics moves.

Introduction

Though incredibly challenging, women's artistic gymnastics is one of the most popular sports in the USA. Courage, strength, power, flexibility, balance, agility, speed, and a combination of technical perfection and creative inventiveness are all integral components of women's artistic gymnastics (Jemni et al.; Zetaruk). From the perspective of physicist's, it is a sport that exemplifies a wide spectrum of physics principles . In fact, physics is such a fundamental part of gymnastics that every gymnastics skill is observed with a combination of multiple theories, principles and laws of physics. Studies show that gymnasts' anthropometric measures and physical features, such as BMI, mass, height, and strength, have a substantial impact on their performance (N. K. Pollock et al.; Sinning). Greater body size and body fat, periods of rapid growth, and more life stress are all linked to an increased injury risk in female gymnasts (Caine and Nassar). For instance, it is critical to understand the link between moments of inertia and the competitive advantage with shorter gymnasts who generate high power-to-mass ratios (Ackland et al.). Although our grasp of gymnastics principles and foundations have increased, there are still gaps in our knowledge of how various physics concepts are applied to different gymnastics skills and influence the performance outcome. This review attempts to describe a few basic physics concepts embedded in all four events of Women's artistic gymnastics, in the order that they are performed at the Olympics.

Vault

Vault is a short-burst event where a gymnast sprints to the vault table and blocks off the apparatus to perform flips and twists in the air. For women gymnastics, the vault table is about 1.25 meters (4.10 feet) high (*USA Gymnastics | USA Gymnastics*). Front handspring is one of the key skills in vault. To perform this skill, the gymnast runs down the runway, jumps on the springboard, blocks off the horse in a handstand, and finally lands her feet on the landing mat. There are four key parts to nail this vault: run, board-hit, pre-flight, and post-flight (Dupuis). The basic physics principles associated with the front handspring are described in detail.

Kinetic Energy

The gymnast's total kinetic energy is calculated by her run (Figure 1, position A) with the equation K.E. = 1/2 mv^2 (where m = mass and v = velocity). The horizontal energy generated by running to the vault table is converted into the energy the gymnast uses to get the necessary height and velocity off the vault table, which is required to execute acrobatic movements in the air (Kubota).

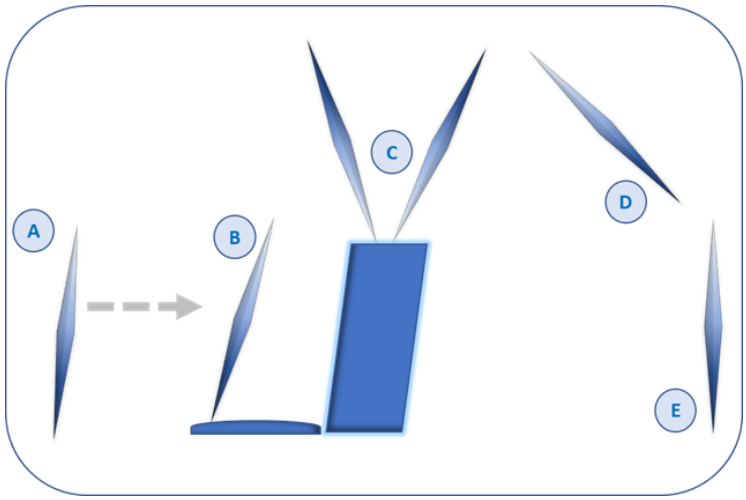

Figure 1: Demonstrates a gymnast performing a front handspring on vault. A to E are the various positions involved in this skill, described in the text. Lighter and darker end of the rhombus represent the anterior and posterior end of the gymnast respectively

Force, Hooke's law, Newton's 2nd Law

The second section, or board-hit (Figure 1, position B), is used to calculate the force the gymnast creates. To calculate the gymnast's force on the springboard, Newton's 2nd law is used: F = ma (where m = gymnast's mass and a = acceleration). The amount of force created on the springboard will vary, and it is proportional to each gymnast's mass and acceleration. For example, a gymnast with a smaller mass has to run quicker to achieve the same amount of force as a gymnast with a larger mass (Dupuis). The gymnast jumps onto the vault using a springboard. According to Hooke's Law, the force required to stretch a spring is proportional to the length that the spring stretches (Sands et al.)**.** Elastic Potential Energy is the energy stored in an elastic object, such as a spring, and is defined by $PE=1/2kx^2$**.** To achieve an optimum force and energy, different types and quantities of springs are utilized to suit each gymnast. During the pre-flight (Figure 1, position C), gymnasts must get an effective block off the vault by maintaining a very specific body position. The shoulders act like springs, so even if the gymnast bends them slightly, the energy will be absorbed and the vault is ruined. In order to achieve a

successful block and move upward, the gymnast must keep her arms as straight as possible and push off with her shoulders (Dupuis).

