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The Identity Development Processes of White/Asian Biracial Versus White Monoracial Adolescents By Eleanor H. Murray

According to the 2020 census, 33.8 million people were biracial in the United States. This was a significant increase compared to the 2010 census, which found only 9 million identify as biracial in the United States. The number of biracial individuals is quickly increasing and many of these individuals are young teens. As a biracial teen of both White and Asian descent, the question of my own identity was more complicated for me than for my monoracial peers. I have been curious about the difference between biracial and monoracial teens. This paper will look at how identity development differs between White/Asian biracial and White monoracial teenagers between the ages of 13 to 18 years old.

Racial identity is a broad term used to describe how individuals categorize themselves between different races or ethnicities (Neblett et al., 2016). It is also how people choose to identify themselves based on their physical appearance, ancestry, and personal preference. There are many models that use stages to theorize how individuals choose their identities. The People of Color Racial Identity Model (PCRIM) describes how people of color find their own culture and identity after previously identifying more with European culture. The White Racial Identity Development Model (WRID) shows the stages of White individuals coming to terms with their own racism and then potentially realizing people of color are different but equal (Helms, 1990). For monoracial teens ages 13 to 18, their racial identity is usually the same as their parents' race. But there has been little research on biracial teens' identities compared to monoracial teens. So how are biracial teens' identities shaped, and are those factors different from those that shape the identities of monoracial teens?

Biracial teens' experiences of finding their racial identities usually are not similar to monoracial teens. It has been found that, growing up, many biracial teens struggle with their identity while being surrounded by mainly monoracial people. Research has shown that there is a high level of internalized oppression in Asian/White biracial individuals (Chong & Kuo, 2015). Internalized oppression is used to describe those of an oppressed group, or non-dominant racial group, that believe negative stereotypes about themselves that were created by their oppressors. This internalized self-oppression can cause low self-esteem and confidence. Chong and Kuo (2015) have categorized three ways biracial Asian/White individuals identify: White dominant,

Asian dominant, and White-Asian integrated. They found that those in the White dominant group had more internalized oppression than either the Asian dominant or White Asian integrated groups. This study found that biracial individuals who identify more with their majority racial group have worse physiological development than individuals who identify more with their non-dominant racial groups or with both racial groups.

How do these biracial individuals acquire internalized oppression? While racial identity is an individual's own personal categorization, it is likely influenced by many other factors. Environment is a big possible factor in an individual's identity, along with how they cope with racism and oppression. (Chong & Kuo, 2015). Internalized oppression contributes to sentiments of shame or dislike toward an individual's heritage. For example, an Asian/White biracial teen that has grown up in a predominantly White area may identify more as White and less with their Asian culture. Suppose an individual is also surrounded by racism and oppression towards Asian communities. In this case, they may also be more inclined to identify with their White side to avoid this racism and their own internal thoughts that internalize the oppression. Thus, racism and environment are possible factors in an Asian/White teen's personal identity.

In addition to environment, physical appearance/phenotype also influences how biracial teens identify. Physical characteristics such as eye shape, hair color, skin color, etc. can cause an individual to resemble one race more or appear racially ambiguous. Biracial individuals are more likely to identify with the race they more physically resemble (Brusa, 2008; Cooke, 1997; Khanna, 2008). Physical appearance is a large factor in how individuals identify the race of others. Although there is a quickly increasing number of biracial individuals, observers still tend to put biracial people into monoracial categories (Feliciano et al., 2016). So biracial individuals will identify differently depending on how they blend into different environments and cultures.

How a parent expresses their own race can also impact how teens identify with their racial identity. It was found in a study, including 51 Asian, White, and White/Asian college students, that in White/Asian interracial heterosexual marriages the child usually identifies more with the race of the Asian parent, regardless of gender (Phillips, 2004). A possible reason for this may be that Asian parents tend to have a closer relationship with their culture compared to their White partners. In contrast, teens may also identify with their White parents more due to cultural assimilation, meaning a minority group or culture comes to resemble a majority group (Pauls, 2019). If the majority of family surroundings are White, then then they are more assimilated into

the dominant White American culture and they may identify less with their Asian culture (Xie & Goyette, 1997).

Unlike biracial teens, it has been found that, in general, monoracial White American teens tend to lack awareness about their racial identity. In many White families, race is not a commonly discussed topic and many White teens have grown up in a color-blind era. Also known as color-blind racism, color-blindness is a term used in post-civil rights era racism. Sociologist Eduardo Bonilla-Silva coined the term, arguing that racism still exists in society, but is often discreetly coded in language and policy (Bonilla-Silva, 2003). Racial socialization is how people learn about racial topics, whether it be racism, assimilation, or others. This is usually taught to children by their parents; for example, black parents teach their children early on about race because of institutionalized racism towards black people. However, it has been found that racial socialization presents differently in White families compared to families of color (Freeman et al., 2022). Many white families teach their children to avoid discussions about race and to remain passive in the face of racial injustice, which indirectly perpetuates racism (Ferguson et al, 2022). Although unintentional, this lack of awareness creates a different kind of racial socialization. White individuals are less likely to think of themselves as having a race (Freeman et al., 2022). Although many parents rely on their children's school to educate them on racial topics, this is not enough, as the school curriculum tends to severely lack focused lessons on social or interpersonal skills that are important to racial socialization. As a result, there is a gap in understanding the influence of race and White racial identity.

In 2020, the pandemic highlighted many racial incidents. These events were widely shared on social media and news networks. Some of these events were the 2021 Capitol Hill interaction, protests for George Floyd, and Donald Trump's comments on China and its people, extra. The succession of all these racially-charged events brought conversations about race into homes across the country, many of which had avoided the topic in the past. Specifically, some White extremists committing racial crimes were being prevalently shown on the news, leading to discussions about the role of White supremacy in our society.

This encouraged many White American teens to reflect critically on their own racial identity for the first time. Up until this point, they had learned about race primarily from their families, environment, and social media. So if not having known about race from their family already, this negative example would be their primary idea of race. Having this topic not been

discussed, many White individuals may not have any relationship with their own racial identity being that they may be inadequately informed about their, and others' racial identities.

One of the biggest issues biracial adolescents must contend with in regard to their racial identity is their self-esteem. The process of integrating their two racial identities is a challenging task for many teens. Kerwin et al (1993) and Gibbs (1989) found that female biracial individuals experienced more anxiety and social problems than biracial adolescent boys (Phillips, 2004). It was found that Asian/White girls reported lower self-esteem and less perceived social acceptance than monoracial girls (Phillips, 2004). As teens, individuals undergo cognitive changes that affect their ability to make sense of the adult world they live in, which affects how they view racism, race, and culture (Phillips, 2004). It was found that many White/Asian adults did not consider themselves to be a “real Asian” (Phillips, 2004). This is possible because they don’t fit the same categories or expectations and the difference in their mixed-race background not being quite the same as monoracial Asians. This affects their self-esteem in terms of fitting in with others and cultural expectations. Biracial teens that struggle with their racial identity can mature into adults that do not have a concrete relationship with either of their ethnicities.

So how is identity development different between White/Asian biracial and White monoracial teenagers between the ages of 13 to 18 years old? Biracial teens’ identities develop through their environment, such as the race of their peers, culture, or racism around them. Not uncommonly, White/Asian biracial teens tend to develop internalized oppression depending on the varying environments they grow up in. Since most individuals categorize others’ race by physical appearance, biracial teens are also affected by how they look. But one of the most important factors is how parents exhibit culture and teach their children about race. Since many monoracial parents do not speak about race with their children, the current majority of monoracial White teens do not have an expanded understanding of racial identity. While both monoracial and biracial teens develop their racial identity through parental teachings and the environment, they do not experience these factors in the same way. The literature has examined how biracial teens are negatively affected by treatment from others for their mixed-race status. Still, more research needs to be conducted on how biracial teens cope with the stressors of their complex identity and how it affects them over their life span.

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Setting the Stage...For More Patriarchy By Clementine Zei

Both Shakespeare's *Taming of the Shrew* and Junger's *10 Things I Hate About You* use setting as a tool to set the underlying power dynamics and justify actions between characters within each scene of the storyline. While setting in a movie can be much more diverse and emphasized than a stage, the hierarchies of power within the play's backdrops are conveyed through code-switches in characters based on location. In both *Taming of the Shrew* and *10 Things I Hate About You*, the scheming Petruchio/Patrick is tasked with winning over tempestuous Katherine and changing her from the "shrew" to a virtuous woman in order for Bianca, her charming sister, to find love as well. Shakespeare, from the Induction to Act V, sets his play in clearly male controlled spaces, such as Petruchio's estate. To appeal to modern audiences, Junger introduces female ruled spaces in order to progress the storyline such as a peek into Kat and Bianca's bedrooms. Yet, the same patriarchal standards that women should act to attract the male gaze and that a woman's place in these new settings is earned by docility, not inherent. Junger attempts to depict a deep dismantling of power hierarchy by gender since the time of Shakespeare's play, but in actuality, Junger constantly glazes over misogyny and mistreatment of female characters with the guise of loud, angsty, and feminist setting/culture. As Junger translates Padua to an upper-middle class high school lifestyle through the circuit of setting which alter Shakespeare's male dominated locations of home and pleasure to seemingly portray a female driven narrative, in actuality, the systemic roots of male dominance permeate into every environment, rendering the patriarchy inherently built into the foundations of society and continually prevalent despite centuries of time between both bodies of work.

As the home of Kat/Katherine and Bianca changes from Baptista's estate to the Stratford residence, Junger initially characterizes the setting, through aerial shots, as a reformed space for Kat to express herself, seemingly initiating the film as a divergence from the themes of *Taming of the Shrew*, yet ultimately suggesting reform in only a performative way. In *Taming of the Shrew*, Shakespeare characterizes the Stratford house not by visuals but rather by who has the ruling within its residence. In order to tutor Bianca and Katherine, Petruchio and Hortensio respectively must speak courteously towards Baptista to get permission, greeting him with, "And you, good, sir. Pray, have you not a daughter / Called Katherine, fair and virtuous?" (II.i.45-6). Shakespeare illustrates an attempt from Petruchio to elucidate politeness as he uses words such

as ‘good sir,’ which translate to virtuous, and ‘pray,’ to humbly preface a request . When he establishes that it is Baptista that has the final, if not only, say in the actions of his daughters, Shakespeare implies the power of the house is given to the patriarch. So when Petruchio speaks to Katherine alone, his virtuous facade drops, as he initially greets her by saying, “Good morrow, Kate, for that’s your name, I hear” (II.i.190). Katherine was never referred to as ‘Kate’ beforehand, so when Petruchio justifies calling her that name with the reasoning ‘I hear,’ he indirectly suggests that he only listens only to his own opinion. Because Katherine receives no respect talking to a man one-on-one, Shakespeare illuminates how the patriarch of the family has monopoly over an estate in Padua, while women garner little respect. However, at the Stratford house in *10 Things I Hate About You*, Junger initially characterizes the setting as Kat sitting by an open window reading “The Bell Jar” by Sylvia Plath and listening to the rock song “Calypso” by Spiderbait. As the camera pans from an upper-middle class neighborhood to the Stratford’s corner house, it highlights the equally bright, large, and similarly designed home to a bright song melody. Yet, once the camera shoots a window into the interior of the home, the melody turns rock and Katherine appears, suggesting how within these settings reform is taking place (10 Things). This initial characterization of Katherine’s angsty music and confidence lounging at the window ruling the core of a conventionally presenting home suggests that Junger is redefining who has power in Kat/Katherine’s family home. These opening visuals illustrate how Junger directly translates the plays’ setting into its modern day transpositions both through set design change and the translation of how gender hierarchy and female freedom is intertwined into setting, raising the question of whether these transformations represent real change or merely a pivot to fit into the 21st century.

While, in the film, Junger implements settings that present as female-dominated, progressing from *Taming of the Shrew*’s solely male ruled spaces, these places are quickly co-opted by male characters, illustrating the fickle nature of female power. One setting where Kat enjoys going to in her free time is the indie rock bar named “Club Skunk,” which upon entering with the goal of asking Kat out, “Patrick walks down the hallway toward the stage [he] is eyed suspiciously by various girls in the hall” (10 Things). Junger conveys, through the girls who ‘suspiciously’ eye Patrick, how certain female settings exist with the expectation of female rule. While men were never legally barred from settings similar to Club Skunk, possessing a solely female space in a patriarchal society creates a rare setting of safety for women. Yet,

Patrick is able to enter this club and immediately gain the upper hand when he compliments Kat's genuine interests by telling her the musicians playing "are no Bikini Kill or Raincoats, but they're not bad," and immediately stands up and walks away, resulting in Kat following him (10 Things). In a quick conversation, Patrick gains power by, unexpectedly, commenting on the music with maintained disinterest when he says the band is 'not bad.' Despite women taking up the majority of space, Patrick is able to have the final word and end the conversation, forcing Kat to chase him. Patrick, upon entering the club, also doesn't ever lose his feeling of authority to tell Kat/women what to do when he tells her "come to bogey's party with me" (10 Things). In phrasing this request as not a question but a command when Patrick tells Kat to 'come,' giving her no choice to decline, Junger illustrates the unwavering and universal dominance and confidence of men, despite entering a female safe space, rendering society's most progressive of settings easily co-opted by internalized gender power dynamics.

Although Junger establishes settings that wholly deny male entrance, unlike Shakespeare, the dominance of the male gaze and idea of what is most desired in a female persona pervades every aspect of setting, illuminating how the film's mask of reform cannot hide the universal patriarchal rule. Even in settings where men are distinctly prohibited, such as when Bianca tells Cameron that he cannot see her room because "a girl's room is very personal," these spaces are still indirectly permeated (10 Things). Bianca justifies her actions, and by extension the appearance of her bedroom by responding to Kat's comment that she doesn't "always have to be who they want [her] to be" by saying that she "happen[s] to like being adored" (10 Things). In telling Kat that she loves social approval, Bianca affirms that her performances of innocence and appearance of femininity are driven by the male gaze. Because she confirms her desire to fit the male gaze, Bianca establishes that she is aware that social success equates to the way she dresses, behaves, her clique, and that her actions are driven by this goal to win the approval of men. Therefore, even Bianca's room, that she rejects Cameron's/the male request to see, isn't immune to the expectations from men to be feminine by wearing pink and liking frills, even without men actually entering the setting.

On the other hand, the relativity of Joey Donner and Kat's treatment in Mr. Morgan's classroom suggests, while women are now offered a seat at the table, the fickleness of a woman's role in a traditionally male dominated space counteracts this reform. When the class is asked about how they liked Ernest Hemingway's, *The Sun Also Rises*, Kat, who "is wearing a camo top

in preparation for her daily war against high school ignorance,” replies, “romantic? Hemingway?!” stating to the class that “He was an abusive alcoholic misogynist” (10 Things). Mr. Morgan asked the class for their various opinions on a book, and Kat answered that question with true evidence from outside research, illustrating how her response was warranted. While she may have delivered her reply passionately frustrated, she held back from name calling and, as the transcription states, spoke in opposition to ‘high school ignorance.’ Yet, the immediate reactions from the class to Kate opening her mouth are eye rolls and Joey Donner retorting, “as opposed to a bitter self-righteous hag who has no friends?” (10 Things). The character that brought in the first instance of disrespect, by calling Kat a ‘hag,’ or an ugly old woman, was Joey Donner. While Kat brought a valid opinion to the class conversation, Joey showed no evidence of reading the novel and only spoke to admonish Kat’s social life, personality, and appearance. Joey and Kat continue their argument as Kat criticizes her school’s reading section, questioning why the class can’t read Sylvia Plath, Charlotte, Bronte, or Simone de Beauvoir. To this, Joey replies, “Is there any chance we could get Kat to take her Midol before she comes to class?” (Junger). Midol is a drug to aid in cramps and PMS from a female’s menstrual cycle, suggesting that Joey is belittling Kat’s opinion by boiling it down to female rage from PMS. Associating a woman’s feelings, if they are anything but happy, with her being on her period aids the stereotype that women are more prone to erratic emotion and unable to make logical decisions as a result. Because of the true nature of this question, since Kat most likely does not take Midol, Joey’s words are dripping with misogyny and disrespect in the classroom setting. The character who is dismissed from the class, however, is Kat, as Mr. Morgan reacts to the conversation by telling her to leave the classroom because she’s “pissing [him] off,” while Joey may stay (10 Things). Because of the clear disparities in the appropriateness of statements from Joey and Kat, yet the latter is the one kicked out, there is an unfair treatment of the female character. Classrooms and education systems are traditionally only for men, so while women are in this classroom, their seats in this setting are still up for debate and in the hands of the man, Mr. Morgan. In fact, as soon as Kat implements an opinion that threatened the antiquated power of men as the dominant heroes in narratives and curriculum, she is kicked out of the space, illuminating how society’s seemingly progressive spaces are still quick to convey their dislike for a non-placid woman, rendering her representation unguaranteed.

In both the final speech of Shakespeare's play and Junger's film Katherine/Kat's belief and personality changes illuminate how she must apply a mask in order to reap most benefits from the sparse freedoms society offers to women. In *Taming of the Shrew*, set at a dinner party with Baptista's family, Petruchio, Lucentio, Hortensio, and the widow, Katherine is asked to give a speech about female domesticity to Bianca and Hortensio's wife. Katherine bolsters her argument by telling the audience that a husband "commits his body / To painful labor both sea and land" while women "liest warm at home, secure and safe" (V.ii.165-7). By comparing the contrasting settings, through the words 'painful labor' versus 'warm' and 'home,' in which a wife must exist versus a husband, Katherine argues that women must pay back their eased lifestyles by submitting to male rule. Through compare and contrast, Katherine utilizes the idea that all settings must be inherently male dominated or at least co-opted by men as a payback for their laborious lifestyles. On the other hand, in Kat's final speech in *10 Things I Hate About You*, she volunteers to read her poem out loud to the class, and instead of being directed towards Bianca and the widow, her words are directed towards Patrick, telling him that "[she] hate[s] it when [he is] not around And the fact that [he] didn't call" but "mostly [she] hates the way [she] [doesn't] hate [him]" (10 Things). Kat begins to cry, an emotion that she has never experienced in this classroom, consequently running away and dismissing herself instead of Mr. Morgan. Because Kat cries while Patrick doesn't, Junger contributes to the narrative that women are more emotional than men, therefore aiding the argument that women should not have seats in male settings. In illustrating how Kat cries and, as a result, leaves her education setting, Junger suggests that there is a negative to female emotion, and the consequence is leaving this traditionally male dominated space. In the two previous classroom scenes, it was Mr. Morgan who sent Kat to the principal's office, who passionately contests these decisions, so in Kat leaving the classroom on her own free will, Junger suggests Kat's taming and stronger adherence to male expectation laid out earlier in the film.

In both the play and the film, the Plaudites of these comedies are introduced at the finale: Shakespeare extends Katherine's speech to all women and Junger cinematographically zooms out from the school, illuminating how the gender related messages established within these storylines are applicable to real life and have widespread influence. In the final two lines of her speech, Katherine calls upon her female audience to "place your hands below your husband's foot" because "my hand is ready, may it do him ease" (V.ii.193-5). In addressing an ambiguous

‘your,’ Shakespeare suggests that Katherine is addressing the audience as a whole, urging women in general to submit to their husbands’ will. Katherine speaks in clear language, spelling out how her next actions will be submission herself, indicating an obvious attempt by Katherine to prove her tameness in order to gain better treatment from Petruchio. In the final minutes of the film, Kat tells Patrick, who had just bought a guitar for her as an apology, that “you can’t just buy me a guitar everytime you screw up,” to which he replies, “Yeah, I know. But then, you know, there’s always drums and bass and maybe even one day a tambourine” (10 Things). Then, after Patrick forces a third kiss on Kat to quiet her, Junger zooms out from the parking lot with an aerial shot of the school as a band plays on the roof. The final moments of the movie, or the final taste left in viewers’ mouths, are Patrick justifying how he can dismiss Kat through buying her presents and forcing her to be quiet by kissing her, suggesting that is the expectation or impression of relationships young viewers should adopt. When Junger zooms out of this scene to pan over the school with the Seattle skyline in the background, he invites viewers to see this movie as representative of not only Padua High School but relationships in general. While Shakespeare’s Plaudite, defined by Northrop Frye as “the invitation to the audience to form part of the comic society,” is clearly spelled out to the audience, Junger utilizes cinematography and indirect dialoguing to subconsciously convey a zoom out from the themes of the film into everyday life (Comedy, 5). Shakespeare’s final moments may be blatantly misogynistic and advocate for the maintenance of a male dominated society not only in Padua but the real world, but Junger’s film masks its roaring patriarchal reality with a peek into female dominated settings and a seat at the table in traditionally male spaces. Junger’s affirmation of antiquated ideals that love is better than being single, women are more emotional, and a woman’s equal seat at the table is earned not expected is so subtle that it might go unnoticed behind the blur of sisterly heart to hearts and Kat’s rock music. This subtleness illuminates a failed attempt in film by modern society to reform these expectations of personality and treatment of women either to appeal to a larger audience or poorly patch the foundations of society. When it is the base of society that is built upon an issue, mere translations and transpositions into a more acceptable, modern setting cannot be sufficient to enact real change. By masking the true misogynistic tones of *10 Things I Hate About You* as it is translated over from *Taming of the Shrew*, Junger creates a deceptive film that, at face value, presents a narrative much more progressive than it actually is,

illuminating that, at its core, society has merely buried patriarchal structures rather than dismantling them, rendering society much more comfortable in its dynamics than it preaches.