Center of Mass, Torque, Newton's 1st and 3rd Law

Finally, during the post-flight (Figure 1, position D), the gymnast's body follows a parabolic path, with her hips as the center of mass. Gymnasts utilize torque to obtain the appropriate rotation speed (Koh and Jennings). A combination of the gymnast's initial upward velocity, from her block, and gravity's downward acceleration allows the gymnast to flip in the air and land back on the ground. This supports Newton's First Law since there is no other force on the gymnast in the x-direction and gravity plays a role in the y-direction (Dupuis). Finally, the landing (Figure 1, position E) supports Newton's Third Law: as the gymnast lands the skills on the ground, the landing mat compresses. Since the mats are soft and flexible, they absorb a large amount of force, indicated by the depth of compression. Within this single vault, Newton's first, second, and third law are put into play (Dupuis).

Uneven Bars

The uneven bars consist of two horizontal bars positioned at different heights. They are sometimes referred to as "uneven parallel bars," "asymmetric bars" or simply the "bars." (Deusen). The top bar is usually about 2.4 meters (7.8 feet) above the floor, while the lower bar is 1.65 meters (5.4 feet) high (*USA Gymnastics | USA Gymnastics*). The most recognizable skills on uneven bars are release moves, pirouettes, and circles. A giant is a "circle" skill in which the gymnast revolves 360 degrees around the bar in a fully extended handstand position. It is often used to gain momentum and increase the gymnast's rotational speed to perform other skills such as releases or dismounts (Deusen). The basic physics concepts embedded within the giant are analyzed further.

Friction

Friction occurs when one surface rubs against another and resists motion between the objects in contact (Kurtus). Before the bars are used, the bars themselves and the gymnast's hands/grips are typically coated with a combination of chalk and water. The chalk coating

enables the gymnast's hands to glide smoothly over the bars, while concurrently providing enough friction for the gymnast to grip the bar (TechWise).

Potential & Kinetic Energy, Torque

The principle of torque, a rotational force around an axis, is applied when a gymnast swings around the bar in a giant. The gymnast stores the highest amount of potential energy when she is in a handstand on top of the bar (Figure 2, position A). Though she has no more potential energy at the bottom of her swing, she has enough kinetic energy and torque to overcome gravity and continue swinging back to the top of the bar (Figure 2, position C). As she starts to swing down, gravity helps her accelerate and convert her potential energy into kinetic energy.

Angular Momentum

Due to frictional forces, a single energy input in the giant will progressively reduce the gymnast's speed. The gymnast's goal, on the other hand, is to go all the way around the bar and increase her angular speed. To swing higher and faster, the gymnast must add energy to the skill (Allain). To add energy, the gymnast has to exert a force as her center of mass moves. In general, the work done on an object can be calculated as $W = Fd\cos\theta$: "d" is the distance traveled by the object and "θ" is the angle between the force and the direction of motion of the object (Allain). As the gymnast's center of mass travels in a circle, a force needs to pull her towards her center of rotation. To accomplish this, the gymnast pulls the bars as she swings down, creating energy to continue around the bar (Figure 2, position B). This energy comes from the gymnast's muscles and goes into the rotational kinetic energy of his motion (Allain). The gymnast's speed will increase with each subsequent time she reaches the bottom of the gigantic.

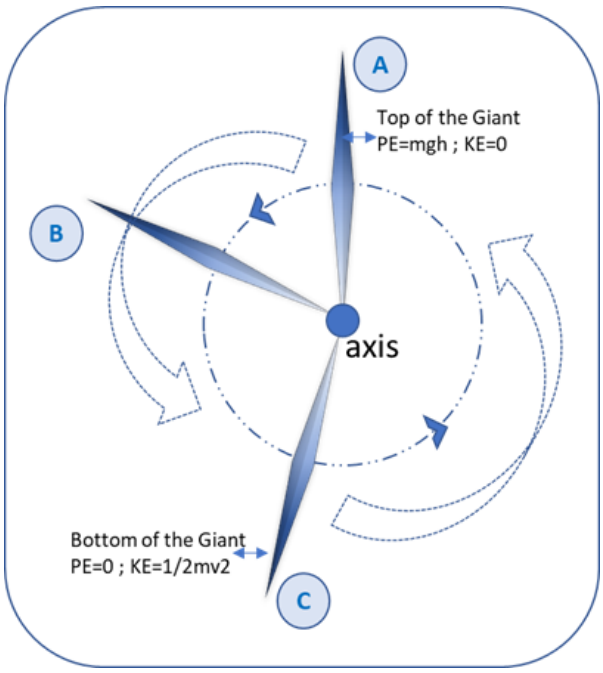

Figure 2: Demonstrates a gymnast performing a giant on the uneven bars. A to C are the various positions involved in this skill, described in the text. Lighter and darker end of the rhombus represent the anterior and posterior end of the gymnast respectively

Centrifugal Force

Centrifugal forces allow the gymnast to perform other skills by utilizing the energy created from the giant. A centrifugal force is "the apparent force that is felt by an object moving in a curved path that acts outwardly away from the center of rotation" (Lucas). During a giant, the gymnast will revolve around the bar several times to accelerate. When the gymnast lets go of the bar, it breaks the centrifugal force. The gymnast will fly in the direction of the linear velocity at the time of release to catch the next bar or dismount (TechWise).

Centripetal Force

Centripetal force is "the force that is necessary to keep an object moving in a curved path and that is directed inward toward the center of rotation" (Lucas). On bars, the centripetal force is generated by the gymnast's grip on the bar, and the bar itself is the point the gymnast is pulled towards (Physics Projects). Centripetal and centrifugal forces are the exact same force but in opposite directions, considering they are experienced from distinct frames of reference (Lucas).

Balance Beam

The balance beam is a long thin surface, typically about 4 inches wide and 4 feet high. Handsprings, saltos, turns, and jumps are all gymnastics skills that are common to beam routines (USA Gymnastics | USA Gymnastics). The technical manipulation of friction, understanding of torque, and awareness of the gymnast's own center of mass are all important factors in allowing the gymnast to successfully perform skills on this apparatus. As it is the easiest event to fall off of, doing challenging skills needs great body and spatial awareness. The basic concepts of physics related to balance beam skills are discussed here.

Center of Mass & Torque

When completing skills on the beam, the gymnast's center of mass must always be above her base of support, usually her hands or feet, to avoid falling off. Usually, the center of mass is near the gymnast's belly button, but it could vary depending on the gymnast's height or mass (Dupuis). A gymnast must be aware of her body position in relation to her surroundings during all her skills in order to land without wobbles. Since the apparatus is only 4 inches wide (10 centimeters), there is very little room for error. If the gymnast lands a skill slightly to one side of the beam, her center of mass will shift. As the gymnast leans more to one side, a greater amount of torque is created. This will either create a "wobble", which will be a deduction to her score, or she may fall off completely (Nugteren). To combat this torque, the gymnast must realign her center of mass. There are two basic ways gymnasts are inherently taught to accomplish this. First, the gymnast will squat down to lower her center of gravity. When her center of gravity is low, the gymnast can lean further to one side without creating enough turning force to tip her over completely and she's able to recover her balance (Physics100 Project). Next, the gymnast may extend the opposite arm or leg from where she's leaning to bring her center of mass back over the beam. This action produces a tipping force in the opposite direction that keeps her balanced. It also redistributes the gymnast's weight and places her center of mass back over the beam (Physics100 Project). If her center of mass is too far over, she will fall off entirely due to gravity, and these two techniques will not be effective.

Friction

Friction opposes the relative motion of two surfaces that are in contact with each other. There are two types of friction used on the beam: sliding friction and static friction. Static friction prevents the object's motion while it's at rest, while sliding friction resists an object's motion while it's moving (CK12 Foundation). Current balance beams are covered with rubber or leather to increase the friction coefficient to prevent the gymnasts from slipping off the equipment (TechWise). Typically, the beam and the gymnast's hands are coated in chalk. The chalk increases the sliding friction between the gymnast and the balance beam to help the gymnast turn and flip with ease. Static friction prevents the gymnast from moving too easily and helps the gymnast grip the beam (Weng). Static friction must be overcome to allow sliding friction to play its role. There are several factors that influence the force of friction, including the gymnast's mass and material of the object. The greater the gymnast's mass, the greater the gymnast presses against the surface of the beam, resulting in a greater static friction (Weng). So, a person with greater mass will have to overcome greater static friction to begin to accelerate. The material of the surface also influences the force of friction. Surfaces that are slippery have less opposing force to motion, making it easier to move, thus decreasing the sliding friction (Weng).