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The NAEL and The GOAT: Shakespeare 's Place in the Scholarly English Canon

By Juni Kim

Introduction

The Norton Anthology of English Literature, often abbreviated as the _NAEL_, is a classic of any introductory literature survey class. The collection of texts that it chooses to include and not include, in addition to how it decides to portray those texts, define what we think of as the current English canon.

In its introductory essay about William Shakespeare, the _NAEL_ argues that the playwright is one of the greatest English writers of all time. They quote a prior Shakespearean anthology stating he was "not of an age, but for all time" (NAEL B 719), indicating that he has distinct qualities that go beyond any ephemeral cultural and literary tastes.

The essay then identifies some of these characteristics that separate Shakespeare from other authors of his time. It first mentions Shakespeare's ability to inject personhood into all his characters, citing their "irreducible selfhood" (NAEL B 721), and contrasts it with other playwrights of his time, who had "[stripped] their characters of all incidental distinguishing traits ... getting to their essences," (NAEL B 721) and a Marlowe play where "the protagonist overwhelms virtually all of the other characters" (NAEL B 721). Other Shakespearean aspects – including his mastery of the English language, his use of anachronisms, and the secular nature of his plays – are then introduced (NAEL B 721). Through these characteristics, the _NAEL_'s editors depict Shakespeare as a writer who sharply deviated from the societal and theatrical norms of his era, thereby granting him and his works the longevity and relevancy that they maintain today.

However, the claim that Shakespeare develops supremely consistent and human characters ignores the nuances of the nature of his plays and of his goals and commitments. Since the _NAEL_'s editors chose to include _Othello_ in their anthology as an example of a "tragic masterpiece" (NAEL B 803), they presumably believe that this play embodies the characteristics that distinguish Shakespeare. Upon close reading of the play, however, the _NAEL_'s view breaks down, as the titular character acts completely differently near the end of the play from how he is initially portrayed, while the villain's actions are logical, given his characterization, but lack clear motivation.

Othello

Throughout the first third of the play, Shakespeare positions Othello as a man deeply rooted in his morals and devotion to Desdemona. But, in a brief conversation, Iago cuts down these values and turns Othello against everyone he has trusted so far in the play. This discontinuity in Othello casts doubt on Shakespeare's production of characters with "irreducible selfhood" (NAEL B 721).

In the first half of the play, Othello is depicted as a devoted and naive outsider with a very strong moral foundation. In the second scene of the play, as Iago wakes Brabantio at the sight of Othello marrying his daughter, Othello proclaims to Iago, "My services, which I have done the signory,/ Shall out-tongue his complaints" (Shakespeare 1.2.18-19). He seems to expect a simple transactional interaction between himself and the state, where they accept his marriage due to his efforts for their wars and in recognition of his strong commitment to his service. A scene later, Othello finds himself explaining his marriage to the Duke, and he brings up both his status as a Moor and his subsequent inability to eloquently speak (despite fluency) in the Venetian manner: "Rude am I in my speech, and little blessed with the soft phrase of peace" (Shakespeare 1.3.81-82).

While being an outsider, he demonstrates his naivete and morality within this society when he intervenes in a drunken brawl between Cassio and Montano in Act II. He asks, "Why, how now, ho? From whence ariseth this?/ Are we turned Turks? And to ourselves do that/ Which heaven hath forbid the Ottomites?" (Shakespeare 2.3.166-68) Despite leading soldiers, Othello immediately asks his soldiers a moral question, "Are we turned Turks?" remaining oblivious of the fact that such fights commonly occur from intoxication and boredom.

This devotion to the Venetian state and his men is complemented by Othello's even stronger love for his wife. In Act III, after talking to Desdemona and Emilia about Cassio's predicament, Othello parts from them while saying, "Perdition catch my soul/ But I do love thee! And when I love thee not,/ Chaos is come again" (Shakespeare 3.3.90-92), which strongly emphasizes his dependence on Desdemona, to the point where she needs to be around and loved by him for him to function.

In 3.3, however, Othello's character takes an inconsistent turn. When Iago asks if Cassio knew of Othello's love for Desdemona, Othello replies with confidence, "He did, from first to

last" (Shakespeare 3.3.95), and, "O yes, and went between us very oft" (Shakespeare 3.3.100). Iago then answers with a terse "indeed?" (3.3.101), which in effect repeats his prior question. Although Othello has made two prior assertions about the certainty of his views on the relationship between Cassio and himself, it is this single word that causes him to doubt Cassio's sincerity, with a suspicious "Is he not honest?" (Shakespeare 3.3.103). This causes a chain of dialogue in which Othello devolves into desperation and distrusts Desdemona, exclaiming, "By the world/ I think my wife be honest, and think she is not; I think that thou art just, and think thou art not" (Shakespeare 3.84-86). In his confusion, Othello does not put up much of a fight against Iago's statements, nor does he seriously doubt Iago's honesty.

Despite Othello's naivete and the strength of the moral foundation that Shakespeare has built up in him before this scene, a single common word of Iago's is sufficient to bring down Othello's entire worldview. This reversal seems to indicate an instance in which the _NAEL_'s claim of Shakespeare's characters as having "irreducible selfhood" breaks down.

A Hypothesis not NAELED

The _NAEL_, in its text on _Othello_, tries to give a justification for this apparent discontinuity. The editors state, "The answer in part seems to lie in the terrible vulnerability of trust. As Iago coolly observes, Othello '[i]s of a constant, loving noble nature' (2.1.285). That nature is bound up with his capacity to cherish his friends, rely on his subordinates, and above all, open his whole soul to his wife: 'My life upon her faith!' (1.3.293). But such openness makes it possible for Iago to penetrate Othello's psychic defenses and refashion his perceptions" (NAEL B 805).

Despite its claim about the fragility of trust, this response ignores the hierarchical nature of trust; most people will have an ordering of whom to trust given a set of contradictory opinions. Assuming the _NAEL_'s argument about Othello being more open to trust others than the average person to be true, Othello's vows, which the _NAEL_ cites, indicate that Desdemona is at the top of this chain, especially since he metaphorically binds his life to her beliefs and thoughts. Furthermore, Othello demotes Iago at the beginning of the play (Shakespeare 1.1.14), which would place Iago further down his hierarchy, even below Cassio, whom he doubts before Iago. Thus, despite the _NAEL_'s best effort, the reasons for why Iago is so effective in turning Othello remain ambiguous.

Iago's Vagueness

Iago is another example of a character that is not well-developed. Although Iago remains a more consistent character than Othello throughout the play, Shakespeare hides his true motives, preventing him from being fully defined. The _NAEL_ acknowledges this conundrum in its exposition on _Othello_: "What is Iago's motive? Why should he want to destroy Othello, on whom his livelihood depends, and Desdemona, whom his own wife, Emilia, serves as lady's maid?" (NAEL B 805).

Throughout the play, there are various allusions to Iago's motives, but they remain incomplete. Starting the play, Iago is scheming with Roderigo and states, "The native act and figure of my heart/ In complement extern, 'tis not long after/ But I will wear my heart upon my sleeve/ For daws to peck at. I am not what I am." (Shakespeare 1.1.59-62). This statement starts with the premise of superficially hiding one's identity, as the "heart upon my sleeve" alludes to more of a physical display of thoughts and emotions. However, Iago concludes his monologue with the famous line, where the verb "am" shifts the perspective from obscuring the self to not having one at all, raising questions about his personhood.

Shakespeare makes another allusion to Iago's character after his initial planning fails, where he justifies himself: "I hate the Moor,/ And it is thought abroad that 'twixt my sheets/ H'as done my office" (Shakespeare 1.3.374-76). The simplicity and definite nature of the first clause seems to imply that Iago has some well-defined and thought-out philosophy influenced by previous experiences. In his next sentence, he brings up the vague suspicion that his own wife cheated on him with Othello, which seems inconsistent with the fact that he is still married to her and uses her in his scheme. This contradiction leaves the explanation of his motives again incomplete.

Even after the tragic sequence of the play concludes, and Iago is arrested, he denies any further information to Othello and even the audience, proclaiming, "Demand me nothing. What you know, you know./ From this time forth I never will speak word" (Shakespeare 5.2.307-08). Even the _NAEL_ does not have an answer to the question of Iago's motives, stating, "Iago's repeated attempts to account for his obsessive, unappeasable hatred of Othello are famously unconvincing" (NAEL B 805).

Shakespeare, by deciding not to elaborate on Iago's intentions but instead to focus on his actions as a plotting villain, is closer to his contemporary playwrights, who believed that

characters should be stripped down to their actions. This contradicts the _NAEL_'s claim that these playwrights are one-dimensional and therefore vastly different from Shakespeare.

Possible Motives

In including characters that are inconsistent and imperfectly developed, Shakespeare juggles two different commitments: the first to character, which the _NAEL_ acknowledges, and the second to writing theater that grabs attention. Although Shakespeare usually fulfills both commitments, they sometimes conflict with one another, and Shakespeare often chooses drama over character development. The _NAEL_ does not include sufficient emphasis on this commitment to drama and thus creates an incomplete picture.

In their own introduction to the sixteenth and seventeenth centuries, the _NAEL_ discusses the problems faced by Elizabethan theater, stating "nearby residents objected to the crowds, the noise, and the crush of carriages. Other, more serious concerns were public health and crime" (NAEL B 32). These descriptions of "crime" and "traffic" gesture at a cacophony of audience members, including non-elites. Thus, any play during this time, to keep the attention of this wide audience, relied in part on simple tropes in addition to any plot twists: and Shakespeare is not exempt from this fact.

Plays during this time also faced stiff competition; the _NAEL_ describes the scale of entertainment (some more crude) that would have been available then: "There were jousts, tournaments, royal entries, religious processions, pageants in honor of newly installed civic officials or ambassadors arriving from abroad; \ldots folk festivals such as Maying, the Feast of Fools, Carnival, and Whitsun Ales" (NAEL B 30-31). Combined with the fact that these plays "relied on admission charges" (NAEL B 32) and thereby the audience to keep returning for new plays, it is a small leap to conclude that plays also would have had to prioritize retaining attention.

With this in mind, Shakespeare occasionally uses obvious characterization and plotting to attract and retain an audience accustomed to these other forms of entertainment. For example, Iago, despite his clear initial statement that he intends to deceive, is referred to as "honest" by Othello in 1.3.284, 1.3.293, 2.3.7, and many more places. Most critically, Othello uses this belief in 3.3.121 in order to make his justification for believing Iago over everyone else, especially Desdemona. Even to the layman, it would have been obvious, along with the compounding

evidence, that Iago has a duplicitous nature and is not "honest." The suspense then lies in anticipating the break from this deception, when Iago's plans align perfectly and he induces tragedy, consequently, keeping the viewers actively watching through the middle scenes of the play.

Shakespeare also uses the previously described inconsistency and underdevelopment of the characters of Othello and Iago to rapidly guide the plot to the cathartic ending. Othello's sudden break from his own values, motivated by a single (illegitimate) seed of doubt, removes extra time that would have been needed to justify such an immense change in character. In addition, any further elaboration of Iago's beliefs and justifications would have required elaborately describing a time before the play's events. Shakespeare's audience likely would have been impatient with this. Therefore, Shakespeare's commitment to drama sometimes leads him to sacrifice his characters' "irreducible selfhood" in favor of what he thinks would interest his audience. The _NAEL_'s four elements that separate Shakespeare, while largely correct, fail to consider all of these factors in his playwriting.

Conclusion

The actions of Iago and Othello in Shakespeare's _Othello_ seem to contradict the _NAEL_'s perception that Shakespeare's characters have near-full personhood; Othello discards his moral and social foundations with a seemingly miniscule insinuation from Iago, while Iago hints at, but never truly reveals, his motivations for destroying Othello. The _NAEL_ tries to explain Othello's motives for his change, but they fall short given the apparent strength of his values and trust. Meanwhile, no further explanation is given for Iago's planning, as even the _NAEL_ admits that his motives are shrouded in mystery. Given these counterexamples, it is apparent that Shakespeare, while still trying to create characters with "irreducible selfhood"---which the _NAEL_ correctly identifies as distinguishing in the context of Elizabethan theater---has an occasionally overriding commitment to fit the theatrical conventions of his time because he was working in an industry reliant on the attention of a mass audience. He therefore adds elements of suspense which inevitably take away from consistency of character, indicating that the _NAEL_'s depiction of Shakespeare is, albeit mostly correct, ultimately insufficient.

GreenLens: An AI-Powered Waste Classification Application By Jack Liu

Abstract

Have you ever finished a meal but were unsure which recycling container to throw away your trash in? You might not know where to throw away your napkins, plates, utensils, leftovers, etc. Not recycling correctly can have devastating environmental damage. Plastic pollution from neglecting to recycle is one of the main causes of ocean pollution, destroying much marine life. This AI-powered waste classification app called GreenLens is able to recognize dozens of common daily wastes that people have little knowledge of how to dispose of properly. GreenLens, using people's phone cameras, is easily accessible to the majority, has the ability to scan and recognize the type of waste in a matter of seconds, and gives detailed instructions on how to dispose of the waste. It is lightweight, yet powerful, allowing it to achieve recognition accuracies of up to 95%. With the help of GreenLens, people will be able to identify common daily wastes easily and dispose of them correctly, thus helping to reduce pollution caused by inappropriate recycling. In this paper, I will talk about how I came up with the idea of developing this application, as well as the technologies that were applied to build GreenLens. In many experiments, GreenLens is able to recognize all wastes trained for the model while also achieving high accuracies.

1. Introduction

Reports have shown that 62% of Americans do not recycle correctly [1]. A high percentage of responders were also not able to recognize which materials are recyclable [1]. Other researchers report that 94% of Americans support recycling, but only 35% of people consistently recycle [2]. There are many harmful effects of not recycling. First, not recycling causes many unwanted plastics and trash to end up in landfills or the ocean, creating pollution for humans and destroying animals' natural habitats [3]. In addition, the continuing problem of wasting resources by not recycling also causes a lot of air pollution, which is detrimental to everyone's health. Finally, the most harmful consequence is the huge increase in greenhouse gasses such as methane and carbon dioxide being present in the atmosphere, resulting in climate change and health problems [4]. In addition, not recycling could result in fossil fuels being used up. Plastic manufacturers and many other factories use fossil fuels, so not recycling would

eventually burn up this fuel reserve. It is estimated that by 2050, the fossil fuel reserve would be all used up [4]. A 2014 report describes that 136 million tons of trash went to landfills, and if it was not for recycling, 258 million tons of trash would pile up in landfills [4]. Recycling can save a lot of resources and help the world be more sustainable. However, reports show that low percentages of people recycle even though the majority of people say recycling is a good thing. Some of the top reasons people do not recycle are an inconvenience, lack of time, lack of knowledge on how to recycle, and laziness [1]. To address this issue, I decided to build a mobile application for IOS designed to facilitate the recycling process for the average person. GreenLens can help resolve this disastrous issue since it is easily accessible and takes a short amount of time. What makes it unique is that in addition to classifying wastes, it also gives proper instructions on how to dispose of the waste to people who may not know.

2. Methodology

The first step was to find a place to code the project. Since this is an IOS app, my mentor and I chose to use Xcode, a software specialized in IOS development. However, I have a windows computer. At first, I tried to use a virtual machine to have a macOS environment on my windows computer, but it was not working. The first step in approaching the project was to find and collect my data. I used folders from the internet with images of common wastes to train in Azure, a cloud computing software that can be used to perform highly computational tasks. The goal here was to use Azure to train an AI model to detect images and recognize each type of waste. The dataset used to train the model was acquired on Kaggle [5], and had 18 labels of different wastes, and each label contains over 100 waste images. The 18 wastes include diapers, bowls, plastic bags, towels, toothpicks, band-aids, thermometers, batteries, bulbs, newspaper, boxes, cans, plastic bottles, glass bottles, napkins, toothpaste tubes, toothbrushes, and leftover food. After training, the model had an accuracy of around 85% to 95% on the training and validation data. The training and validation accuracy were similar, so we can be sure we found a good balance between overfitting and model complexity. After training the model and tuning model hyperparameters, I exported the model as a .ml file to be implemented into the program. I then used Xcode to develop GreenLens for using data from the model and the camera configuration on an iPhone. The camera captures many constant images, then processes each image frame into the model to calculate what type of waste it is. Then GreenLens will return

what type of waste it has detected (residual, hazardous, recyclable, or food waste) and detailed instructions on how to dispose of it

3. Experiments & Results

Table 1: TRAINING ACCURACY - GreenLens

Class	Precision	Recall	A.P.	
Newspaper	100.0%	100.0%	100.0%	
Diapers	100.0%	100.0%	100.0%	
Thermometer	95.2%	100.0%	99.2%	
Leftover Food	95.2%	100.0%	99.8%	
Battery	95.2%	90.9%	98.7%	108
Cartons/Boxes	95.0%	95.0%	99.2%	
Bowls/Dishes	95.0%	95.0%	96.9%	
Towels/Rag	94.1%	80.0%	96.1%	
Cans	93.8%	68.2%	93.0%	
Plastic Bag	92.9%	65.0%	80.7%	
Plastic Bottle	90.5%	90.5%	98.0%	
Glass Bottle	90.0%	90.0%	97.6%	
Bulbs	84.2%	80.0%	94.5%	100
Toothpicks	83.3%	78.9%	82.8%	
Toothpaste Tube	83.3%	52.6%	76.2%	
Toothbrush	83.3%	78.9%	85.7%	
Band-aid	81.0%	85.0%	93.6%	
Towels/Rags	70.0%	70.0%	83.3%	

The results from the tests were very successful. It was able to recognize all labels with at least 85% accuracy. It only takes a few seconds to detect what waste it is after pointing the camera at something. GreenLens is extremely efficient since it is portable and helps users effectively identify wastes and provides instructions for disposing of them.

4. Conclusion and Future Work

Recycling properly is important because plastic pollution destroys the environment. In addition, most Americans are unsure how to recycle properly, causing further damage. By training images in Azure and developing an IOS app called GreenLens in Xcode, we have shown that we can solve this problem with this app that can scan different wastes and classify them along with providing disposal instructions. Our solution was shown to be 85% effective at solving the problem. In the future, I might consider making the model more accurate by training more images under each waste label to do a better job.

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Improving The Accuracy of COVID-19 Diagnosis Using X-ray Imaging By Jaehong Kim

Abstract

Recently COVID-19 and viral pneumonia have heavily affected the world's public health. Among methods to detect lung diseases, chest radiography is considered to be the most effective means by health professionals. Thus, this paper focuses on the design of a convolutional neural network (CNN) to classify COVID-19 and pneumonia X-ray images. Based on code from Kaggle, an online community platform for data scientists and machine learning engineers, three different datasets were trained and tested to identify lung disease using VGG-16. The code was refined to include image pre-processing and avoid potential overfitting. Given that the original dataset was limited and did not reflect real-world circumstances, more X-ray images were added to train and test the model. In addition, the modified model — with changes in the number of epochs and addition of image pre-processing — included larger image datasets. Using a larger number of X-ray images for testing, the modified model achieved a higher accuracy (85%) than the original code (80%). Ultimately, the expensive and time-consuming diagnosis of lung diseases using computed tomography will be replaced with the accurate yet cheaper and more accessible method of chest radiography, X-ray. This model shows promise for application in the medical field, but more research and validation are required before employing it in clinical practice.