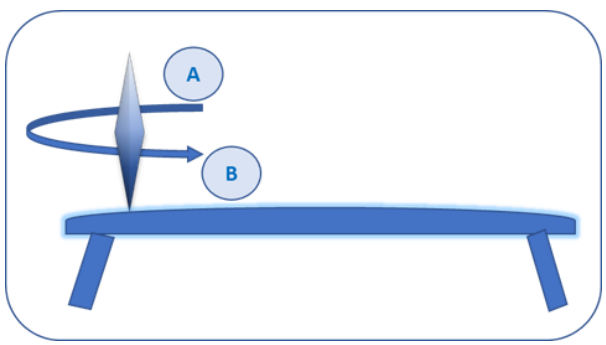

Figure 3: Demonstrates a gymnast performing a full turn on balance beam. A to B are the various positions involved in this skill, described in the text. Lighter and darker end of the speckle represent the anterior and posterior end of the gymnast respectively

Angular Velocity, Conservation of angular momentum & Inertia

On balance beam, several concepts can be identified with a simple full turn. To perform this skill, the gymnast turns in a complete circle on one leg in relève position (Figure 3, position A to B). As the gymnast begins to turn, she draws her arms inward and above her head. She also moves her free leg inward into either her ankle or knee. This combination of inward movement

from her arms and legs increases the angular velocity of the turn (Dupuis). This technique is an example of the conservation of angular momentum. The gymnast's moment of inertia decreases as she brings her arms and legs inward, and her angular velocity increases, allowing her to perform the full turn successfully (Dupuis). At the end of the turn, her arms drop to her sides, and the free leg straightens in front of her to increase her moment of inertia and decrease her angular velocity. This final motion allows the gymnast to slow down and finish squarely on the beam.

Floor Exercise

An Olympic floor exercise mat is required to be 12 meters by 12 meters, or about 40 by 40 feet (USA Gymnastics | USA Gymnastics). The floor exercise is composed of a layer of carpet that covers a matrix of small springs (Dupuis). This provides the floor with surface elasticity, allowing the gymnast to perform extraordinary tumbling skills. Handstands, Cartwheels, Round-Offs, and Walkovers are only some of the basic skills associated with floor exercise. The relationship between floor skills and the laws of physics are illustrated further.

Hooke's Law

The material of the floor itself is key to the gymnast's performance and ability to perform skills. Elastic Potential Energy is the energy stored in an elastic object, such as a spring, and is defined by $PE=1/2kx^2$**.** This concept is Hooke's law: k measures the stiffness and strength of the spring floor, and x is how far the spring is displaced by the impact (McInerney and Kelley). When the gymnast jumps on the floor, there will be a point when the energy she expends is less than the energy the floor stores. At this moment, the spring floor will return the gymnast's energy and propel her into the air, allowing her to do flips and twists (McInerney and Kelley). Newton's third law states that "when one body exerts a force on a second body, the second body simultaneously exerts a force equal in magnitude and opposite in direction on the first body". If gymnasts tumbled on a hard surface, such as concrete, the force that the gymnast drives into the ground would be reflected back very fast, which is dangerous to the gymnast (McInerney and Kelley). The Gymnova floor that gymnasts usually tumble on is " a layer of carpeted foam, on a layer of plywood that is supported by an array of springs". These layers lengthen the duration of

the impact and spread the overall force applied to the gymnast across a longer period of time, which prevents injury (McInerney and Kelley).

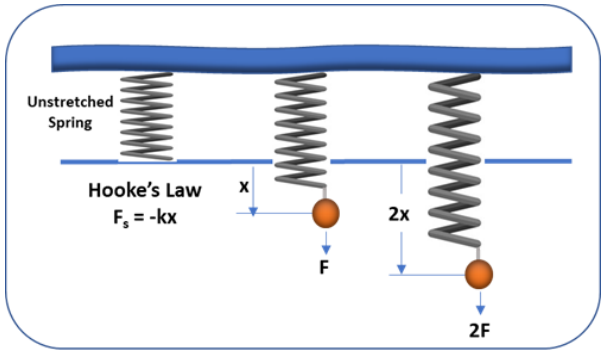

Figure 4: Schematic representation of Hooke's law, to demonstrate the relationship between the force applied to an unstretched spring and the amount the spring is stretched. Fs - spring force, k – spring constant, and x amount of extension. The negative sign indicates that the force is always directed opposite to the displacement

Law of Conservation of Energy

The law of conservation of energy states that energy cannot be created nor destroyed. The gymnast redirects her horizontal energy from her sprint, to the vertical and rotational energy needed for her tumbling. The kinetic energy comes from chemical energy released within the gymnast's muscles (McInerney and Kelley). In order for the gymnast to perform skills in the air successfully, she has to get high enough and maximize her airtime. To do this, the gymnast must execute a specific launch angle that conserves the majority of the kinetic energy produced during her sprint. It's the launch angle and speed of the run that significantly influence how high the gymnast goes (Spivack).

Angular Momentum & Inertia

When the gymnast is in the air, the only force she is influenced by is her weight, due to gravity. When a gymnast first pushes off the mat, she has all the angular momentum for the entire skill (Spivack). The gymnast's angular momentum depends on how fast she rotates around each axis and how her body's mass is distributed about each axis (Fink). From the time she pushes-off the floor, no momentum is gained nor lost. However, the gymnast can change the rate of her rotation without pushing off anything, allowing her to perform various aerial feats. To do this, the gymnast changes the distance of her center of mass from the axis of rotation. The

angular speed increases/decreases by changing the distance between the mass and the axis of rotation (Deusen). For example, if the gymnast pulls her arms and legs closer to her body, making her center of mass smaller, she will spin faster with a higher rotation rate. The gymnast can control her rotation rate by repositioning her arms and legs during the motion, thereby changing her moment of inertia and her rotation rate(Spivack).

Velocity

A gymnast flips when she rotates around the horizontal axis along her hips (Rhett Allain). Since gravitational forces only work in the vertical direction, there are no net horizontal forces acting on the gymnast. The gymnast will move at the same horizontal velocity when she's in the air as when she was running on the ground. In the vertical direction, she launches upward with some vertical velocity, depending on her launch angle and speed. This velocity decreases as she travels up until it reaches zero at the highest point of the skill. After reaching her highest point, she moves downward and prepares to land the skill (Rhett Allain).

Torque

There are two ways that a gymnast can twist in the air. The first way is called a "torque twist". Torque is the rotational equivalent of a force. It cannot be applied when the gymnast is in the air. Rather, it is utilized as the gymnast pushes off the ground (Rhett Allain) . Depending on the amount of force and technique the gymnast pushes off of, this torque will result in a twisting motion once she leaves the ground. The second option is with an "asymmetric arm movement" (McInerney and Kelley). Once a person is in the air, she can change her body position, creating a non-symmetric mass distribution (Rhett Allain). This will allow the gymnast to twist and rotate around her axis.

Torque, Law of Conservation of Angular Momentum

A double-back demonstrates the idea of torque very well. A double-back is performed by completing a round-off back-handspring and then two flips in a tucked, piked, or layed-out position. During this skill, the gymnast's center of mass follows a parabolic path (Dupuis). Surprisingly, a double-back in the tuck and pike positions have equal difficulty values, but a double-layout has a higher value. This rule is quite confusing to gymnasts without understanding

the laws of physics. If the axis distance of the rotating object is larger, like a double layout, more torque is required to rotate the object at the same angular acceleration (Dupuis). This clearly demonstrates the law of conservation of angular momentum. The gymnast's moment of inertia is smallest, and her angular velocity is greatest in a tuck, and vice-versa in a layout. After completing a double tuck, the gymnast lengthens her body to increase her moment of inertia and slow down her angular velocity, so that she can land safely (Dupuis).