Introduction

The world population has suffered from several lung diseases, including pneumonia and SARS-CoV-2 (COVID-19). Along with other diagnostic methods, health professionals prominently select chest radiography as a distinctive means to detect lung diseases. X-ray has been employed for pneumonia detection; however, physicians prefer computed tomography (CT) over X-ray for COVID-19 detection because chest CT allows more accurate observation as a sensitive routine imaging tool for the disease.¹⁻³ Nevertheless, Royal College of Radiologists argued that CT should not be utilized as the sole diagnostic tool for potential COVID-19 patients due to challenging hygiene management: ventilation, airflow, and sanitizing and cleaning the scanner rooms.^{4,5} Moreover, according to the New Hampshire Insurance Department, the statewide average cost for chest CT is \$3,243 while the average cost for chest X-ray is \$702.^{6,7}

The price difference causes health disparities, possibly leading to the lack of accessibility to accurate chest radiographic diagnosis of COVID-19. Thus, this paper focuses on classifying COVID-19 and pneumonia images with chest X-ray images to improve lung disease detection using the VGG-16 convolutional neural network.

COVID-19

COVID-19 has significantly affected the entire world since December 2019. Starting in Wuhan, China, the disease spread rapidly to other Asian countries including Thailand, South Korea, Japan, Singapore, and Iran.⁸⁻¹⁰ The disease continued to spread across the borders, leading the World Health Organization (WHO) to declare the COVID-19 outbreak as a pandemic.¹¹ COVID-19 results in human respiratory tract infections ranging from mild cold to severe respiratory distress syndrome.¹² COVID-19 infections spread through contact and droplet transmission.^{13, 14} Thus, the common means of spreading the infection include transmission by cough, sneeze, droplet inhalation, and contact with oral, nasal, and eye mucous membranes.¹⁵ The common symptoms of COVID-19 mainly include fever, cough, and myalgia along with sore throat, headache, chills, nausea or vomiting, diarrhea, ageusia, and conjunctival congestion.¹⁴ Moreover, older patients who previously had a chronic underlying health condition, such as cardiovascular disease, lung disease, kidney disease, or invasive tumors, experience severe symptoms from COVID-19.¹⁶

Detection and diagnosis of COVID-19 commonly occur using two methods: real-time reverse transcription polymerase chain reaction (RT-PCR) and chest radiographs such as computed tomography (CT) and X-ray, both being the most powerful radiological imaging tools for detecting COVID-19 related pneumonia.¹⁷⁻²⁰ Due to false-negative results from RT-PCR, radiographs — especially CT scans — provide a more sensitive diagnosis of COVID-19 than RT-PCR.^{21,22}

Viral Pneumonia

Pneumonia is a common disease and remains a leading cause of death among young children in developing countries and the elderly in developed countries.²³ The WHO recently recorded 450 million cases of pneumonia with 4 million deaths annually, which represents 7% of all deaths.^{24, 25} The United States estimates more than \$17 billion is lost annually because of the

economic burden of community-infected pneumonia.²⁶ Viral pneumonia could result from SARS, avian influenza A virus (H5N1), 2009 pandemic influenza A (H1N1), and MERS.²³ Pneumonia with lung damage occurred in about 16% of all people infected with the SARS virus and 80% of severely ill patients.²³ Most avian influenza patients experience pneumonia and the most common cause of death from avian influenza is progressive respiratory failure.²⁷ Half of severe cases of H1N1 in Australia had viral pneumonia or acute respiratory distress syndrome, a rapid progressive disease which causes fluid to leak into the lungs.^{28, 29} Scientific development, including PCR and chest radiography, supports advanced detection and examination of respiratory virus infections such as pneumonia.^{23, 30}

Due to the challenge of testing specimens, the American Thoracic Society recommends chest radiography for a pneumonia diagnosis.^{23, 30} Images of SARS, H5N1 and H1N1 infections are often “interstitial, patchy, and bilateral.”³¹ Since pneumonia can be caused by various respiratory diseases including SARS-Coronavirus, MERS, and Human Parainfluenza Virus, radiographs of viral pneumonia allow radiologists to distinguish viral infections.³²

Machine Learning

Convolutional Neural Network (CNN) is a type of feed-forward artificial neural network machine learning method that has been successfully applied to analyze visual images. It is inspired by biological processes of neurons in the animal visual cortex.³³ Accordingly, this paper focuses on a machine learning model that employs CNN. The model will allow the expensive and time-consuming diagnostic of lung diseases using computed tomography to be replaced with accurate yet cheaper and more accessible chest radiography, X-ray.

Materials and Method

To improve lung disease detection, I initially implemented code from Kaggle to expand my understanding of the VGG-16 model and image classification with lung X-ray images.^A The model that I adopted in this experiment is VGG-16, which is a convolutional neural network known as “ConvNet.” Before VGG-16 was presented, many CNN models used large convolution filters. Convolution filters allow a model to process an image by adjusting a pixel along with other adjacent pixels. However, VGG-16 adopted a small-size filter (3x3), and it made VGG-16

strong at image classification and anomaly detection. The small-size filter will allow the model to process images with better resolution on specific parts of the images.

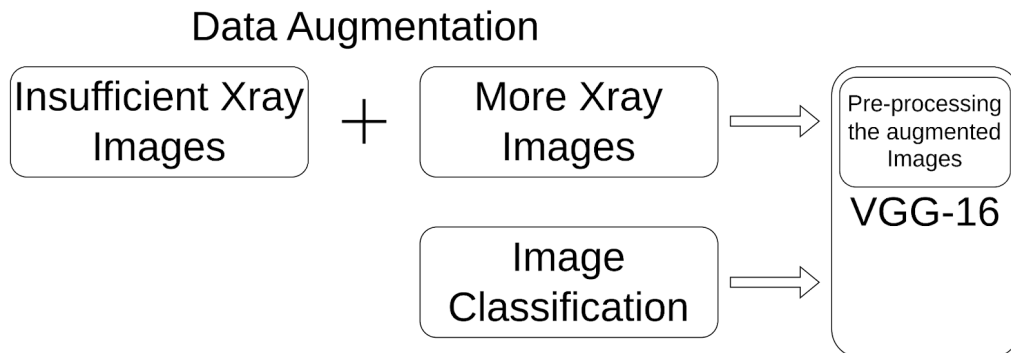


Fig. 1. Model structure.

The original training code contains modifications to the VGG-16 model with two dense layers and two drop-out layers, which clarify the grayscale images and prevent overfitting. Using drop-out nodes in the dense layer reduces overfitting because the random drop-out nodes will decrease the possibility of one node significantly influencing the output.

Additionally, due to an immense portion of images having unnecessary information that can confuse my model during the training, I added an image preprocessing step to zoom in on every input image.

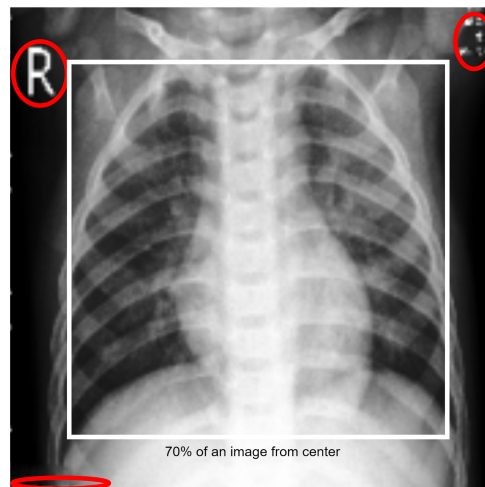


Fig. 2. Visualization of the Image Preprocessing.

Red: Unnecessary information for my model White: Area of an image that goes into my model Dataset

I implemented three different types of datasets: original, enhanced, and real-world images. The datasets include chest X-ray images of COVID-19, viral pneumonia, and normal patients. The original dataset is the identical dataset of 317 images the original model employed. The small number of images limits the practicality of the model, which was improved by using additional images from another Kaggle radiography database.^B The enhanced dataset is a combination of the original dataset and partial images from the radiography database, composing 4345 X-ray images. Finally, the real-world situation dataset includes 15470 X-ray images for training and testing.

Experiment

To successfully process a large number of images, I utilized an NVIDIA V100 GPU to train and test my model. I planned and executed three different approaches for improvement: 1. running the original code with three different datasets; 2. tuning of hyperparameter; 3. image preprocessing.

After running the initial notebook, I expected that there was overfitting when using the original code with the original dataset. Hence, I decreased the epoch value to 45 from 64. Overfitting occurs when the model learns the pattern from the training data with no generalization to the test data. Reducing number of epochs allows the model to learn the pattern from the training data fewer since epoch indicates the number of the algorithm process the training dataset.

However, the images of datasets retain unnecessary information at the edge. For example, the direction mark, date, or shapes of medical appliances are irrelevant to the model. Therefore, as shown in Figure 2, I added image preprocessing to eliminate unnecessary information from the datasets.

Results

Approach	Evaluation Benchmark		
	Original Dataset (317 Images for	Enhanced Dataset (4345 Images for	Real-world Dataset

	Train & Test)	Train & Test)	(15470 Images for Train & Test)
	Accuracy	Accuracy	Accuracy
Original Code	98%	86%	80%
A (Decrease Epochs from 64 to 45)	99%	88%	82%
B (Image Preprocessing)	99%	93%	85%

Table 1. Performance Comparison Between Datasets. Red = Original Code. Blue = Complete Modified Code

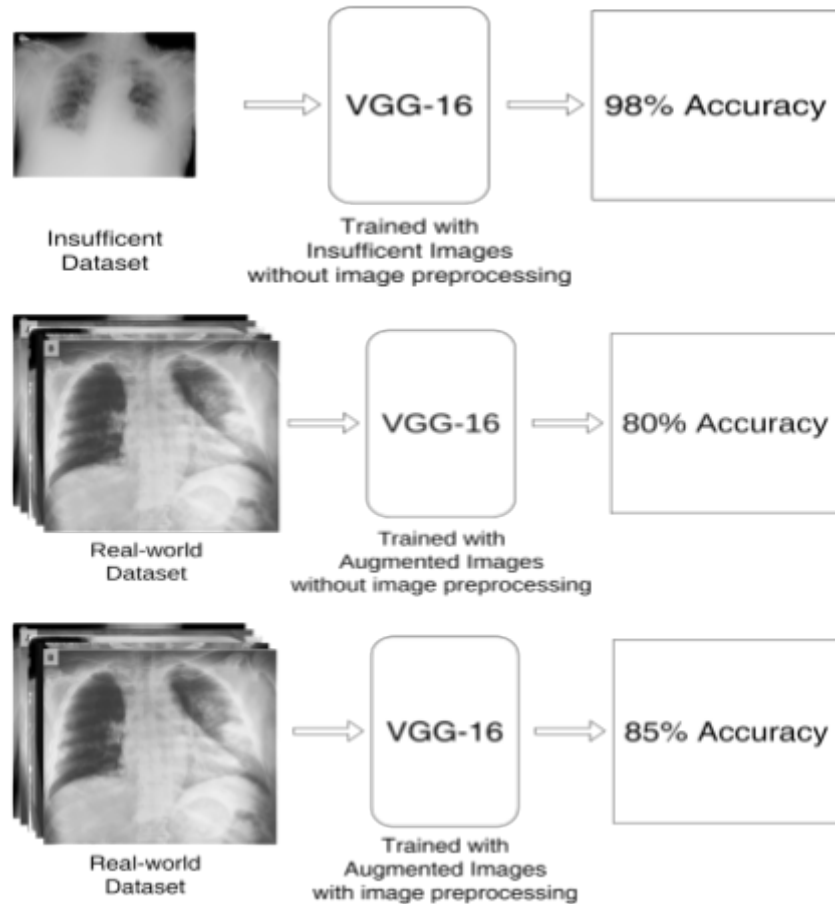


Fig. 3. Structures of 3 Different Codes with Original and Real-world Dataset

First, I tested the original code; the original code without image preprocessing shows 98% accuracy for the original dataset. However, when I trained and tested it with Enhanced Dataset and Real-world dataset, it showed 86% and 80% accuracy, respectively. Thus, I decreased the epoch number from 64 to 45. The accuracy improved for each dataset to 99%, 88%, and 82%, for the original, enhances, and real-world datasets, respectively. To minimize the effects of the unnecessary information, I decided to crop 30% of the edge from the image. After I applied the image preprocessing steps, the accuracy from the enhanced dataset and real-world dataset improved to 93% and 84%, from 86% and 80%, for the x dataset and y dataset, respectively.

Conclusion

The VGG-16 model allowed us to distinguish between the chest X-ray images of normal, COVID-19, or viral pneumonia-infected patients. Decreasing the epoch value from 64 to 45 allowed the model to prevent overfitting of the original dataset. The value 45 was chosen since it was not extremely smaller than 64 and ensured 99% accuracy with the original dataset, being higher than the accuracy with an epoch value of 64. Similarly, discarding 30% of the edge of the images allowed the model to process accurately without excluding essential information. By increasing the size of the dataset and adding the image preprocessing step, the accuracy decreased compared to the original code and original dataset. However, the range of the model coverage increased because it was trained with a roughly 50 times bigger dataset with an image preprocessing step.

The model ultimately increases the utility of chest X-ray pictures to distinguish between SARS-CoV-2 or pneumonia. The high accuracy of the diagnosis using the model and X-ray images would allow patients who do not have access to CT to be diagnosed. X-ray is the most favored chest radiography for COVID-19 detection. Clinicians will not be able to apply the model directly to diagnose the disease, but provided context that deep learning models with large sizes and refinement of the dataset aids the model to achieve higher accuracy. Moreover, the effectiveness of diagnosis would benefit from this model since COVID-19 and pneumonia are both lung diseases.

Further research on using AI in medicine for this application is still required. Since the accuracy is 85% within 15,470 X-ray images, the model does not demonstrate perfect detection

of lung diseases. Furthermore, unexpected variables including the defection of X-ray machines and the medical condition of the patient might inhibit the model to perform optimally. As the variance of COVID-19 is diverse, the hopeful result of future research in this area will lead to more accurate diagnostics with those variants along with other respiratory diseases. The pandemic has not ended and the future impact of the disease is still unknown. Ultimately, the result of the model contributes to a hopeful message to end the pandemic with improved medical technology.

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Parabolic Evolution in Twentieth-Century Science Fiction Masterpieces: *The Time Machine* and *Planet of the Apes* By Edward Yoon

In *The Planet of the Apes* (1968), the sacred scrolls of ape society state that “Beware the beast man, for he is the devil's pawn. Alone among God's primates, he kills for sport, lust, or greed. Yes, he will murder his brother to possess his brother's land. Let him not breed in great numbers, for he will make a desert of his home and yours. Shun him. Drive him back into his jungle lair: For he is the harbinger of death” (*Planet of the Apes*).

Mankind kills and demolishes for land, food, other basic necessities, and materialistic pleasures as reflected in many historical happenings: the world wars, the Cold War, etc. As proven through the *Time Machine* and the *Planet of the Apes*, it is inevitable that top species turn into colonial powers and end up harming their own selves. Throughout history, colonialism has been a means for brutally and willfully taking over others' land for one's own benefit. The greed and violence in human nature sparked multiple battles for humans spewing great bloodshed among their brothers. Many dictators have arisen throughout the course of history and have been cruelly murdering their allies, and enemies for the sole purpose of expansion. They believe that once their dominance is asserted after colonialism is fulfilled, they will become an economic and political superpower. This pattern throughout history and my two sources is evident in the 1968 film *Planet of the Apes* and H.G. Wells' 1895 novella *The Time Machine*. Colonialism is an inevitable and gruesome part of any civilization with different types of species in a society.

Both sources show how not many of these gruesome colonizers even had the faintest idea that their goals of expanding their country and benefiting their country would eventually bring about the demise of their own land. Nearly every ruler who has tried to colonize another land or species always ends up in a lower position. *The Time Machine* will be explored mainly through the theories that the Time Traveler suggests of how the world came to be in the future. *Planet of the Apes* will explore the holy texts of the apes and their outlook on humanity. I argue that both sources, despite the fact that they were produced more than seventy years apart, draw on an idiom of evolutionary theory to present this theme that I call “parabolic evolution.”

Parabolic evolution is a pessimistic way of conceiving of the history and future of humanity that emphasizes human arrogance and self-deception. Taking these two words separately, by evolution I refer to the familiar definition: the change of species over time due to

natural selection. The common understanding of evolution is either linear or exponential, as both styles of graphs gradually increase (metaphorically improve) over time. For example, humans often assume that human evolution will lead to more intelligent and peaceful future generations. [constant progress] As shown through history, cavemen have developed into civilized people and those people have developed into us.

However, in *The Time Machine* and *Planet of the Apes*, evolution is represented as parabolic, with peaks and inevitable downfalls. Before the peak, the human race evolves quickly towards a better life, just as in the linear or exponential understandings of evolution. But soon, it reaches its peak and goes into a steep decline, losing the intelligence, peace, and other advantages of its rise. Crucially, this parabolic pattern of evolution is natural and inevitable: both sources emphasize that humans should not be so arrogant as to think they can escape it.

The Time Machine

The Time Machine reflects the relationship between colonialism, parabolic evolution, and the lack of successful colonizers throughout history. The Time Machine was written by HG Wells in 1895 which was right after the Sino-Japanese War and before World War 1. It was a time when war and colonialism was raging over the world. Also, Wells was known to be an evolutionary thinker and his views were portrayed in this novella. In *The Time Machine*, the Time Traveler travels through time only to discover a disappointing and catastrophic society where humans have essentially “gone backward.” When he arrives, he explores but loses his time machine. He finds that humans have devolved into two species, the Eloi and the Morlocks, which have taken away their human quality. The Eloi have become dimwitted and have lost most of their ability to think intelligently and act with survival techniques, while the Morlocks have become vicious creatures who devour the Eloi and act like savage beasts. Yet, the Eloi are beautiful and enjoy lavish lifestyles. The Time Traveler journeys through this eccentric world developing different theories to explain what devastating effects turned humanity into such foul creatures. After all, the future did not seem the idyllic future that they expected..

Before delving into the theories themselves, I will introduce the protagonist in more detail, with a focus on his adventurous and curious traits. The Time Traveler is not like many others as he enjoys discovery over the safety of his life.

When he first arrives in the distant future, the Time Traveler is met with a bizarre human race who are childlike, passive in nature, who lack ambition and knowledge. During his stay, he discovers that the Eloi are not the only human species of the future, but he proposes his first theory based on his belief that all of the humans have turned into Eloi, which shows his social class. In the futuristic world, he has only yet experienced the upper world, the society of the Elois, and does not have any knowledge of the existence of the Morlocks. The first theory suggests that the time traveler only takes into account the society that he has lived in. He has lived in a world where many people below his social class toil for days in order to support the opulent living conditions of the rich. Therefore, he believes that since the Elois are able to live in such pompous conditions, they are his direct descendants. Also, it is normal for the Time Traveler to theorize about the origin and what story he should tell to his friends rather than looking out for his life as it is custom for rich people in Europe. He assumes that his model for society would spread everywhere else throughout the future as well. We can characterize this theory as “Utopian,” naive, and idealistic by the Time Traveler as this could only happen if there are no “dips” in the evolution of mankind.

His second theory is prompted by his discovery of a species dwelling underground which he initially believes is as dim-witted as the Eloi. Rather than all humans evolving into Eloi, now the Time Traveler decides that the “social difference between the Capitalist and the Labourer” (Wells, 36) has led to a diversion into two species. He believes that the pre-evolution Morlocks were utilized for grotesque and physical tools such as the underground Metropolitan Railway in London and jobs that the low-lives would take on. The characteristics of the Morlocks enjoying the dark caves and only coming out at night reflects what the workers have grown accustomed to spending many months under the ground. On the other hand, the rich and luxurious people who spend their lives above the ground, sipping their tea and enjoying the physical and physiological luxuries of life have grown naive. The rich people have become educated and have increased facilities that prevent the lower class from developing. This prevented social contact between the two species which divided them. Above the ground was a civilized, yet inexperienced group who have gone through parabolic evolution, and below the ground was a savage group of people who devolved. This reflects colonialism’s relationship to parabolic evolution because the colonialists were not able to develop over the long span of time. Due to strict hierarchical rules, the upper class of Europe would sit back in their majestic palaces and watch the inferior “species”

gruesomely go after each other's throats. However, after venturing into the tunnels of the Morlocks, the time traveler realizes he misjudged their temperament. The Morlocks were predators and the Eloi were their game: "These Eloi were mere fatted cattle, which the ant-like Morlocks preserved and preyed upon—probably saw to the breeding of" (Wells 90). Wells' depiction of the Morlocks and Eloi can be read as a perfect metaphor of class division and a critique of capitalist societies. As a result of an overly capitalist system that divided humanity into several species, each class evolved. Humanity arrived at a stage where evolution followed its natural course as the chasm between the upper and lower classes widened. He is shifting from a capitalist ideal of competition but relative logic between the wealthy and poor and perhaps even the potential for the poor to become wealthy to one of a more communist bent, where there is an inherent struggle between the classes that now has become biological.