Discussion

The widely held belief among coaches is that smaller gymnasts with a high strength-to-mass ratio are better able to handle their own bulk during complicated rotational gymnastics feats. Gymnasts taller in height need more strength to flip and twist their complete body (Ackland et al.). Compared to the height of elite athletes in other sports, the stature of competitive female gymnasts is quite astounding. Team USA's Aly Raisman is one of the tallest female gymnasts at 5'2'', while Simone Biles falls just a few inches below her at 4'8'', making her the shortest American athlete. Surprisingly, Simone towers over Flavia Lopes Saravia, a 22-year-old Brazilian gymnast, who is 4'4'' (Moss). Studies reported that active female gymnasts' skeletal systems grew at a slower rate throughout gymnastics training but caught up during periods of reduced training and retirement (Theodoropoulou et al.; Georgopoulos et al.). Controversially, a more recent study showed that Gymnastics training does not appear to attenuate growth (Malina et al.). Rather, taller kids have a harder time in gymnastics, so they drop out or move on to other sports. Although the biological mechanism is still inconclusive that intense gymnastics training negatively influences the endocrine system, delays puberty and decreases the rate of skeletal system maturation for female gymnasts, The moment of inertia, a concept of physics, behind successful gymnasts remains true.

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Theory X and Theory Y: McGregor's Theories of Management Applied to Working from Home in the Era of COVID-19 by Daniel Youssef

Abstract

Now more than ever, employers need to know how to effectively manage and motivate their employees -- especially in light of the COVID-19 pandemic, which has presented a diverse set of new challenges, including the transition to working from home. Theory X and Theory Y are prominent theories of management as it relates to motivating employees. A deeper view into these theories will be provided using self-determination theory (SDT). This paradigm is applied to determine when one theory is better than the other when managing employees during the COVID-19 pandemic, especially those who are working from home. In previous studies, researchers believed that Theory Y was more effective, as Theory X can cause friction in the workplace in an organization that relies on authoritarian management. However, in contrast to researchers' assumptions that Theory Y is always a more appropriate method, using the framework of SDT, scenarios will be proposed in which one theory would be better utilized than the other, as supported by previous research.

Keywords: Theory X and Theory Y, self-determination theory, psychology, management, working from home

Introduction

When the COVID-19 pandemic broke out, numerous facets of life were affected, including business practices. One of the most salient changes is the adjustment from in-person to remote work. As working from home continues to become more prevalent, employers must be able to effectively manage their employees. Theory X and Theory Y are two management styles, developed by Douglas McGregor, which dictate the appropriate management method based on assumptions about employees. Theory X states that employees do not like to work and must be influenced into working via external rewards, and in some cases, punishments. Theory Y states that employees enjoy working and are motivated to do so, and, as such, employers should take a less controlling approach in their management style. This allows employees the flexibility to pursue their goals. In this paper, self-determination theory (SDT), a theory of self-motivation, is incorporated into Theories X and Y, enriching researchers' knowledge of these theories. With this framework, propositions will be created and applied to scenarios in which employees are working from home.

Review of Literature

Theory X and Theory Y, which were developed by Douglas McGregor, a professor of management at the Massachusetts Institute of Technology, are based on the belief that managers make assumptions about the attitudes and behaviors of their employees (Gannon, 2013). Theory X assumes that employees are lazy and work solely for money or other extrinsic rewards. As such, they must be coerced into working via those extrinsic rewards. Theory X also prescribes that punishments have the same effect. In contrast, Theory Y assumes that employees enjoy working and need no external rewards or close supervision to be motivated to do so. Thus, employers take a less controlling approach in their management style. This allows employees the freedom to accomplish their goals in the way that most motivates them and optimizes the enjoyment of their work. In determining when to use which method, researchers have considered a variety of factors, most of which are encapsulated in the demographics of employees and/or the industry in which they work.

Demographics

Researchers have considered the demographics of employees, more specifically their age and gender, as factors in the use of Theory X or Theory Y. Results do not support this. Marjan Bojadziev et al. (2016) conducted a study at the University American College Skopje and found that, regardless of age, employees preferred Theory Y, causing high levels of intrinsic motivation and satisfaction with their organization. Conversely, Elen Navasardyan of the American University of Armenia conducted a study that determined that, notwithstanding gender, employees have higher levels of extrinsic motivation than intrinsic motivation, indicating a preference for Theory X management (Navasardyan, 2018). Thus, age and gender do not seem to play a significant role in the preferred management style of employees. However, while both studies indicate a preference for one style for all employees, both studies reach different conclusions in terms of preferred management style.

Industry

Since preferences for Theory X and Y are not universal, the industries in which employees work may also influence their preferred management style. In the business process outsourcing (BPO) industry in the Philippines, employees were found to prefer Theory X (Delle-Vergini, 2018). In one study of the retail industry in Ireland, employees at an Irish retail company were found to be best motivated with external, financial incentives, a key motivator found in Theory X management (Keogh, 2011). Another study in 2020, which examined employees at the Calvin Klein outlets, reached the same conclusion: employees were found to be better motivated with monetary rewards (Lahtinen, 2020). In a 2018 study conducted by the University of Central Florida, researchers examined multiple public sector organizations to determine their preferred method of management. Employees' preferences for a certain method differed based on the organization. In organizations that utilize authoritarian management, such as the Department of Motor Vehicles and the Fire Department, Theory X was the preferred management style. Other departments, however, such as the Department of Parks and Recreation and Arts Department, prefer Theory Y. In school systems, employees seem to prefer Theory Y management. In a 1993 study of Chicago public schools, school staff overwhelmingly preferred principals who utilized Y-management rather than X-management, especially those in

elementary and secondary schools (Gillman, 1993). As such, the type of industry in which employees work likely affects their preferred management style.

As in the case of age and gender, these results are not always consistent, and they sometimes differ from the expectations of researchers (Aykut, 2019). There does not appear to be an underlying framework for when to use one management theory over the other. A framework, based on self-determination theory, will be offered, contributing to this literature.

Theoretical Framework

Self-Determination Theory (SDT) is a theory of motivation that focuses on human behavior, motivated by the fulfillment of psychological needs (Deci & Ryan, 2000). It posits that people have three fundamental psychological needs related to self-actualization: autonomy, competence, and relatedness (Deci & Ryan, 2000). Autonomy is the feeling of free will. Competence is the need to learn skills. Relatedness is the sense of belonging with others. This paradigm places motivation within the bounds of self-actualization and the three needs. Intrinsic motivation is self-motivation, caused when the individual finds enjoyment in the activity itself and is therefore motivated to complete it. For people who are extrinsically motivated, external influences like rewards and punishments are necessary. Theory X's assumptions about employees parallel those of employees that are extrinsically motivated, as both types of employees are motivated by extrinsic rewards, and Theory Y's assumptions parallel those of intrinsically motivated employees. Thus, the tenets of SDT and the determinants of motivation in SDT can be used to predict whether people behave like the assumed employees in Theory X or Y, and therefore, the best management style for a given situation. X-management is better suited for employees who are extrinsically motivated, while Y-management is better for those who are intrinsically motivated.

Researchers have assumed that Theory Y is invariably a better management style. For example, in a study conducted by Linnaeus University, the researchers hypothesized that female employees would have higher job satisfaction under Y-management. The data did not support the hypothesis (Aykut, 2019). Bojadziev et al. (2016) also assumed that Theory Y was a superior management method, but this was not always the case. Despite these inconsistencies, researchers have not provided a predictive framework to determine when and why Theory X could serve as a

more effective management style. Using the provided framework, propositions will be created to explain this discrepancy and help researchers determine when one style would be better utilized.

Propositions

Proposition 1: According to Self-Determination Theory, the extent to which a behavior is intrinsically motivated depends on the extent to which the activity fulfills one's psychological needs (Deci & Ryan, 2000). As an employee's motivation determines whether they would optimally respond to Theory X or Theory Y, the extent to which an employee's psychological needs are fulfilled determines which theory to utilize. This would explain some of the inconsistent findings mentioned in the previous section. In the study of the BPO industry in the Philippines, it was found that employees preferred Theory X. This may not be correlated with the industry in particular, as the Philippines and many other countries in the region have an organizational culture of hierarchical management (Delle-Vergini, 2018). In the Fire Department example, the department runs on strict guidelines with a rigid organizational structure akin to the military. Employees are allowed very little autonomy and there is scarce room for creativity in such a job. Other departments, however, such as the Department of Parks and Recreation and Arts Department, rely on creativity to come up with new ideas and advance their work. This creativity can only be achieved when allowed to do so under a Theory Y structure, as Theory Y is associated with higher levels of creativity. Therefore, the extent to which employees can satisfy their basic psychological needs influences their intrinsic motivation. As such, employees who cannot fulfill their needs of autonomy, competence, and relatedness at work will respond better to Theory X. Formally:

Proposition 1: An employee who feels their psychological needs are being fulfilled would perform better under Theory Y management.