All of the Time Traveler's theories are based upon the intellectual and historical context of Europe in the late nineteenth and early twentieth centuries, where social classes were an important aspect of society. Society was highly based on the roles of specific people and was roughly divided between two classes: [19c class structure].

When he arrives in the distant future, he thus believes the working class had developed over the years their ability to do physical labor and had honed the survival skills that turned them into cannibalistic undergrounders. On the other hand, the rich's sense of laziness had increased. Their sense of survival has decreased significantly and they have become less intelligent. The rich and luxurious people who had been excessively focused on colonizing parts of the world have ironically gone backward in their development. In the nineteenth and twentieth centuries, rich and wealthy people were regarded as intelligent and educated. This is significant to the idea of colonialism because the rich did not see any competition.

A fear that existed in Victorian society was the fear of colonialism of their own nation which led them to colonize others. Cantor and Hufnagel argue that becoming as primitive as the cultures they conquered was something that the imperial British greatly feared (3). The Victorian Era (1837-1901) was a time of exploration and expansion: the British Empire conquered about a quarter of the earth's surface. They saw themselves as superior to and far more advanced than the civilizations they encountered – echoing the relationship between the upper and lower classes at home, only on a global scale. They used this as an excuse and a justification for laying them under the Union Jack and converting them to British religion, language, and education. Since

Victorian society thought of themselves to be so far ahead, they thought the conquered colonies to be the inferior beings of the empire's past. However, degeneration on the part of the British would push this balance of power in the opposite direction. A degenerated future meant the loss of all the power that the British Empire had accumulated and all the wealth and comfort it brought with it. The Morlocks of the Time Traveller's tale illustrate this; they are taking their revenge on their former masters, the Eloi, by controlling them and raising them for pig slaughter just in order to devour them. Just as the Eloi are becoming cannibalized by their former subjects, so might the British Empire and therefore, the Victorian society, become cannibalized by their former colonies in a degenerated future.

In this section, Parabolic evolution that can be seen through the time machine was emphasized. The Eloi and the Morlocks represent the realistic evolution of modern Englishmen. This pattern of parabolic evolution can also be seen in real life.

The Planet of the Apes

The 1960s is a time right after the Second World War. Superpowers such as Germany and Japan had desperately tried to take power over the world. This can be seen as the peak of colonialism. *The Planet of the Apes*, released in 1968, takes place in a future world where 4 astronauts head out to space based on the theory that time flows differently when traveling at the speed of light. They crashland on a planet they do not know is Earth nearly 2000 years after taking off. They encounter speechless humans and recognize them to be aliens and think that they are on another planet. After exploring, they come across a species that call themselves apes and are superior to men. They leash the men like wild animals and do what humans do to wild, savage, and uncontrollable creatures. George Taylor, a man who flew in on the spaceship with three other men, is the only one left alive after the ambush from the apes. In this mysterious world, humans are not able to talk because their brains do not function as they do in the twentieth century. The "superior" apes test run tests like humans run animal testing on these creatures. They wish to figure out why men's brains are not able to function properly and speak, since physiologically they appear able to do so. They have conducted tests on Landon, one of Taylor's fellow astronauts, and have turned him into a dimwitted pile of flesh through lobotomy that doesn't give him any distinguishing traits from other savage animals.

A supportive chimpanzee named Dr. Zira attempts to assist Taylor in getting freedom from the apes because she finds it fascinating that such an inferior species that they found to be was actually a man who could reason and speak. Therefore, she stands up for the man in front of the hearing and tries to fight for Taylor. However, when she tries to bring up the archaeological evidence her fiancé Cornelius found in his expeditions during his journey, a high-powered scientist orangutan named Dr. Zaius immediately eradicates all possible evidence. It can be shown that the apes were previously evolved from man as he destroys the paper airplane with the expression that it would harm his own civilization. He also asks his workers to immediately decimate the cavern in which there is archaeological evidence of previous civilizations. This is a contest over human rights and Taylor's struggle for fair treatment.

Planet of the Apes represents colonialism and evolution showing how humans fare when they are complete outcasts of a seemingly familiar society. But for Taylor and the (human) audiences, a primary question is how human-ape relations came to be inverted. During the movie, it is stated in the beginning and at the end that humans killed their brothers, tortured their own people, satisfied their own greed with any technique, and conquered land while holding their own species hostage. This can be seen through Taylor's radio transmission and the reading of the holy scriptures by Zaius. This is evidence of colonialism as when Taylor left, it was approximately the late twentieth century a time circa the Vietnamese war. Each country was striving to gain small territory strategic benefits over the world. For example, Germany was shooting down innocent civilians just to shake England into giving up some of their territory without a strong fight. That civilization that was so strong-willed in colonization has turned into speechless monsters and savage apes. In order to keep society as it is, Zaius constantly destroys evidence of the past which means that he has no intentions of evolving anymore.

Just as in *The Time Machine*, *Planet of the Apes* suggests that colonialism does *not* lead to a better world, but in fact one where the powerful colonization society falls into weakness and even oppression at the hands of the formerly colonized. The apes' world is very similar to a nineteenth-century, twentieth-century, and twenty-first-century world as the governing systems and court of law are very similar. Yet, their technology and practices are not sufficiently "up-to-date." Their system of law, which was most likely passed down from their ancestors, was men. However, Darwin's theory of natural selection most likely differentiated the two species. Natural Selection is where one part or species of population becomes the entire population over

generations of reproduction. The species is normally chosen through their ability to survive their conditions. The species that evolved into apes was able to gain more physical manpower from the others who could not speak. Soon, the world was divided into two categories, the apes who think they are superior, and the humans that are inferior.

Compared to the time traveler, Taylor is very similar in the way that they process the new world and the background from which their stories were built even though they have their different objectives. Both the Time Traveler and Taylor won't stop resisting or fighting until they get what they want, even if it means risking their lives. At the beginning of the story, the Time Traveler is motivated to risk his life and try his time machine because he wants to see the future, prove that human civilization continues to progress, and out of a sense of pride in his own intelligence. When he arrives, he wants to discover more about the lifestyles of humans in the future, so he explores. He also wants to collect proof that he went to the future. But when he loses the time machine, all he can think about is returning home, and to achieve this, he risks his life several times: exploring the area, going down the hole, and fighting off Morlocks. This stubbornness and bravery seem typical of the nineteenth-century man, and in fact important for him, if he wants to be a great man, like a scientist or an explorer. But in the future, he finds that he is the only person who has this trait: the Eloi around him have no motivations beyond a vague sense of fear of the Morlocks. Therefore, the story suggests that humans in the future may evolve so they no longer have any motivation or grit.

Like the Time Traveler, at the beginning of the film, Taylor wants to contribute to expanding human knowledge and be a leader in space exploration. He also tries to explore and learn more about the world where he has landed, but when he is captured, his attention turns to focus on his own survival and his freedom. Almost immediately, he steals the notepad from Zira so he can prove that he can write. Later, he escapes from his prison to try to avoid being castrated and lobotomized. And at the very end of the film, with the help of his chimpanzee allies, he escapes the ape settlement and even takes Doctor Zaius as a hostage to help them get away. Like in *The Time Machine*, Taylor is the only one with this degree of stubbornness, especially compared to the other humans, who seem unhappy but don't do anything to escape. They share similar traits as both creatures work towards goals: escaping and researching the human brain respectively.

Also, in both ending scenes of the movie, the time traveler and Taylor wish to prove that they are superior to their adversaries. The Time Traveler spends a fortune trying to come up with a time machine for the sole purpose of showing the other scientists how superior his intellectual capabilities are. In order to showcase such abilities, he risks his life and travels into the future for the sole purpose to showcase his knowledge. Also, in the final scene of *Planet of the Apes*, Taylor holds Zaius hostage to show that he is superior to the apes. He desperately wishes to show that his own home society, twentieth-century Earth, is far more developed than the puny apes. This hints at their violent and striving natures as both will do whatever it takes to achieve their collective goals. The Time Traveler ends up killing many Morlocks just to retrieve his device to get back home. Therefore, this shows a huge similarity between the two protagonists.

The message of the movie is that any species once evolved, will devolve. This is a fixed fate but there is no need to be pessimistic about our future as devolution will be nearly millions of years in the future.

Conclusion

Colonialism, the ability to conquer, is the peak of one people's evolution, but it is a short peak: they will quickly and inevitably go into decline and face the vengeance of those they hurt along the way. This is what we see with the Morlocks and the apes. In *The Time Machine*, as Elois wanted to lead more opulent lives, they evolved into lesser beings. They solved all of the problems facing humans, but this only led to new problems such as humanity generally moving backwards. This is where I believe parabolic evolution is most directly relevant. Literally, a parabola represents the timeline of human evolution according to Wells. In a downward-facing parabola, once a point reaches its peak, it is bound to go down. This is what happened with Elois. In the Time Traveler's final hypothesis, he hypothesized that the Elois used to be the rich class who were in control of their city and population. This or a few years of life after this period can be seen as the peak. After, the Elois became lazy as they could not hone their survival instinct as the lower class did all of their grunt work.

Although it was released in a different medium and a different century, *Planet of the Apes* offers a similar analysis of human civilization: we humans are at the peak and will soon fall. However, as stated in the holy scriptures, the Apes were meant to tear each other apart for land

and small advantages over each other. If seen closely, the legal system, dining system, and hunting systems all seem to be downgraded versions of the respective human activities.

Parabolic evolution is the process of natural evolution that takes place for millions of centuries. Once a species develops, it's bound to go down. What we see as constant progress toward a better future is in fact doomed to slip into decline. and that these sources remind us not to be too arrogant and to focus on being perhaps kinder to one another

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Understanding the Correlation Between the Diagnosis Outcome of Breast Cancer and Anemia Using Machine Learning-Based Classification Models By Aarav Gupta

Abstract

Breast cancer is a leading cause of death among women globally, with millions of cases diagnosed each year. Anemia is a common blood disorder affecting millions of people worldwide. Early and reliable diagnosis of both anemia and breast cancer can prevent complications and reduce the number of deaths caused by these diseases. Machine learning (ML) algorithms have the potential to contribute significantly to the early detection of both, thus saving lives. This study seeks to further investigate the relationship between the types of features extracted and the accuracy of a diagnosis by evaluating the performance of three widely used and reliable ML algorithms in the context of both breast cancer and anemia diagnosis: Decision Tree, Logistic Regression, and K-Nearest-Neighbors(KNN). We observed that the Decision Tree algorithm represented the highest accuracy of 0.926 for the anemia dataset, while the KNN algorithm showed the highest accuracy of 0.947 for the breast cancer dataset, in which all models performed with an accuracy between 90% and 95%. Through the correlation study, we found that, in the anemia dataset, the Hemoglobin level (correlation coefficient of -0.703) and Hematocrit level (correlation coefficient of -0.668), variables are the strongest predictors for the type of anemia. In the other dataset, the predictor variables (texture_mean, perimeter_mean, fractal_dimension_se, and texture_worst) have a correlation of nearly 1.00 with the diagnosis. By comparing the performance of these algorithms in diagnosing breast cancer and anemia, the results of this study demonstrate the potential of ML algorithms in the medical field and highlight the importance of considering the type and quality of predictors when evaluating the performance of these algorithms. These findings can have important implications for developing improved tools to diagnose and treat breast cancer and anemia. They may also suggest ideas for future studies and evaluate the potential of these algorithms in improving diagnosis and treatment outcomes.

Introduction

Anemia is a prevalent and potentially serious health condition that affects individuals of all ages and has significant global health impacts [1]. The World Health Organization (WHO)

estimates that 42% of children less than 5 years of age and 40% of pregnant women are anemic [1]. The prevalence of anemia is higher in developing countries and parts of the world, particularly in sub-Saharan Africa and South Asia, where it affects over 40% of their population [1]. The WHO defines anemia as a hemoglobin concentration below 120 g/L in adult men and 110 g/L in adult women [2]. Studies have shown that anemia is more common in women than in men, with a higher prevalence in pregnant women [2]. Anemia is also more common in older adults, with a higher prevalence in those over the age of 65 [2]. It can lead to fatigue, weakness, and impaired cognitive function, and has been linked to a variety of conditions, including cardiovascular disease, cancer, and infections [3]. Breast cancer is the most common cancer in women worldwide, and the incidence of it varies greatly by region. It is more prevalent in countries with higher income, and the majority of breast cancer occurs in women over the age of 50, while only 0.5% of all breast cancer affects men [4]. Accurate and timely diagnosis and treatment of both anemia and breast cancer are important for improving individual and population health outcomes.

There has been a growing body of research on the application of machine learning techniques for the diagnosis and classification of anemia and breast cancer. Previous studies have demonstrated the potential of machine learning algorithms to improve diagnostic accuracy and efficiency, as well as to identify patterns and trends that may be missed by traditional methods. A study by Yildiz et al. used four different artificial learning methods (Artificial Neural Networks, Support Vector Machines, Naïve Bayes, and Ensemble Decision Tree) as classification algorithms to diagnose 12 different types of anemia [5]. The model was trained and evaluated using a dataset of 1663 samples, comprising hemogram data and general information such as age, sex, chronic diseases, and symptoms, collected from patient files at a university hospital in Turkey. The highest accuracy of 85.6% was achieved using Bagged Decision Trees and the validities of the models were determined through measurements such as accuracy, classification error, area under the curve, precision, recall, and F-score [5]. In another study by Naji et al., five algorithms, including Support Vector Machine (SVM), Random Forest, Logistic Regression, Decision tree, and K-Nearest Neighbors (KNN), were applied to the Breast Cancer Wisconsin Diagnostic dataset and their performance was compared using metrics such as the confusion matrix, accuracy, and precision [6]. The results showed that SVM outperformed the other algorithms, achieving the highest accuracy of 97.2% [6]. These works demonstrate the potential

of using machine learning techniques in the diagnosis of breast cancer and anemia and highlight the need for further research in this area.

In this study, we first perform a comprehensive correlation analysis between the physiological attributes and the diagnosis outcome independently for breast cancer and anemia. Next, we use different classification-based machine learning algorithms to develop a predictive model for the diagnosis outcome regarding each disease. Three algorithms are used for both the breast cancer and anemia datasets, including KNN, Decision Tree, and Logistic Regression. The performance of the models is evaluated using a variety of metrics, including accuracy, sensitivity, and specificity, which were calculated using confusion matrices. The algorithms are implemented using Scikit-learn, Numpy, Pandas, Matplotlib, Seaborn, and MLxtend in the Python programming language (version 3.9), with the Anaconda environment (version 2.3.1) serving as the platform for development and execution. There is a novelty in this study since anemia and breast cancer have not been compared to each other with the application of machine learning algorithms in order to understand the relationship between accuracy and types of features in a dataset. The results of this study can help in the medical diagnosis and understanding of the correlation between anemia and breast cancer.

Results

The anemia dataset used in this study was obtained from the Faculty of Medicine, Tokat Gaziosmanpasa University, Turkey [7]. The data contains the complete blood count test results of 15,300 patients, of which 10,379 were female and 4921 were male, in the 5-year interval between 2013 and 2018. The dataset consists of 1019 (7%) patients with Hemoglobin (HGB) anemia, 4182 (27%) patients with iron deficiency, 199 (1%) patients with B12 deficiency, 153 (1%) patients with folate deficiency, and 9747 (64%) patients who had no anemia. The data of pregnant women, children, and patients with cancer are excluded from the study (for more information on the features and their descriptions, refer to Table 1).

In order to classify breast cancer tumors into malignant or benign, we use data from the Breast Cancer Wisconsin (Diagnostic) Dataset [13]. For the breast cancer diagnosis task, the Breast Cancer Wisconsin Diagnostic dataset (BCWD) is used (for more information on the features and their descriptions, refer to Table 2). The samples are labeled as benign (212 samples) or malignant (357 samples). Both of the datasets were accessed through the Kaggle

website. One of the goals of this study is to determine the extent to which different types of features can influence the performance of the algorithms. The anemia dataset has information about the patient's blood measurements such as HGB and B12 levels (Table 1), whereas the breast cancer dataset includes information regarding measurements of the tumor itself (Table 2). After the preprocessing steps were done by removing lowly correlated variables with the target variable in the Anemia dataset, the increase in accuracy, sensitivity, and specificity indicates that removing them helps improve the model. Breast cancer classification is binary such that class 0 corresponds to being cancer free while class 1 corresponds to having cancer. Anemia diagnosis is based on 5 classes such that there is a class of anemia, each for the deficiency of Hemoglobin (Class 1), Iron (Class 2), Folate (Class 3), B12 (Class 4), and a fifth class to represent the patients without any type of anemia (Class 0). For the anemia dataset only, predictor variables that have a correlation with the target variable between -0.04 and 0.04 are removed to improve the accuracy of the three models (Figures 1-2), as suggested in previous studies [8]. However, this wasn't done with breast cancer since removing those predictor variables showed little to no difference in the model. The anemia dataset has close to 15,000 rows while the breast cancer dataset has nearly 500. The breast cancer dataset also has 3 more columns, which may be a possible contributor to the higher accuracy of breast cancer diagnosis. Most likely, the types of information/features that were recorded in each dataset are the main reason for the differences in the accuracies between the algorithms applied to both datasets.

Table 1. Definitions of Parameters for the Anemia Dataset

Parameter	Description	Unit
B12	B12	ng/mL
BA	Basophils	103/ μ L
EO	Eosinophil	103/ μ L
FERRITE	Ferrite	ng/mL
FOLATE	Folate	ng/mL
GENDER	Female/Male	0–1
HCT	Hematocrit	%

HGB	Hemoglobin	gr/dL
LY	Lenfosit	103/ μ L
MCH	Mean Corpuscular Hemoglobin	pg
MCHC	Mean Corpuscular Hemoglobin Concentration	gr/dL
MCV	Mean Corpuscular Volume	fL
MO	Monositler	103/ μ L
MPV	Mean Platelet Volume	fL
NE	Neutrophils	103/ μ L
PCT	Plateletcrit	K/uL
PDW	Platelet Distribution Width	fL
PLT	Platelets	K/uL
RBC	Red Blood Cells	Milyon/
RDW	Red Cell Distribution Width	%
SD	Serum Iron	μ g/dL
SDTSD	$(SD/TSD) * 100$	μ g/dL
TSD	Total Serum Iron	μ g/dL
WBC	White Blood Cells	103/mL

Table 2. Definitions of Parameters for the Breast Cancer Dataset

Parameter	Description
id	Unique ID
diagnosis	Target: M - Malignant B - Benign
radius_mean	Radius of Lobes

texture_mean	Mean of Surface Texture
perimeter_mean	Outer Perimeter of Lobes
area_mean	Mean Area of Lobes
smoothness_mean	Mean of Smoothness Levels
compactness_mean	Mean of Compactness
concavity_mean	Mean of Concavity
concave points_mean	Mean of Concave Points
symmetry_mean	Mean of Symmetry
fractal_dimension_mean	Mean of Fractal Dimension
radius_se	SE of Radius
texture_se	SE of Texture
perimeter_se	SE of Perimeter
area_se	SE of Area
smoothness_se	SE of Smoothness Levels
compactness_se	SE of Compactness
concavity_se	SE of Concavity
concave points_se	SE of Concave Points
symmetry_se	SE of Symmetry
fractal_dimension_se	SE of Fractal Dimension
radius_worst	Worst Radius
texture_worst	Worst Texture
perimeter_worst	Worst Perimeter
area_worst	Worst Area
smoothness_worst	Worst Smoothness

compactness_worst	Worst Compactness
concavity_worst	Worst Concavity
concave points_worst	Worst Concave Points
symmetry_worst	Worst Symmetry
fractal_dimension_worst	Worst Fractal Dimension

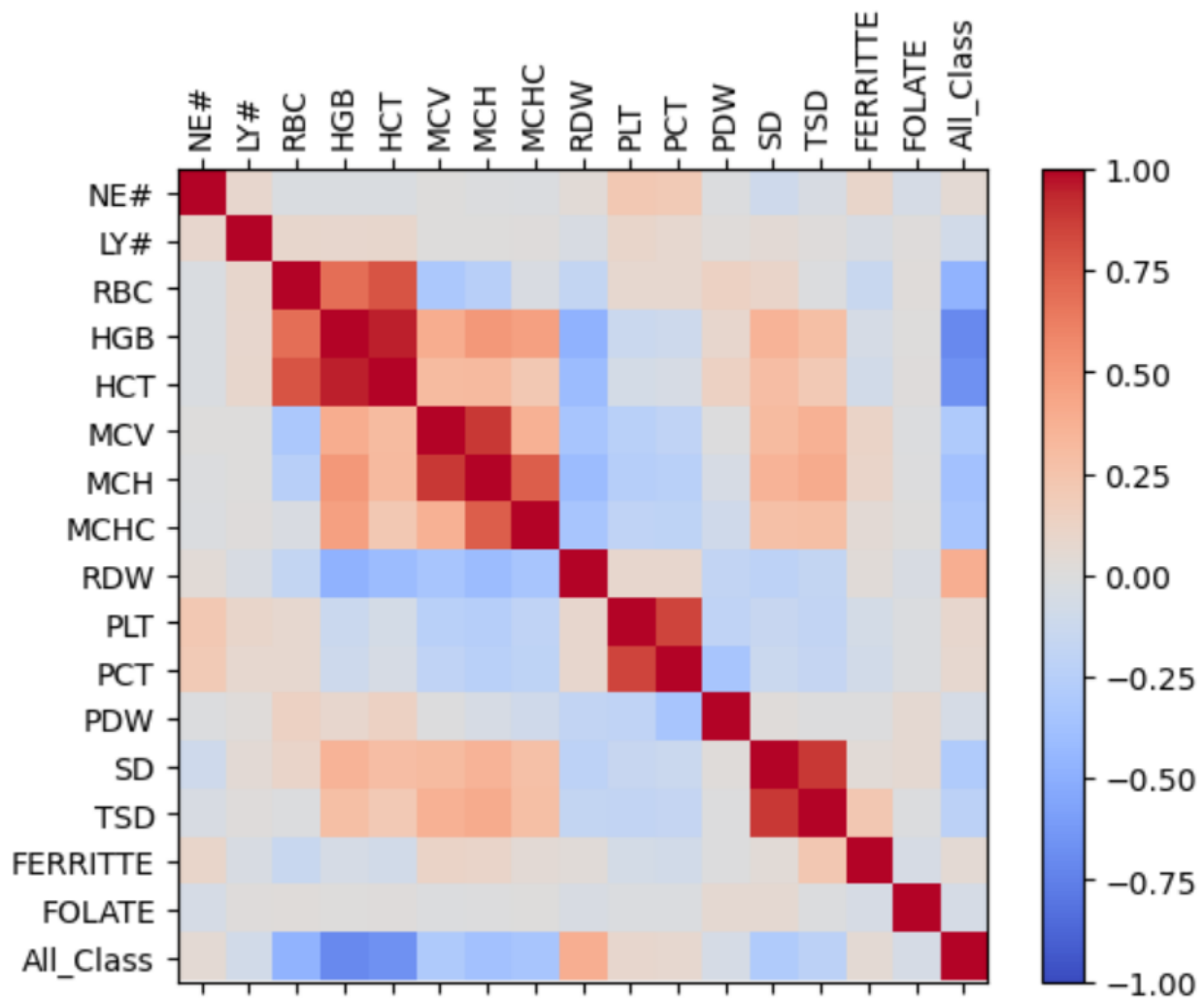


Figure 1. Overview of a correlation table for variables in the Anemia Dataset after preprocessing

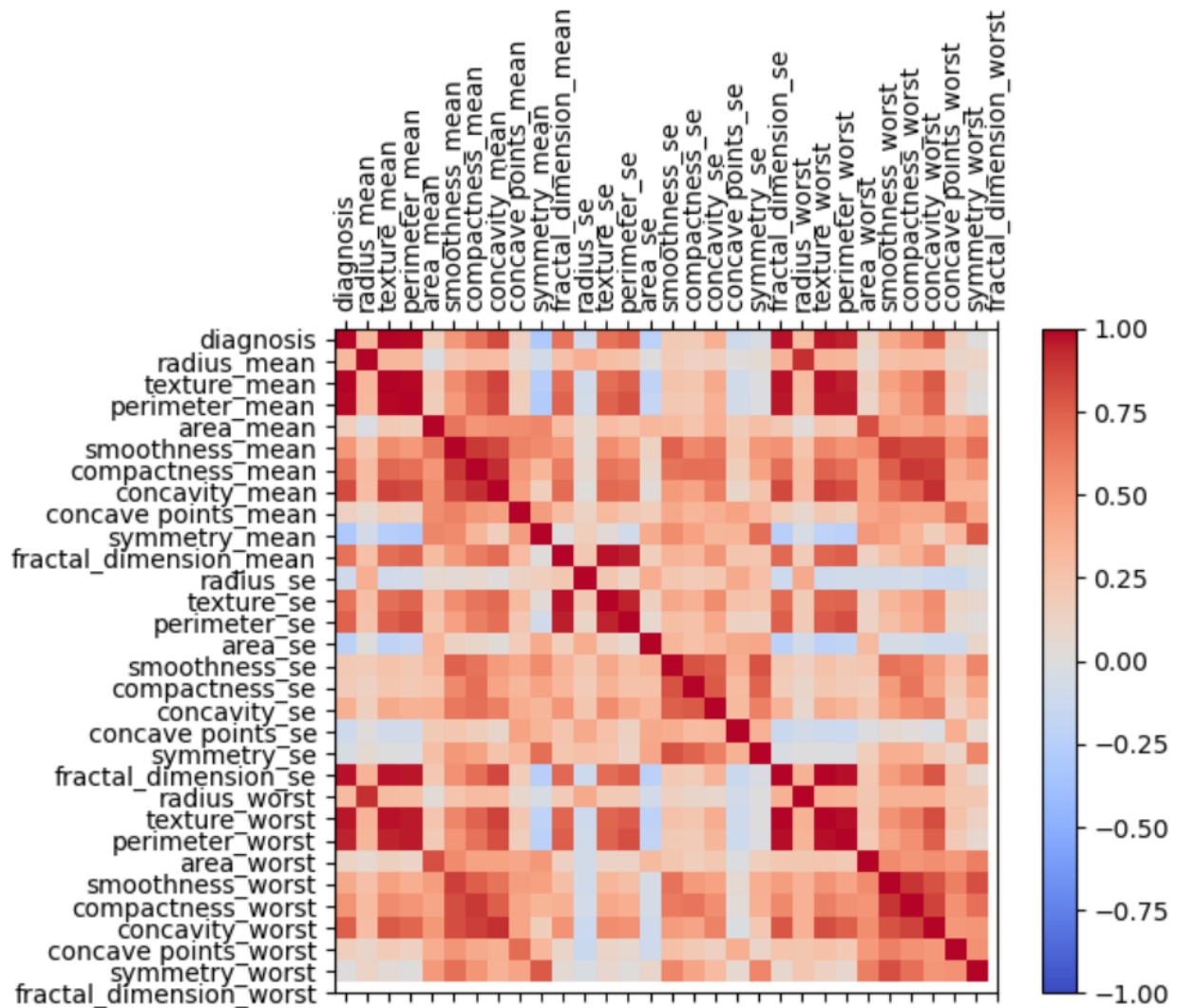


Figure 2. Overview of a correlation table for variables in the Breast Cancer Dataset

In this study, three algorithms (K-Nearest-Neighbors, Decision Tree, and Logistic Regression) are applied to both the anemia and breast cancer datasets. In order to prune the tree, we test different criterion(gini and entropy) and max_depth values until we reduce the number of nodes in the decision tree and it is legible (Figure 3). For all models, we test the data with an 80/20 train-test split. For the code of the Decision Tree model, pruning is conducted for both anemia and breast cancer (since the decision tree had a more than ideal amount of nodes and branches) in order to be able to draw conclusions from the decision tree by looking at it and analyzing the image of the tree (Figures 4-5). Since no parameters are added to KNN or Logistic Regression, they yield a lower accuracy, especially for the anemia dataset; however, Decision

Tree yields the highest accuracy for anemia diagnosis. No additional parameters are added because this study intends to determine the validity of the models without changing the extra features of those models. The KNN algorithm is used without any specific parameters, and so are the Decision Tree and Logistic Regression algorithms; however, for the Decision Tree algorithm that is applied to the anemia dataset, we prune the decision tree so that the image isn't illegible with excess nodes and branches (Figure 6). We study how the models perform on their own without the extra changes in order to test the efficiency of applying nonparametric machine learning algorithms to the fields of anemia and breast cancer diagnoses. It is important to note that the performance of each algorithm can vary depending on the specific dataset and the chosen parameters. Further research is needed to determine the optimal parameters for each algorithm and to compare the performance of these algorithms with other commonly used algorithms.

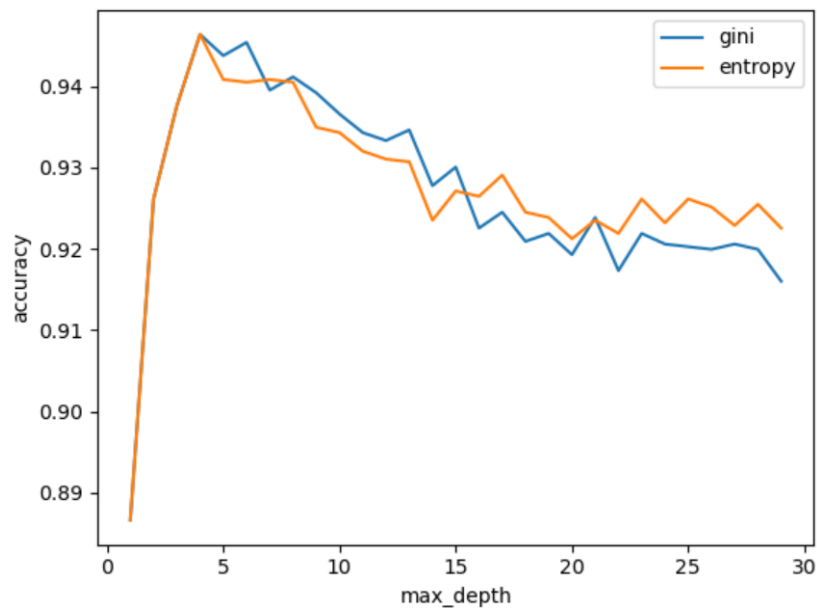


Figure 3. Overview of accuracy and comparison between the gini and entropy criterion as the parameter 'max_depth' is increased in the Decision Tree algorithm(Anemia Dataset)

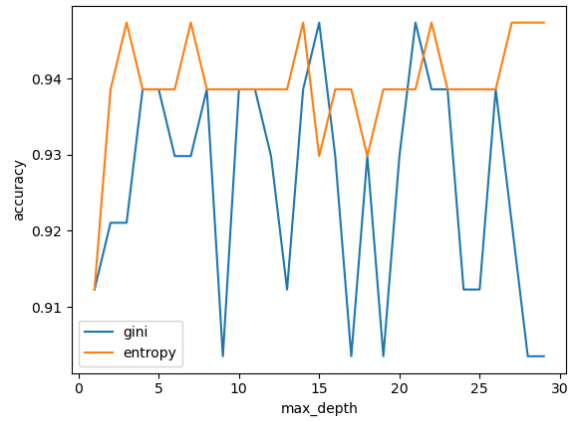


Figure 4. Overview of accuracy and comparison between the gini and entropy criterion as the parameter 'max_depth' is increased in the Decision Tree algorithm(Breast Cancer Dataset)

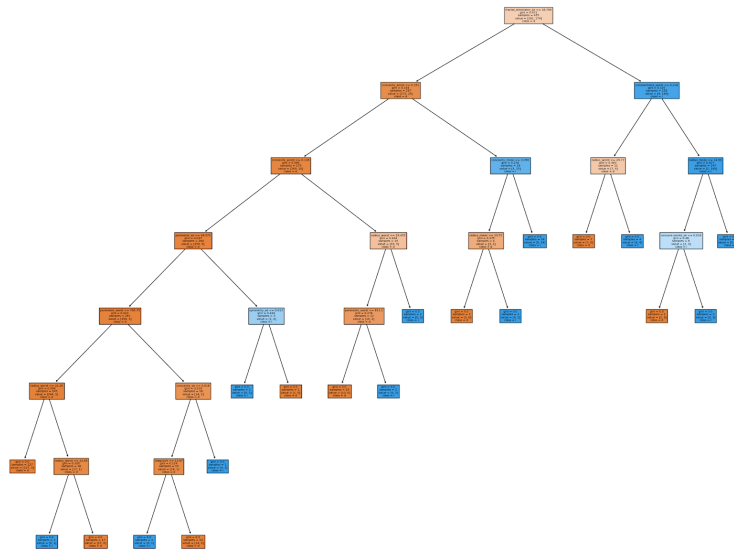


Figure 5. Image of the Decision Tree after we applied the model to the Breast Cancer dataset

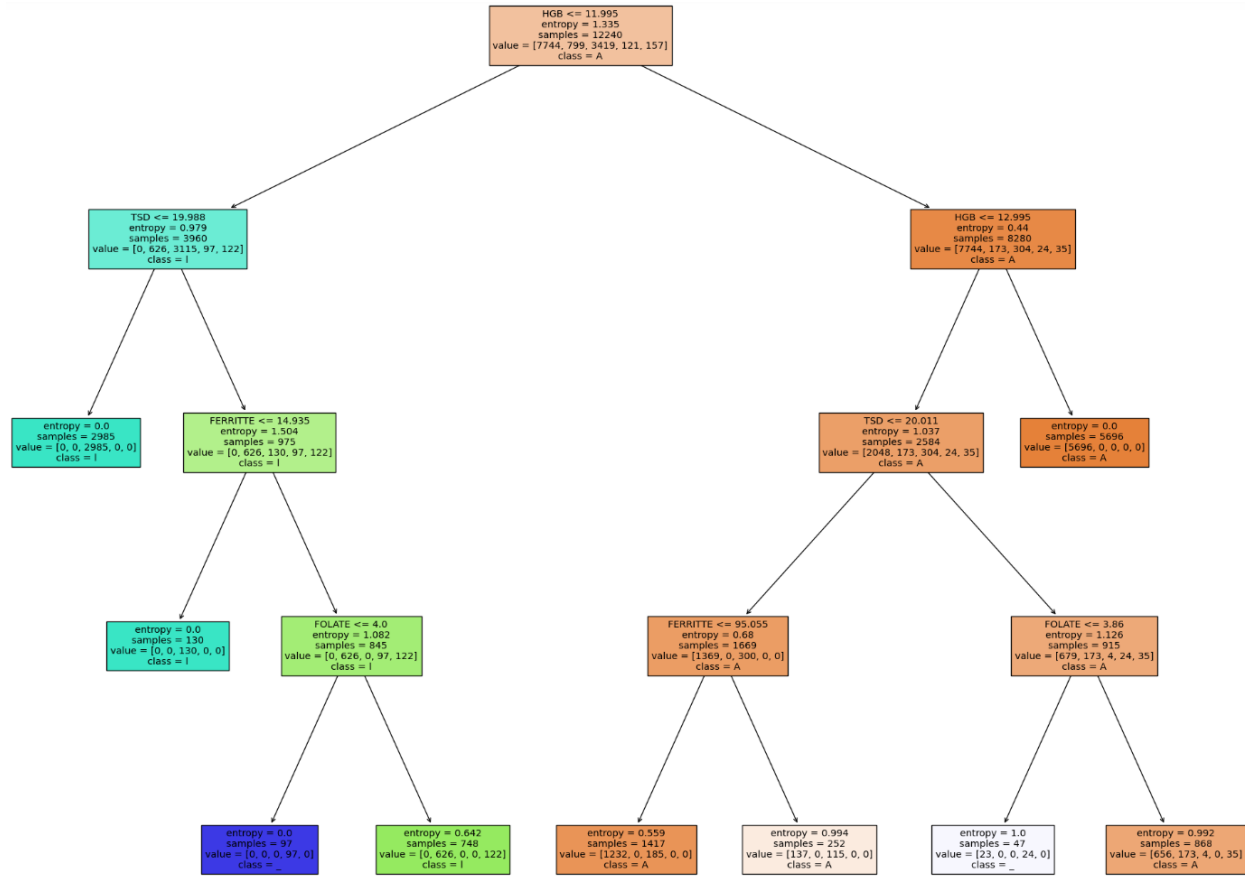


Figure 6. Image of the Decision Tree after we applied the model to the Breast Cancer dataset and pruned the decision tree

The results indicate that the performance of the algorithms varies depending on the specific dataset and the chosen algorithm. For the anemia dataset, the Decision Tree algorithm has the highest accuracy of 0.926, followed by Logistic Regression with 0.814 and KNN with 0.691 (Figure 7). The Decision Tree algorithm also performs the best in terms of sensitivity with 0.913 (Figure 7). This suggests that the features in the anemia dataset may be better suited for the Decision Tree algorithm and that this algorithm may be a good choice for anemia diagnosis, especially when using data with the same type of features. Additionally, we observe that the Decision Tree algorithm is less sensitive to the choice of parameters and performs well without any fine-tuning. For the breast cancer dataset, the KNN algorithm has the highest accuracy of 0.947, followed by Logistic Regression with 0.929 and Decision Tree with 0.903 (Figure 7). The KNN algorithm also performed the best in terms of sensitivity with 0.931 (Figure 7). This

suggests that the features in the breast cancer dataset may be better suited for the KNN algorithm and that this algorithm may be a good choice for breast cancer diagnosis. In terms of specificity, the Logistic Regression algorithm performs well for both datasets (Figure 7). It is worth mentioning that this is a small sample, and it is important to consider other factors such as the size and quality of the dataset, the complexity of the model, and the specific characteristics of the target population. Overall, our study suggests that the Decision Tree algorithm performs the best on the anemia dataset, while the KNN algorithm performs the best on the breast cancer dataset. Furthermore, Logistic Regression performs well for both datasets with a good balance between sensitivity and specificity. These findings have many implications for the selection of algorithms in research studies involving anemia and breast cancer diagnosis.

Accuracy, Sensitivity and Specificity of ML algorithms

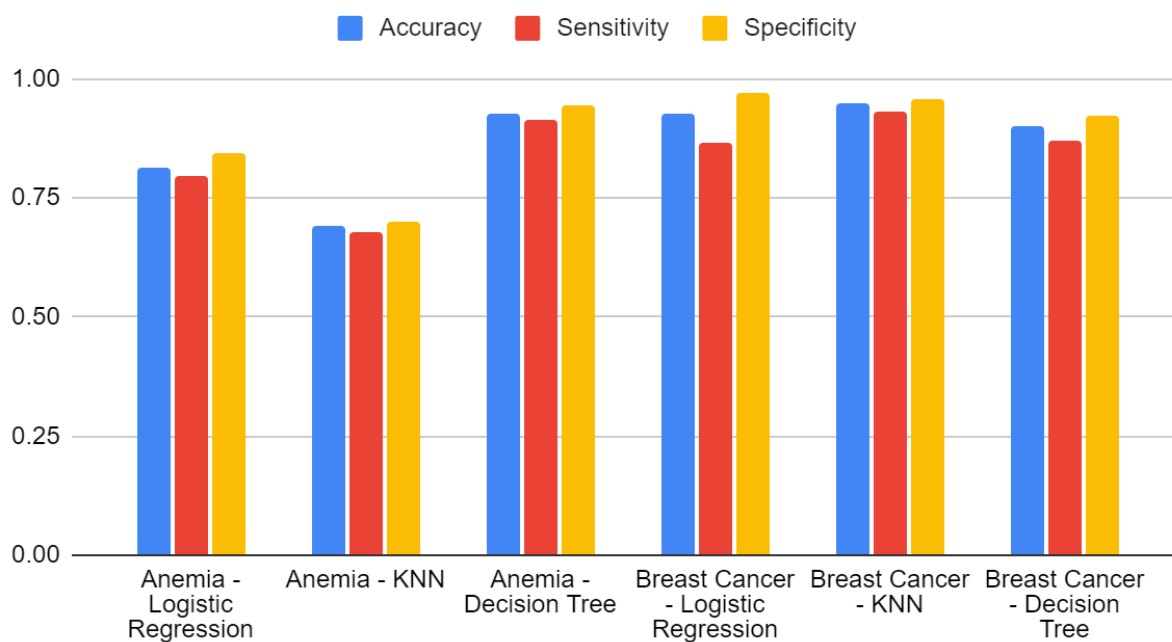


Figure 7. Bar graph representing accuracies, sensitivities, and specificities of the three machine learning algorithms applied to the each of both datasets

Discussion

In this study, the three machine learning-based classification algorithms selected for our classification analysis are widely used and considered reliable [10], namely, Decision Tree, Logistic Regression, and K-Nearest Neighbor (KNN). Decision Trees are known for their

interpretability, as they can provide a clear visualization of the relationships between the predictors and the outcome. Logistic Regression, on the other hand, is a simple and popular method for binary classification problems and provides interpretable coefficients that can help identify important predictors. Finally, KNN is a simple and effective algorithm that is especially useful when the relationship between the predictors and the outcome is non-linear. These three algorithms have been widely used in previous studies [9-10] and are thought of as reliable for many reasons. Also, these algorithms are relatively simple to understand and implement, which makes them accessible to a wide range of users. In addition to that, they can handle various types of data, including continuous, categorical, and mixed data, making them suitable for a wide range of classification problems. Specifically, Decision Trees and Logistic Regression provide interpretable models that can provide insights into the relationships between the predictors and the outcome [9]. Finally, these algorithms have been widely tested and validated in a variety of contexts, which has demonstrated their robustness and reliability in practice [10].