Proposition 2: According to SDT, the extent to which the basic needs are fulfilled determines whether or not an employee is intrinsically motivated. However, need fulfillment should only be related to intrinsic motivation if the employee associates need fulfillment with work (Pacesila, 2020). This provides a moderator for Proposition 1. Since motivation affects whether employees will be influenced by Theory X or Theory Y, fulfillment of needs should only affect whether X or Y should be used if fulfillment is directly related to work. While employees who are working remotely are not intrinsically motivated by the tasks they perform, they still

associate work with the fulfillment of their needs. Thus, the implementation of work programs to fulfill needs will shift the preference to Theory Y. Formally:

P2: Need fulfillment leads to a preference for Theory Y management, to the extent that need fulfillment is associated with work.

These propositions will be applied to an area of management that has gained new prominence since the start of the COVID-19 pandemic: working from home.

Application

The framework in integrating SDT with Theory X and Theory Y can be applied to working from home, which has become increasingly common in recent years, and has increased in popularity during the pandemic. Before the pandemic, 17% of employees in the United States were working from home; this increased to 44% during the pandemic (Mlitz, 2020).

There are numerous differences between in-person and remote work that affect need fulfillment. When employees work from home, they are surrounded by objects that distract them. If an employee who is working remotely chooses to ignore the aforementioned distractions and focus on their work, they can achieve a sense of autonomy. In a physical workplace, however, these distractions do not exist, or are at least minimized, so that feeling of autonomy cannot be achieved.

In many, although not all, remote work settings, programs that can help employees learn new skills for their job, such as career advancement programs, are not available. Without such programs, employees may believe that they are not learning all the skills they need to best complete their work, and thus, they may not achieve the psychological need of competence.

In an in-person setting, employees can satisfy their need for relatedness through camaraderie with coworkers. However, in a remote workplace, employees are more distant from their coworkers, and the fact that any interactions are virtual may mean that they cannot satisfy the need for relatedness in the way they could while working in-person. As such, employees might not be able to fulfill their need for relatedness when working remotely, at least by current practices.

Framework Recommendations

The influence of remote versus in-person work on need fulfillment has been discussed, which is the foundation of both propositions. Therefore, recommendations based on those influences will be proposed:

Per Proposition 1, the extent to which one's needs are fulfilled would determine whether to use Theory X or Theory Y. However, some of the basic psychological needs may be enhanced by working from home, while others are diminished. To determine the net effect, managers must understand the type of employees they have. If they are extraverted, they may place more emphasis on relatedness for need fulfillment. If they are Type A personalities, they may achieve optimum motivation by being allowed to manage themselves; therefore, they may place more emphasis on autonomy for need fulfillment. The former, then, would be motivated by external rewards and punishments, while the latter would strive for need fulfillment and prefer Theory Y.

Even if employees feel their needs are not currently being fulfilled, companies have tools to help fulfill them. For example, if employees are not able to fulfill their need for relatedness, but their organization cannot impose a Theory Y structure, employers can bolster relatedness through events such as virtual happy hour, etc. They can also try sending surveys to employees, prompting them to submit ideas on how employees can better connect with each other. This strategy may be better incorporated into a Theory Y structure.

Per Proposition 2, need fulfillment can lead to greater intrinsic motivation and Theory Y use if need fulfillment is specifically associated with work. Companies have several options that they can consider to more intimately connect certain fulfillment areas with the office. Since employees associate work with need fulfillment, companies can change the way they describe events to better increase employee turnout and satisfaction; this may take the course of, for example, renaming "virtual happy hour" to "company-sponsored virtual happy hour." Companies can also provide scholarships for employees looking to continue their education. These could be called "company skill scholarships." These changes may cause employees to attribute their need fulfillment to the company. As a final example, a company-sponsored mindfulness program, which emphasizes greater focus and fewer distractions, may have employees attributing their increased autonomy (because they are not distracted at home) to the company, rather than to themselves, increasing the likelihood that they would benefit from Theory Y management.

Future Research

The researcher has found limited literature on the relationship between the basic psychological needs and remote work. Also, subsequent research could focus on other factors that may influence an employees' preferred management style, such as their personality, the status of employees' upcoming projects, and company culture.

Conclusion

In light of the COVID-19 pandemic, managers must be able to effectively manage their employees -- who are working from home in greater numbers than ever before -- using Theory X and Theory Y. Although Theories X and Y have been prominent management theories since their inception in the 1950s, no guidelines were available to help managers determine which style of management to utilize, and when. A second theory of motivation, self-determination theory, was integrated to develop a framework, from which several novel propositions were developed as to when one theory is superior to the other. The propositions were applied to working from home. These propositions also help explain inconsistencies in previous research.

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