Although all three of these algorithms are widely used and considered reliable for a variety of reasons, some of these models work better on different datasets than others, and there can be many interpretations and reasons as to why this is. The anemia dataset has close to 15,000 rows while the breast cancer dataset has nearly 500, which means the anemia dataset has significantly more data. To the best of our knowledge, we can conclude that the breast cancer algorithms may yield higher accuracies due to the types of features in the dataset, such as Worst Area or Worst Smoothness, and the number of features/columns in the dataset. The correlation between the measurements of a breast cancer tumor and patient diagnosis is most likely stronger than the correlation between measurements from a blood sample and the patient's anemia diagnosis (Figures 1-2). To the best of our knowledge, we can also presume that the stronger correlation of variables could be because the types of information/features that were recorded in each dataset were different, and one of them suits a dataset better than the other, leading to better validity measurements.

It is important to acknowledge the limitations of the study. Firstly, the patient dataset used in this study may be limited to a specific nationality because the nationality of the patients is not one of the features in either dataset. It would be valuable to expand the study to include patients from a more diverse range of backgrounds in future work. Secondly, the results of this study are based on a specific set of predictors and it would be interesting to explore the impact of adding

additional predictors on the performance of the algorithms. Comparing the performance of different classification algorithms on larger, more diverse datasets could help identify the strengths and weaknesses of each algorithm, and lead to the development of improved algorithms in the future. Also, investigating the impact of adding additional predictors or incorporating different types of predictors on the performance of the algorithms could help improve their predictive power, in addition to combining the strengths of different algorithms into hybrid models (e.g. combining decision trees with neural networks) could lead to improved performance in specific contexts [11]. In order to learn more about these algorithms and their performance, future studies could employ a variety of methods, including large-scale simulations, controlled experiments, and real-world case studies. In addition, utilizing advanced evaluation metrics such as partial dependence plots, permutation importance, and visualizations could help shed light on the relationships between the predictors and the outcome [12].

Conclusion

In this study, we evaluated the performance of three popular classification algorithms (Decision Tree, Logistic Regression, and KNN) in the context of breast cancer diagnosis and anemia diagnosis, measured the accuracy, sensitivity, and specificity of each algorithm, and found that they performed well, with some variation in performance between the algorithms. This study represents a novel contribution in that it compares the performance of these algorithms in the context of both diagnoses and offers interpretations as to why the variations occur in measurements of the validity of the models. One of the key findings of this study is that the difference in accuracy between the algorithms could be due to the different types of features included in the dataset. Furthermore, we found that Decision Tree performed the best on the anemia dataset, while KNN had the best results when applied on the breast cancer dataset. This highlights the importance of considering the type and quality of the predictors when evaluating the performance of classification algorithms. There are numerous possibilities in future studies to improve the efficiency and usability of these models through various techniques; for example, optimizing the hyperparameters used in the structure of a machine learning algorithm. Our results suggest that these algorithms could be useful tools for assisting healthcare professionals in making informed decisions about patient diagnosis and treatment in the future.

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Proving the Human Aesthetic Preference for Symmetry Through Morphology and Computer Science By Edward Koh and Cameron Fink

The human perception of beauty and aesthetic preference has perennially been concerned with one concept: symmetry. Whether or not this stems from evolutionary bilateral symmetry in a multitude of organisms, the human affinity for the identical is ever present. It was studied using a four step process, involving first the creation of examples – symmetrical and unsymmetrical – using existing artwork, verifying the symmetry of the images through the use of a computer program, collecting preference data via a survey, and finally drawing conclusions based on that data. We wanted to see if the natural human affinity for symmetry exists, if it is still relevant – even in a day where beauty standards change by the second and art is ever-evolving.

An art piece was required for the study. It was imperative the chosen piece could be both easily manipulated for experimental setup and offer relevant observations. Given that one author of this article was studying at MIT over the summer, *Bars of Color within Squares* proved to be a perfect choice for a study on symmetry: its simplistic displays of paint against cement created by Sol LeWitt is one of the most famous works of art on MIT's campus, and was found to be a recreateable model.

We chose to use Adobe Illustrator, a graphics and design program to recreate segments of the art piece virtually. We aimed to recreate segments of the original piece as a control, and then produce more symmetrical versions of the same excerpts in order to determine preference. These versions had to contain the same core elements of the piece consistent – colors, angles, and placement of different shapes – as the symmetrical versions of the artwork were created. Adobe Illustrator allowed us to do exactly this. For the sake of simplicity, the symmetrical recreations of the artworks will be referenced as *modified symmetrical versions*, with the recreations being referenced as *original versions*. The two segments – piece A and piece B – that were chosen appear as follows.

Figure 1: The evolution of piece A, from photo, to a recreation, to a modified, symmetrical version

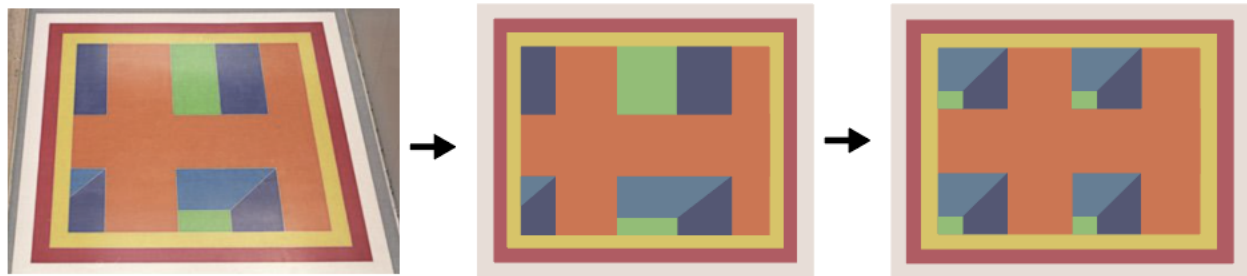
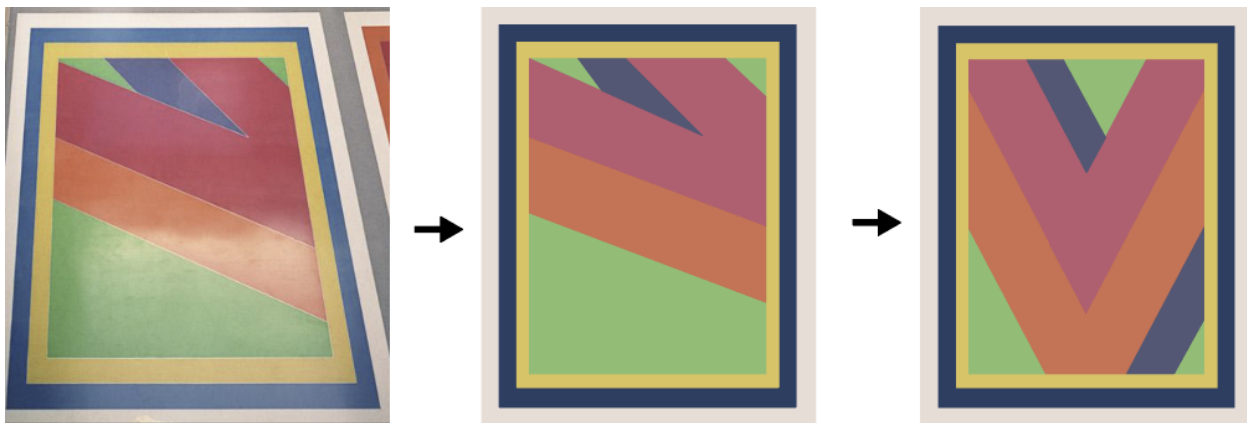


Figure 2: The evolution of piece B, from photo, to a recreation, to a modified, symmetrical version



A method to prove the modified symmetrical versions were more symmetrical than the originals was required before observations could be made. The quantification of symmetry has been a pursuit in parts of clinical and research fields for an extensive time, however, current methods are limited and are insufficient for many use cases. {REFERENCE} If one searches for a method that applies to two-dimensional images, this technology simply does not exist. Formulas ask for reference values and specific angles, things that shut the door on application of symmetry to common concepts. In addition, limitations also come from results being unclear, inconsistent, and as a result of some existing methods, artificially inflated. We had to create a method that would quickly, simply, and correctly put a number on a symmetrical analysis. This method is a software, which we named Symmetrix.

In simple terms, Symmetrix works as listed below.

The image-symmetry evaluation algorithm was implemented using Python, and functionally, Symmetrix can be broken down into a five-step process:

1. Images are divided in half by their respective axis for each type of symmetry
2. One of the two halves – the second half in the Python implementation – is translated respective to type of symmetry, to be comparable to the other half:
 - a. position value being rewritten to be the second pixel and so on.
3. Pixels are then given a sequential position value, with the reference point being the first pixel in the top left corner of the respectable half..
4. Pixels with the same position value in each half are then compared:
 - a. If both pixels have the same color, N_{sym} is increased by one and N_{total} is increased by one.
 - b. If both pixels are not the same color, N_{total} is increased by one, N_{sym} remains unchanged
5. The Symmetry Evaluation Index (SEI) is calculated as the fraction N_{sym} divided by N_{total} , or the number of symmetrical pixels divided by the number of total pixels

SEI Equation

$$\frac{N_{sym}}{N_{total}}$$

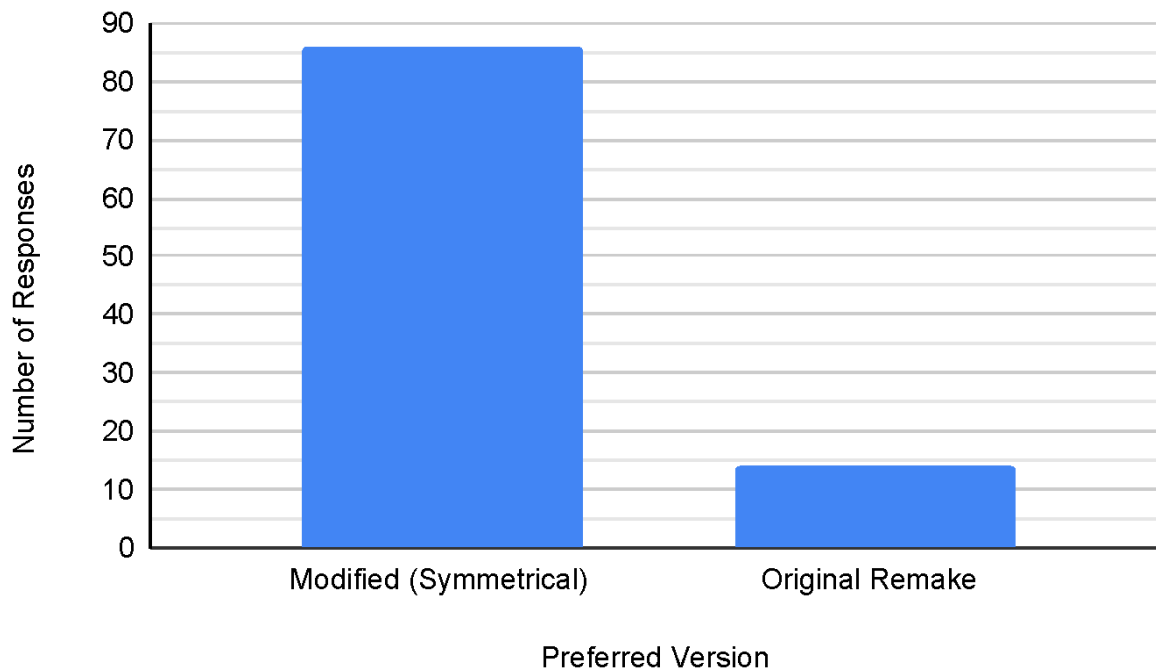
Using this process, Piece A's *modified symmetrical version* was shown to have a SEI of 86.9%, with the *original version*'s SEI being 84.1%. In the *original version*, there was a horizontal symmetry rating of 52.9%, but in the *modified symmetrical version*, there was a rating of 58.1%.

After the modified symmetrical versions of the pieces were created and verified as such, the study could start. To minimize bias and create accurate conclusions, the team sampled randomly. This study was done in the summer, where Edward Koh was staying, participating in the Research Science Institute (RSI). Each RSI student staying at MIT's Next House Dormitory was assigned a number. Of the numbers, 50 were chosen with a randomized number generator. A survey was sent out, on which the modified symmetrical versions and original remakes of piece A and B were shown, and individuals were questioned on which version of the piece they preferred aesthetically. Specifically, the following question was asked: **Which image is more aesthetically appealing?**

This question was presented twice, once for version A and once for version B. The results of the survey are as follows, 86 responses preferring the modified symmetrical versions, and 14 preferring the originals.

Aesthetic Preference of Symmetry

Evaluated using Bars of Color Within Squares by Sol LeWitt



I chose to do a proportional z-test using this data. Through the equation seen below, using a null hypothesis of 50%, the result is a z score of 7.2, and a p value of 3.03×10^{-13} , which shows that the data to be statistically significant at a level of $\alpha = 0.05$.

$$z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}}$$

Computer science has become one of the most popular and competitive fields, as solutions to a plethora of long standing issues can be made via technology, and will continue to be done. The Symmetrix software is an example of this. It is not limited to just art, quantifying symmetry is a pursuit many fields are chasing. For example, applications to studies on protein

structure and gait analysis can be made using the software. In addition, possible applications could be found in plastic surgery and orthodontics. However, the most exciting one, and what the team is actively pursuing, is symmetry detection for diagnosis of malignancy in melanoma. This project has turned into a full-blown biotech startup, named Elda Bio LLC. We are currently in the process of protecting our software through a patent, and expanding upon our software.

Noticing Psychological Gender Differences Makes World Equal By Ruoqing Wang

Men and women behave differently; observations about these differences have been fueling literary plot points across language and culture perhaps since the invention of the written word. Unfortunately, these gender differences do not often result in men and women being held in the same light. The great Aristotle, who earned himself the nickname "the father of biology" for his influence (Leroi, 2015), deemed women inferior over their inability to "...control themselves physically and psychologically through the exercise of reason the way men can" (Whaley, 2003). One hundred years earlier and half a world away, Confucius likewise was condemning women to be the inferior gender, laying the foundation for a patriarchal society that still exists in China today (Batista, 2017). While Aristotle and Confucius attributed psychological/behavioral differences to women's inferior biology, influential thinkers proto-feminist Mary Wollstonecraft (1792) and utilitarian philosopher John Stuart Mill (1869) have argued any behavioral differences are due to the patriarchal and unequal society women must grow up in.

Psychology has, of course, come a long way in the last 2400 years. By reviewing the body of evidence, we can see both biological and social factors influence the psychological gender differences but social factors outweigh the biological ones. What's more, this distinction is important in the fight for a more equal society because an overemphasis on biological factors propagates gender inequality.

There are observable biological differences between males and females in brain structure which are reported by numerous researchers in the past centuries. Research published by SAGE in 2011 suggests substantial gender differences including the behaviors of emotion, memory, perception, language, and other cognitive domains in the brain. Male and female brains have different connectivity of the gray matter and white matter regions, which is the possible difference that underlies gender-related cognitive differences (Gong, He, Evans, 2011). There are differences in volume and tissue densities in the amygdala, hippocampus, and insula (Ruigrok et al., 2014), which are the areas of the brain linked the different psychological disorders and offer an explanation for the higher prevalence of certain disorders in males and others for females (Rutter et al., 2003).

The most likely explanation for these observable differences in brain structure between genders is prenatal exposure to the gonadal hormone, testosterone. Testosterone influences neural survival, neuroanatomical connectivity, and neurochemical specification, producing sex differences in brain structure and function. One clear indication of how this has immediate tangible effects on behavior is the toy preference with infants: researchers found male babies are more attracted to things that can move fast in space, like toy cars, while baby girls paid more attention to dolls (Hines, 2011).

Yet looking at how hormones affect the brain also provides us with a salient example of social factors being far more important to understanding behavioral distances. Estrogen has been found by Eisinger et al. (2017) to be the driver in increased motivation for reproduction, but also responsible for heightening vulnerability to drug addiction. Based on the higher levels of estrogen in females, if biology were the driving factor to gender differences then we would expect the gender of substance dependency to skew female. However, dependence on alcohol, tobacco, or illicit drugs is higher in men (NIH, 2020). Of a study of 5-year birth cohorts from 1891 to 2001, males born in the early 1900s were three times more likely to have problematic alcohol use, compared to males born in the late 1900s only being 1.2 times more likely to have problematic alcohol use (Thibaut, 2018). Male and female brain biology didn't change during this century—but social norms around alcohol did (Sudhinaraset, Wigglesworth, Takeuchi, 2016).

Moreover, we cannot think strictly in terms of “males have male brains” and “females have female brains,” but we instead must imagine our brains exist on a male-female continuum. Using neuroimaging, Zhang et al. (2021) found variance in brain connectivity both within gender and age groups, suggesting not only do some males have more ‘female’ brains than some females and vice versa but that any differences vary over a lifetime. Instead of thinking purely in terms of ‘male’ and ‘female’, it can be useful instead to adopt the Empathizing-Systemizing theory to distinguish between ‘male’ brain types (which have a more developed systemizing function) with ‘female’ brain types (having more developed empathizing function). This allows us to better imagine how some women have ‘male’ brain types and some men have ‘female’ brain types, and this cognitive distinction about empathizing-systemizing was a more powerful predictor of personality than biological sex (Svedholm-Kakkinen, Ojala, Lindeman, 2018).

Thus, equally important to understand the psychological difference between men and women is to understand the role societal factors play, such as experiences and relationships. People have different social experiences and responsibilities in different age periods affecting gender differences as well.

Within the socialization literature, the concept of sex-role identification is central and is a major factor in the development of gender differences. According to this, children first identify with a particular gender and then seek to validate this identification by matching their attributes with the standards of behavior, motivations, and feelings that they perceive to be appropriate to the gender. The Social Role Theory suggests that gender differences in aptitude and personality traits often reflect traditional gender roles in society (Putrevu, 2001). This line of reasoning suggests that gender differences are developing by being recognized as the “guidance”, and its impacts can be seen throughout our lives at different ages.

Age growth is the foundation of having different kinds of social experiences. Prenatal influence factors affect some aspects between genders, but more impacts are done by postnatal factors, such as early infancy, and postnatal experiences can influence the child's character. The experiment is on children playing with different sex-typed toys. For example, toy cars are given to boys, while dolls are given to girls. This experiment shows that different kinds of toys have the potential in changing brain structure and function in children's brains. This kind of experience can change regions of the changing brain throughout the lifespan(Hines, 2011). This is important because brain differences are shaped by the toys which last lifelong, and children cannot choose the type of their toys.

People cannot avoid having relationships with others when having various social experiences, in this way, social relationships influence the characteristics of people from different age ranges. For young people who are working and frequently have a social life with others, network behavior is a big difference between genders. Gender differences impact the utility of networking behavior as a career-enhancing strategy. Women in organizations have tended to occupy less influential positions with fewer resources available to them. Research shows that men and women do not benefit equally from the investments they make in their careers and that multiple forces are at work to help maintain existing power structures in organizations (Forret, Dougherty, 2004). The analyses reveal that old women have larger networks and receive support from multiple sources, while old men tend to rely on their spouses

exclusively. The degrees of satisfaction between old men and women are also compared. Old men report greater satisfaction with marriage than women (Akiyama, 1987). In high family pressure, old women need to care for their family more than old men, while older men were more likely to see changes in social participation, so older women were more likely to report "negative" psychological symptoms (Atchley, 1976). Newton has found that social roles influence both their onset and their expression. Women's midlife personality development is related to their relationship with career and family commitments. Women mainly focus on their development of self-identity such as talent and career in their early middle age. When time passes and when they get into later middle age, their focuses change and they put more effort into their family (Newton, 2010).

Recognizing the role social factors play in the psychological differences between genders is key if we are striving for gender equality in society. As the role of nurture over nature is so important, propagating narratives of women's inferiority has a hugely negative impact on women. Overinflated claims of gender differences related to biological factors in our popular media carry substantial costs (Hyde, 2005). Sociocultural factors like media and gender inequality contribute to gender differences and gender bias (Hyde, Mezulis, 2020). Ideological roles are accepted and recognized by people and cause people to further behave according to these roles, which has led to the unequal distribution of social and economic power and status hierarchies (Shields, 2007).

The early history of studying the brain of different genders was full of stereotypes, which impeded progress towards equality. In the 18th and 19th centuries, ideas about women's brains being inferior to men's in size, emotional stability, and scientific ineptitude, led to cultural notions that women were unfit for any kind of power and greatness. Stereotypes even skewed the results of scientific studies (Rippon, 2020). Years later, scientists focused on the connections between structures rather than just the sizes, finding that the human brains were more proactive concerning information gathering. In the 21st century, scientists suggested that the human brain would continuously fulfill itself when people were observing the world. Brains reflected the lives their owners lived, not just the sex. The relationship between a brain and its world is a two-way flow. Then they experimented on children, and they found that even babies were quickly soaking up the cultural information around them. Our brains are just like babies, learning the rules and applications. This experiment confirms that previous research has been influenced by gender

stereotypes. Rippon (2020) argues that brains can reveal the physical and social worlds their owners are living in and differences between brains are made by different road settings when humans are from babies to adults. Social cognition research suggests that the most commonly associated characteristics of the typical female or "woman" stereotype are "emotional, weak, dependent, passive, uncompetitive, and not confident". Men and women are both suffering from role stress, such as women are taking responsibilities from workplace and also from family which undertake more than men, and men are taking on a relatively high physical distress. Clearly, stereotypes and social roles contain misconceptions, but they do serve as prescriptive devices regarding behavior (Babin & Boles, 1998). In another word, a gendered world produces a gendered brain.

While the seeing there are observable differences between men and women is as easy as taking a walk on the street or turning on the latest trending show, digging in to the causes of these differences is far more complex. The psychological differences between the genders is a combination of prenatal biological factors and postnatal social experiences. Understanding how these social experiences and environmental factors is hugely important, because misconceptions about the impact of the biological differences has been the cornerstone of patriarchal systems across times and continents than deprives women of agency and opportunity A proper understanding of how our environment leads to psychological differences between men and women is necessary for us to build a society with more gender equality.

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Effective Hedging Strategy for Investment Trading Firms in Response to US Oil Price Volatility

By Rohit S. Naidu

Abstract

This study examines the use of the Student T distribution in hedging against losses from oil prices in a Firm's stock portfolio. A comprehensive literature review was conducted to examine previous research on the relationship between energy prices and stock prices, and the feasibility of hedging stocks with oil. Using a historical simulation and the Student T distribution, the effectiveness of hedging with various ETFs was evaluated based on data from October 8, 2018 through October 8, 2022. The results of the analysis highlight the importance of the Student T distribution in accurately evaluating the effectiveness of hedging strategies and the usefulness of TLT as an effective ETF for hedging against oil price losses.

Introduction

Hedging against fluctuations in oil prices is a critical concern for many investment trading firms, as any large price changes in these prices can have significant impacts on their business and Firm's Portfolio. Previous research has examined the relationship between energy prices and stock prices, and the feasibility of using oil as a hedge for stock portfolios. However, these studies have primarily used traditional distributions such as the normal distribution to evaluate the effectiveness of hedging. This study aims to explore the use of the Student T distribution in hedging against losses from oil prices in Firm's stock portfolio. The Student T distribution is known to capture tail values more accurately, which can be important in accurately assessing the risk in financial markets. By using the Student T distribution, this study aims to provide a more accurate evaluation of the effectiveness of hedging against losses incurred due to fall in oil price.

Methodology

Hedging against oil price fluctuations is important for many investment trading firms, as large price fluctuations can have a significant impact on their business and portfolio. Previous research has examined the relationship between energy prices and stock prices, and the

feasibility of hedging stocks with oil. Below listed are earlier research and proposed methods for hedging strategies.

Batten *et al.* (2017) examined the relationship between energy and stock prices in the context of Asia, including China and Japan. The study found that Asian stock markets tend to follow oil prices, in line with what the international markets are reading. However, the study also identified time-varying consolidations between individual stock market and energy portfolios, which may limit the benefits of diversification in terms of risk mitigation. The study also finds that this relationship can be used to hedge common factors arising from energy risk, providing investors with positive time-varying risk-adjusted returns.

In a follow-up study, Batten *et al.* (2019) examined the feasibility of hedging equities with oil using a dynamic conditional correlation (DCC) approach. The results of this study showed that there are economic benefits to hedging equities with oil, although hedging effectiveness is dependent on time and market conditions. The study also found that the Global Financial Crisis (GFC) event impacted hedging effectiveness, leading to a positive rise in hedge ratios and increased hedging effectiveness during this period. The study identified the Implied Volatility Index (VIX) as the most important factor among a set of common financial and macroeconomic factors. The VIX shock will negatively impact equity oil hedge portfolio returns during a time of global financial uncertainty. The study finds that the appreciation of the US dollar against the euro is associated with lower hedge portfolio returns, and that gold prices and maturity spreads are important in explaining hedge portfolio returns after the global financial crisis.

Lee and Chiou (2011) developed his two-step methodology for studying the impact of oil shocks on stock returns. Using a regime-switching model to account for jumps, the study found that large fluctuations in oil prices (West Texas Intermediate; WTI) have a negative impact on S&P 500 returns. However, the same result did not hold in a regime with low oil price volatility. The study suggests that a well-diversified portfolio should take into account oil price shocks to improve the accuracy of oil price risk hedging.

Halfawi *et al.* (2019) used daily data from 2010 to 2016 to analyze volatility spillover between oil and equity markets in oil importing and oil exporting countries. In this study, we used symmetric and asymmetric versions of dynamic conditional correlation (DCC) and modified DCC (cDCC). Portfolio consideration and hedging implications from the GARCH

model. The results show that oil importing countries were severely affected by delayed oil price shocks, with less evidence of equity market interdependence in both oil importing and oil exporting countries. The study also found that delayed oil price shocks negatively affected stock markets in oil importing countries, while stock markets in oil exporting countries were more affected by the current oil price shock. The study concluded that oil importing countries could benefit from hedging strategies to mitigate the impact of oil price shocks on their stock markets.

Overall, previous studies have explored the relationship between energy prices and stock prices, and the feasibility of hedging stocks with oil. The results of these studies suggest that hedging equities with oil may yield economic returns, but the effectiveness of such hedging strategies will vary depending on market conditions and other factors. There is also evidence that oil importing countries may be more vulnerable to oil price shocks and could benefit from hedging strategies to reduce the impact of such shocks on their stock markets. Our study builds on this body of knowledge by examining the use of adjusted close price data and log returns to analyze the performance of various ETFs as potential hedges against oil price volatility. Our hypothesis is that government bonds represented by the ticker TLT could be a good option to hedge oil price volatility given their inverse correlation with yields. By analyzing the performance of TLT and other ETFs using log returns, we aim to provide insight into the most appropriate options for hedging oil price volatility using an equity portfolio.

Experiment

A Correlation Heat Map provides a graphical representation of the correlation of stock prices across multiple stocks. It is used to analyze the relationships between the stocks, and how their prices move in relation to one another. The heat map shows the correlations between the stocks by coloring each cell according to its correlation coefficient. The correlation coefficient ranges from -1 to 1, where -1 indicates a perfect negative correlation, 0 indicates no correlation, and 1 indicates a perfect positive correlation. White indicates a positive correlation, while black indicates a negative correlation. By analyzing the correlation heat map, investors can identify which stocks move in sync with each other, and which ones move in the opposite direction. This helps them form a better understanding of the stock market and make more informed decisions. An example of a correlation heatmap is shown below (Figure 1). After testing many tickers using a brute force algorithm, TLT was determined to be one of the best tickers to hedge against oil. As

the (United States Oil ETF) USO decreases, (iShares 20 Plus Year Treasury Bond ETF) TLT has a trend of increasing which is an observation that can be used for hedging.

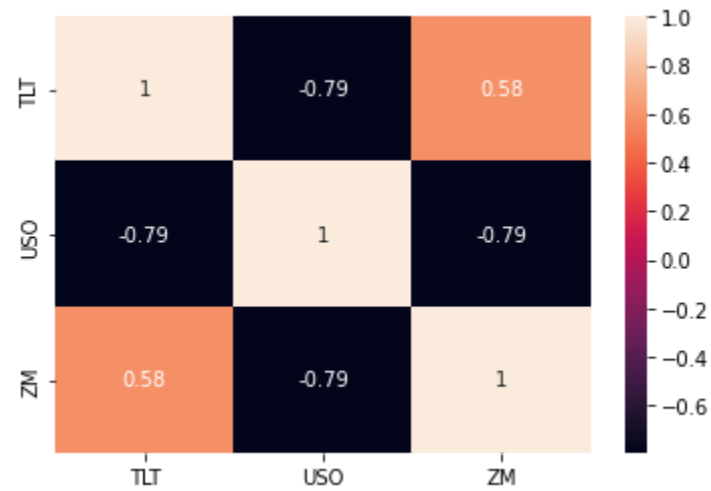


Figure 1. A heat map showing the correlation between the three assets: TLT, USO, and ZM.

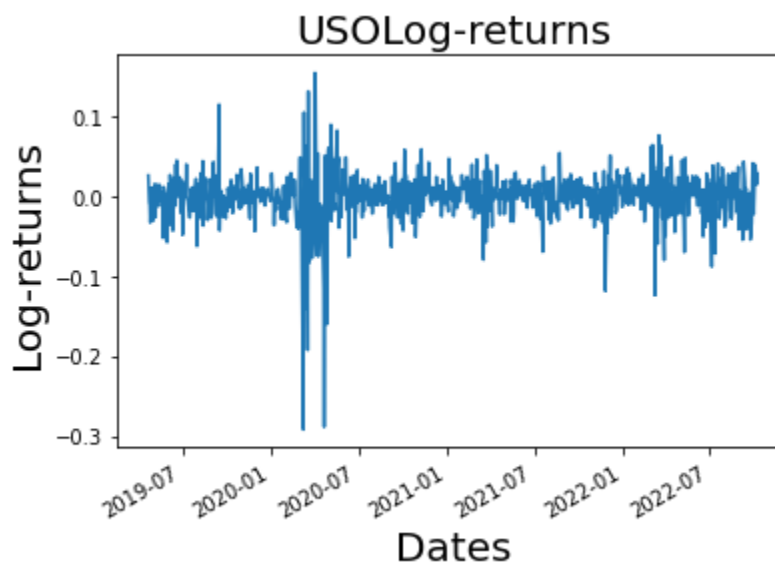


Figure 2. A line graph with log returns on the y-axis and dates on the x-axis.

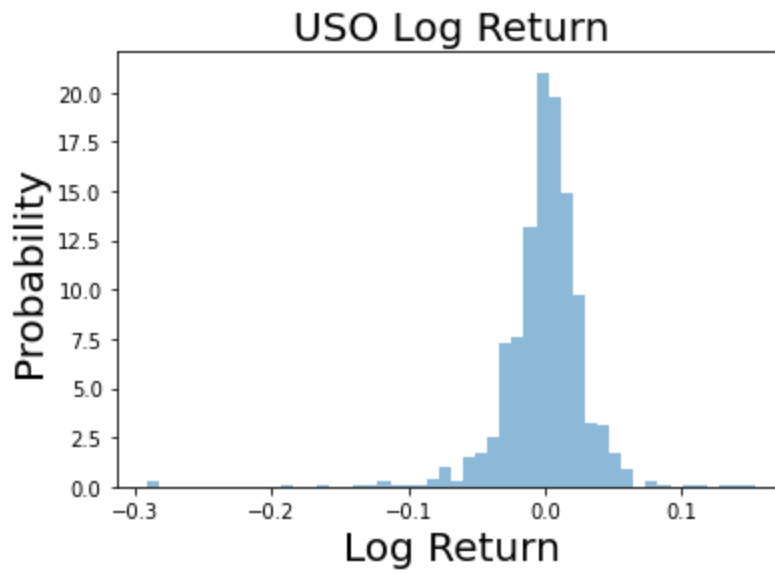


Figure 3. A histogram of USO stock log returns with probability on the y-axis and log returns on the x-axis.

Normal Distribution

After the data is prepared as shown in Figure 2 and Figure 3 using the log returns from October 8, 2018 to October 8, 2022, it is plotted on a histogram with the x-axis indicating the log return and the y-axis indicating the probability (Figure 4). The data is relatively symmetrical and doesn't have a strong left or right skew. Next a normal distribution bell curve is fitted into the data. The normal distribution bell curve models the data with increasing accuracy as the data is farther from the center. Subsequently, the bell curve does not model the data accurately towards the center of the plot. It is evident that the normal distribution bell curve does not accurately model the data.

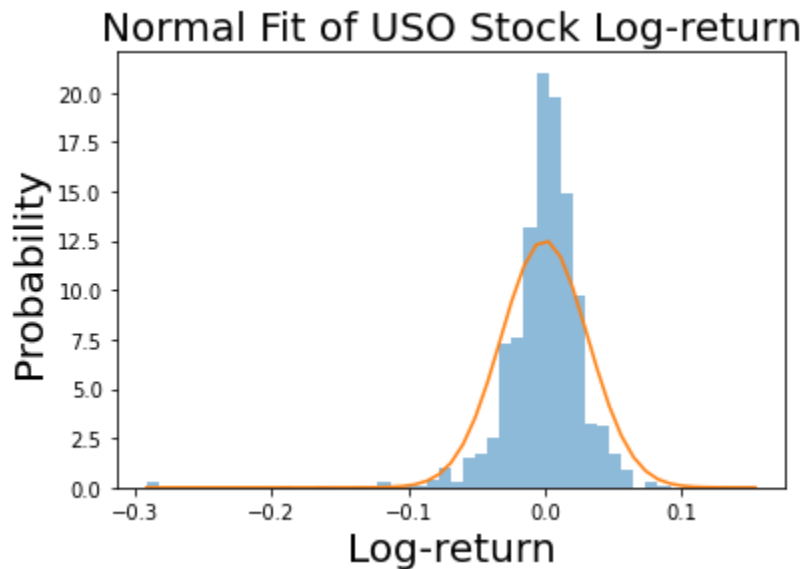


Figure 4. A histogram of USO stock log returns with a normal distribution fit line, showing probability on the y-axis and log returns on the x-axis.

QQ plot

A quantile-quantile plot (or Q-Q plot) is a graphical tool used to compare two probability distributions. In this project we use it to display the sample quantiles of one distribution on the vertical axis and the corresponding theoretical quantiles of a reference distribution on the horizontal axis. A Q-Q plot shows how the two distributions compare in terms of their quantiles by drawing a straight line that indicates how the sample quantiles and theoretical quantiles are related. This line should be approximately linear if the data follows the reference distribution. Since the line is not followed in Figure 5, it indicates that the data deviates from the reference distribution in some way. We wanted to measure the probability of extreme values using QQ Plot, since the probability of extreme values are not represented well on histograms. Based on the QQ plot we can determine that the normal distribution will not be accurate for the tail values of USO, so we would want to use the Student T distribution to accurately capture the tail values.

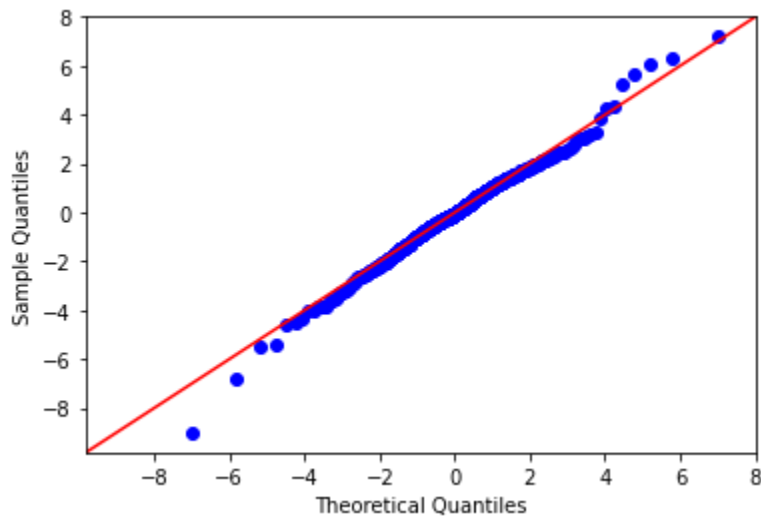
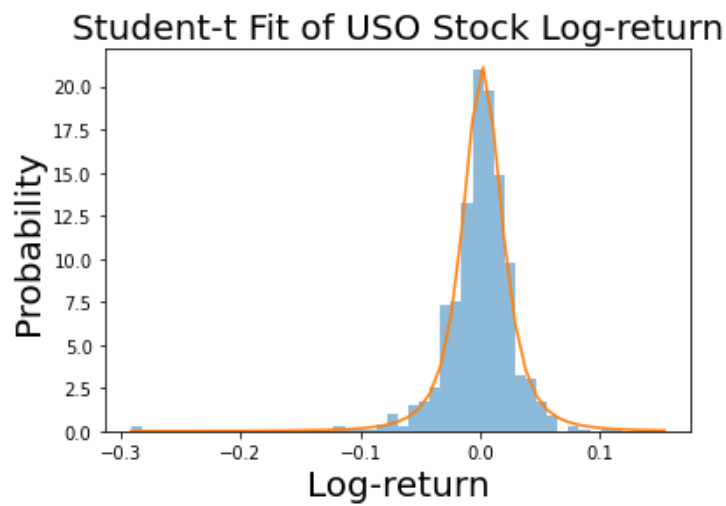


Figure 5. QQ plot of USO normal distribution.

Student-t Distribution

In order to get a more accurate bell curve that models the data without inaccuracy towards the center, we can use a t-fit of the log return data. The t-fit solves the problem of the normal distribution not modeling the data accurately in the center. This bell curve does have data in the histogram that exceeds the probability estimates of the bell curve. The Student-t Distribution captures the tail values of log returns better than the normal distribution.



Model Metrics

Value-at-Risk, commonly referred to as VaR measures the maximum loss in value of a given asset at a set time interval and confidence level. We can run a historical simulation and plot the log returns and probability on a histogram. The log returns would be plotted on the x-axis and the probability plotted on the y-axis. After doing so it becomes possible to calculate the VaR from the left tail of the distribution. The VaR would vary based on the time interval and confidence level, so in order to compare the VaR of different assets the time intervals and confidence levels should be equivalent.

Expected Shortfall

Expected Shortfall (ES) is a risk measure that quantifies the expected loss in value of an asset or portfolio beyond a certain confidence level. It is calculated as the average loss above the VaR threshold, which is the level at which the maximum loss is expected to occur at a given confidence level. ES is often used in combination with VaR as a more comprehensive measure of risk, as it takes into account not only the maximum expected loss, but also the likelihood and severity of losses beyond that threshold. This allows for a more accurate assessment of the potential risks and losses associated with an asset or portfolio.

Results

Based on the results of our analysis, it can be concluded that the use of the Student T-distribution and considering both Value-at-Risk (VaR) and Expected Shortfall (ES) is an important factor in evaluating the effectiveness of hedging strategies. The correlation heat map helps to identify which ETFs are most effective at hedging against a particular risk, such as oil price losses. In this case, TLT was identified as the most effective ETF for hedging against oil price losses, with a strong inverse correlation to oil prices.

The results of the analysis of USO and TLT are presented in Tables 1 and 2, respectively. The tables show the quantile, Value-at-Risk (rVaR) and Expected Shortfall (rES) values for each significance level. At a 5% significance level, the rVaR for USO is 0.039775 and the rES is 0.067709, meaning that an amount equal to 0.039775 times the portfolio value needs to be set aside to prevent losses with a confidence level of 95%. On the other hand, the rVaR and rES for TLT are 0.016915 and 0.024066, respectively, at the same significance level. This suggests that a much smaller amount of capital needs to be set aside to hedge against oil price losses when

incorporating TLT into the portfolio. The tables provide valuable information for Firms to make informed decisions about their capital reserves and better manage the potential risks and losses associated with different ETFs.

Table 1. TLT Significance Level and corresponding Quantile, rVaR, rES values

Significance Level	Quantile	rVaR	rES
10%	-0.012528	0.012450	0.019270
5%	-0.017059	0.016915	0.024066
1%	-0.028388	0.027988	0.036832

Table 2. USO Significance Level and corresponding Quantile, rVaR, rES values

Significance Level	Quantile	rVaR	rES
10%	-0.027155	0.026790	0.050068
5%	-0.040588	0.039775	0.067709
1%	-0.084115	0.080674	0.124957

In Figure 7, we can see the Student-t fit of TLT stock log returns. The x-axis represents log returns, while the y-axis represents the density of the distribution. This figure shows the distribution of the log returns of TLT and how it fits the Student T-distribution, demonstrating the suitability of using the Student T-distribution to evaluate the risk of portfolio drawdown.

Figure 7. Student-t Fit of TLT Stock Log return (x-axis:Log Returns, y-axis:Density)

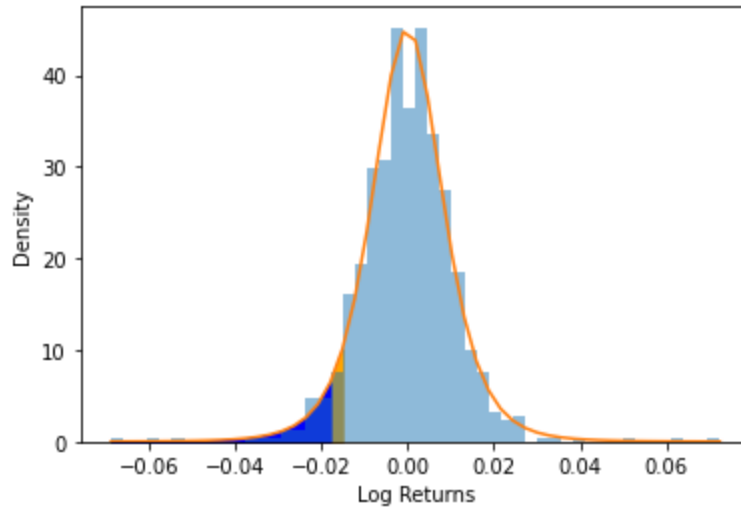
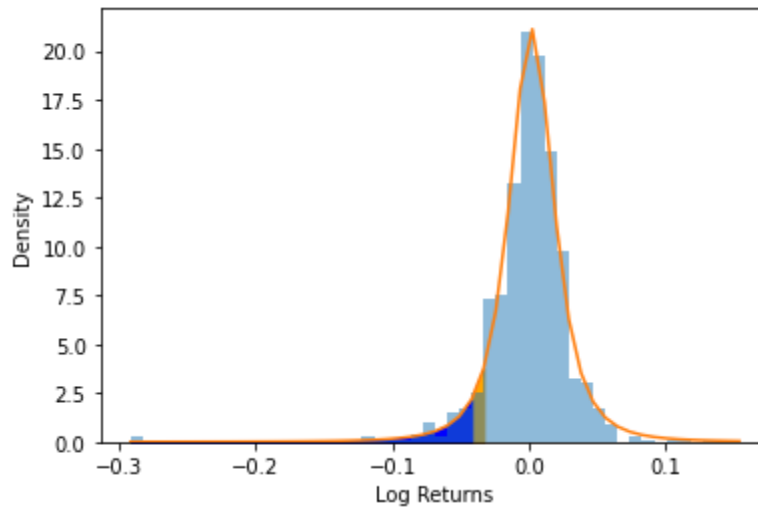


Figure 8. Student-t Fit of USO Stock Log return (x-axis:Log Returns, y-axis:Density)



Similarly, in Figure 8, we see the Student-t fit of USO stock log returns. The x-axis represents log returns, while the y-axis represents the density of the distribution. This figure shows the distribution of the log returns of USO and how it fits the Student T-distribution.

In conclusion, the results of this analysis highlight the importance of using the Student T-distribution and considering both Value-at-Risk (VaR) and Expected Shortfall (ES) when evaluating hedging strategies for portfolio drawdown. By doing so, Firms Can make more informed decisions about their capital reserves and better manage the potential risks and losses associated with different ETFs.

Limitation

There are several limitations to this research that should be considered when interpreting the results. Firstly, the analysis is based on historical data and therefore may not accurately reflect future performance. Although attempts were made to control for the impact of the Global Financial Crisis and other macroeconomic events, it is possible that future events could have a different impact on the relationship between oil prices and stock prices.

Secondly, the analysis only considered a limited number of ETFs and therefore may not be representative of the entire market. It is possible that there may be other ETFs that are more effective at hedging against oil price losses that were not included in this analysis.

Thirdly, the analysis only looked at a specific time period, from 2018 to 2022. It is possible that the relationship between oil prices and stock prices may differ over other time periods.

Finally, the analysis was based on the use of log returns, which may not accurately reflect the true economic impact of price changes. It is possible that using different measures of returns, such as arithmetic returns, could lead to different conclusions.

Overall, these limitations suggest that the results of this research should be interpreted with caution, and further research may be necessary to fully understand the effectiveness of hedging against oil price losses in a stock portfolio.

Conclusion

In conclusion, this research examines the feasibility of hedging against oil price losses in a stock portfolio through the use of ETFs. An evaluation of the correlation between oil prices and stock prices, as well as an examination of the effectiveness of different ETFs, led to identification of TLT as the most effective ETF for hedging against oil price losses. This analysis highlighted the importance of considering the use of the Student T-distribution in evaluating the risk of portfolio drawdown, as well as both Value-at-Risk (VaR) and Expected Shortfall (ES) in assessing the potential risks and losses associated with different ETFs.

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Bilingualism in the Brain By Simone Parekh

Abstract

In a world where learning languages is a vital skill, one can question the makeup of how different languages are processed in the brain. The world has become a global village. There is diversity not only in terms of human beings, but cultural and language diversity as well. To be successful in the present day world, it is important for people to know more than one language for communication, learning, and business. The accepted definition of bilingualism is being able to “speak two languages fluently”, but the definition in the scientific field has been long debated. The reason for debate behind who is considered bilingual is due to a lot of factors, such as one’s skill level in the language, their nativity to the language, their upbringing, and age. Being bilingual has become very predominant and 43% of the population of the world is bilingual. The purpose of this paper is to discuss the true definition of bilingualism, the various factors involved, one being bilingual and the brain’s area of language production and comprehension. In this paper, the central question I aim to answer is, does a bilingual brain, even when a bilingual is only using one language, process linguistic information in the same manner as a monolingual brain? First, I will attempt to define bilingualism and what classifies someone as bilingual with all the factors taken into consideration. Additionally, I will discuss which parts of the brain are involved in language production and comprehension. I will also dissect how a monolingual brain works in comparison to a bilingual brain, and reference various other studies that have investigated how the brain processes language. Finally, I will address my question regarding which processes and areas are the same between monolinguals and bilinguals, and which are different.

Defining Bilingualism and Monolingualism

Recently, the question of bilinguals having more brain abilities than monolinguals has become a popular and highly researched topic. According to Braj Kachru, an Indian linguist, the classic definition of Bilingualism is “native - like control of two languages”. However, the scientific definition today is a lot more elastic, for example, “the presence of two or more languages”. In the scientific world, there is an obstacle in simply and precisely defining bilingualism, due to a large number of factors that play into deciding if one is truly bilingual.

Many countries throughout Europe speak various different languages, and it is common for people in countries like India to speak the national language & several regional dialects. Throughout my research, I read many different definitions for bilingualism. When conducting research about language processing in the brain, researchers initially encounter the issue of not understanding who is and who is not bilingual, and the aspects of determining in which people are appropriate for the study. These factors include: age, sex, linguistic background, total languages learnt, language proficiencies, language uses, language attitudes, and language mode. Language attitude is simply one's attitude towards the language, and the process they underwent while learning the language. Language mode is a variable that changes the language experience of bilinguals, and the advantages they have. One of the key things measured to determine if one is bilingual are the five modes of literacy: linguistic (written and spoken words), visual (images), aural (sound and music), gestural (movement and body language), and spatial (position and proximity). With all of these various factors involved, most bilinguals do not even see themselves as bilingual. Traditionally, there are very hardset definitions for both Monolinguals and Bilinguals. These definitions define people at either extreme and do not specify anything towards those who fall in the middle. Monolinguals are those without functional or creative use of a language beyond the native language (or at the beginning stages). Bilinguals are raised bilingual, who began learning before adolescence, or are so highly fluent that they are absolutely considered bilinguals. One of the largest questions researchers have is trying to define who fits the flexible definitions of today.

Surprisingly, monolinguals are in the minority in comparison to bilinguals. A controversial topic among those studying linguistics is the claim that bilinguals are nothing but the sum of two monolinguals. According to the Oxford dictionary a monoglot is one that "knows or is able to use one language".

Being bilingual is not necessarily an advantage. It is believed that monolinguals have an easier time identifying themselves and have a stronger sense of self. It is a cultural issue that does not affect all bilinguals, but affects a good amount. Many people who are not brought up bilingually eventually learn bits and pieces of languages throughout their lifetime, but the amount they learn must be substantial in order to see if one fits the parameters of being bilingual, circling back to the issue of defining bilingualism.

Bilingualism is assessed on the level of skill development and the frequent use of the language, along with the age one learns the second language. Children are much better at learning languages than all other age groups because their brains are still developing. A child who is exposed to numerous languages at a young age has a much easier time picking up on those languages, and is able to retain and speak the languages they hear. For children, learning language is part of their brain chemistry, they are simply learning subconsciously. Other age groups have to consciously learn the information and work to retain it.

Then of course, there are the connections between the languages. L1 refers to a speaker's first language, whereas L2 refers to the speaker's second language. L1 is learned through a process called FLA, or first language acquisition. FLA is the process of gaining the capacity to learn human language and communication without having previous capabilities, and it is learned automatically during infancy. Native speakers have proficiency represented by "internalized knowledge" of several areas including: appropriate use of idiomatic expressions, correct language form usage, natural pronunciation, cultural context, and a large and vast vocabulary. However, it is possible to have multiple first languages as long as they were learned before puberty. For example, children who have grown up in households where multiple languages are spoken, may simply learn those languages natively, and that is what makes a bilingual. L2 is a second language, or a foreign language. If you have an L2, you are a non - native speaker of that language. L2s are learned through a process called second language acquisition, or SLA. SLA is the process of acquiring language capacity after another language has already been learned natively. Learning an L2 requires conscious effort, is most likely learnt after puberty, and an acquired L2 can only be known at a non - native proficiency. An L2 cannot be mastered to the same level as an L1, even highly advanced L2 learners are simply called near - native speakers. L2 can be used to refer to any number of languages learned after puberty; one can have multiple L2s, but most likely will not have multiple L1s.

Brain Areas Involved in Language Processing

Language processes in bilinguals and monolinguals alike, is the product of many specialized brain centers working together. The four lobes of the brain play four distinct, yet similarly important roles in controlling various processes throughout the brain. The four lobes

are the occipital, temporal, frontal, and parietal lobe. However, the ones most implicated in processing language are the temporal, frontal, and parietal lobes.

First, the frontal lobe is the part of the brain that controls important skills like one's ability to express emotions, problem - solving skills, memory, language, judgment, and sexual behaviors. It can be seen as the control panel of our personality, and equips us with the skills we require to communicate properly with others. It assists in planning, self - control, memory formation, empathy, and attention. The frontal lobe allows us to formulate our thoughts into speech, and produce everyday movements like walking and running. Additionally, it is responsible for primary motor function - our ability to consciously move our muscles, and contains an important area for language processing and production called the broca's area.

The Broca's area is located near the motor cortex in the inferior frontal gyrus, a gyrus that processes speech and language. It is the region most responsible for a person's ability to speak languages fluently. The area is involved in speech production, regulates one's breathing patterns while speaking, and assists in producing vocalizations that are necessary for normal speech. Additionally, it guarantees coordination in the muscles used for respiration: the larynx, pharynx, and the cheeks, lips, jaws, and tongue. If damage is caused to the area, sounds can be made, but words cannot be formed properly. Broca's aphasia, which occurs when the area is injured, one is able to comprehend what is being said, but unable to speak fluently as the brain is not able to control the fluency of the speech. It causes a lot of frustration as the person knows what they want to say but cannot properly express their words. It is also called the auditory association area and the receptive speech area. It utilizes feedback received from other areas to send motor commands out. Many speech related problems can happen due to damage to a specific area. While the Broca's area is a key language center, in order to read, speak, and write, other areas of the brain need to function in coordination.

The temporal lobe is located above the brainstem and cerebellum. The primary responsibility is creating and preserving conscious and long - term memory. The lobe also plays a role in visual and sound processing and is important for object and language recognition. Additionally, it contains the Wernicke's area, the limbic system, and the primary auditory cortex. It is the first area responsible for interpreting sounds heard by the ears, it receives different frequencies, sounds, and pitches, and is able to give them specific meaning. The Temporal lobe is responsible for selective hearing, filtering out the unnecessary frequencies allowing a person to

focus on the important sounds from the environment. This lobe plays a major role in understanding and giving meaning to language, making language distinguishable and understandable.

The limbic system, which is located in between the two temporal lobes, also has relevance to language comprehension. Lanandella says that L1 in comparison to L2 is based on the limbic system. When a second language is learned in a natural setting it indicates more development of the limbic system. However, if it is learned in a formal setting it entails mainly neocortical structures. For example, learning a language in school would be a formal way to learn it, as opposed to growing up around people who speak a different language, which would be an informal way to learn it. The limbic system is only involved in L2 acquisition in which L2 appears part of a human's emotional state.

The parietal lobe is located behind the frontal lobe. It essentially processes sensory information from the outside world in relation to touch, taste, and temperature. It also heavily relies on other areas of the body to receive information from, like nerves. The parietal lobe also sends the information gathered to other parts of the brain, the beginning point of sensory processing, it deals with many sensations like touch, pressure, pain, all the somatic senses. Additionally, it contains the supramarginal gyrus, the specific gyrus that contains the Wernicke's area.

The Wernicke's area is located close to the auditory cortex and in the superior temporal gyrus, a gyrus involved in auditory processing. The area is located in the temporal lobe, and also extends into the parietal lobe. Wernicke's area is associated with language comprehension, receiving the necessary information from the sensory association areas. It is important in one's personality as it integrates the sensory information received and handles the access to auditory and visual memories. It is located in the dominant side temporal lobe, making it responsible for processing and giving meaning to speech and the written word. Wernicke's area helps a person understand speech and language. For example, someone suffering from Wernicke's Aphasia will have difficulty or be unable to understand or speak, and may misuse words or speak in a nonsensical way.

Differences in Cognition Between Monolinguals and Bilinguals

Surprisingly, monolinguals are in the minority in comparison to bilinguals. A controversial topic among those studying linguistics is the claim that bilinguals are nothing but the sum of two monolinguals. According to the Oxford dictionary a monoglot is one that “knows or is able to use one language”.

Being bilingual is not necessarily an advantage. It is believed that monolinguals have an easier time identifying themselves and have a stronger sense of self. It is a cultural issue that does not affect all bilinguals, but affects a good amount. Many people who are not brought up bilingually eventually learn bits and pieces of languages throughout their lifetime, but the amount they learn must be substantial in order to see if one fits the parameters of being bilingual, circling back to the issue of defining bilingualism.

Bilingualism does not have as large of an effect in adulthood as it does in old age and childhood. In old age, it protects against cognitive decline, which is associated with a delay in the onset symptoms of memory - related diseases like dementia. For a long time, it was widely believed that there would be consequences for bilingual children, such as confusion between languages. However, bilingual children performed superiorly on most tests, especially those requiring symbol manipulation and reorganization. The difference between monolingual and bilingual children was later explored and studies showed a significant advantage for bilingual children's ability to solve linguistic problems on the basis of understanding concepts like the difference between form and meaning and metalinguistic awareness, the ability to distance oneself from the content of speech in order to reflect upon and manipulate the structure of language. This shows that being bilingual may provide some advantages in learning and memory.

However, there are also some disadvantages to being bilingual. The verbal skills of bilinguals in each language are commonly weaker than those for monolingual speakers of each language. On picture naming tasks, bilingual participants are shown to be slower and less accurate. They also had slower responses for both comprehending and producing words, even in their first and dominant languages. Bilinguals at all ages demonstrate better executive control skills than their monolingual counterparts. Executive control is defined as the set of cognitive skills for functions like inhibition, switching attention between activities, and a strong working memory. These skills emerge late in development and slow early aging through supporting things like high level thought, multi - tasking, and sustained attention to various subjects. The neuronal

networks responsible for executive control are centered in the frontal lobe and have connections to other regions.

What Area of the Brain is Designated for Each Language as Bilinguals?

Finally, circling back to the central question regarding brain areas designated for bilinguals. Does a bilingual brain, even when a bilingual is only using one language, process linguistic information in the same manner as a monolingual brain? Do bilinguals have one general language representation system or two distinct language representational systems?

Through fMRI investigation it has been shown that in bilinguals, there is a large amount of shared brain representation between the two languages. fMRI, or functional magnetic resonance imaging, measures brain activity by detecting changes associated with blood flow. The shared representation is especially present in early and expert bilinguals in contrast to bilinguals that fall in the middle of the scale.

The convergence of brain networks that are present in bilingual processes is shown by the level of proficiency of the bilingual. Proficient bilinguals show similarity in brain activations across different languages; semantic processes are also shown in similar areas of the brain.

Another fMRI study was conducted on bilinguals who spoke both Portuguese and English. The study compared patterns of activation during the classification of brain activity for nouns across languages. For example, the pattern of activation by the Portuguese (L1) word “cabana” can be used to properly identify the brain activation pattern for the English (L2) word “hut” and vice - versa. These findings indicate the lingual properties of words are represented similarly at the neural level in proficient bilinguals. They also indicate that it is possible to identify the word a bilingual was thinking about solely based on the brain activation for that word in another language. Bilinguals have generalized improvements in the functioning of a brain circuit that supports the most essential and limited aspects of human cognition. It strengthens executive functioning capabilities and benefits a cognitive reserve that protects an individual from the cognitive decline that occurs with age.

Organization of a bilingual mind consists of two independently - represented language systems that are uniquely accessed in response to the context. For example, a fluent French - English Parisian does not need to even consider how to order a coffee in English while making the request for one in French. Fluent bilinguals show some measure of activation of both

languages and some interaction between them at all times even in the context of only one of the languages.

Bilinguals also have a conceptual meaning of words that does not rely on the translation of words to the first language. Proficient bilinguals are equally able to name pictures and categorize words in either language. Abstract & common nouns are shared across languages. Additionally, bilinguals showed more right - hemisphere temporal and occipital activation, which is surprising considering that the wernicke's and broca's areas are located primarily in the frontal and parietal lobe. Right hemisphere areas that are used may support cognitive processes associated with a variety of things, including sign language production.

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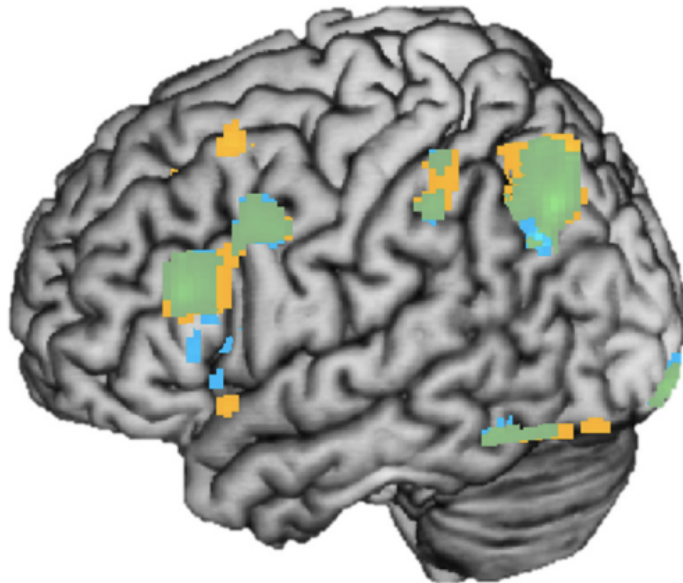


Figure 1. A network of brain activation showing shared semantic representation for word reading in bilinguals: orange shows activation for L2 (english) and blue shows activation for L1 (Portuguese). Green shows overlap between L1 and L2. (Buchweitz 2013)

Conclusion

This paper has investigated the topic of bilingualism in the brain, and understanding how the brain comprehends different languages. First, I aimed to define bilingualism in a way that

was applicable to the rest of the paper and the latter research analyzed. I forged a link between L1 and L2 and their relevance to actual language learning in the brain. Then, I located which areas of the brain are vital to language processing, and the distinct roles they play. Subsequently, I compared the way monolinguals interpret language to the way bilinguals interpret language, and which area of the brain is designated for each. Finally, I was able to draw the conclusion that there is a large amount of shared brain representation between the two languages, and the brain is able to identify languages through the brain activation patterns in either language. These findings reveal that bilinguals do process language differently than monolinguals, and there is shared representation in the brain for both languages. While there has been a lot of research done to address this question, there are certainly more questions to be answered. More studies can be done regarding bilinguals who are fluent in two similar languages in comparison to bilinguals fluent in two radically different languages. The bilingual brain is incredibly complex and fascinating.

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**Did You See What I Did With Those Anarchist Bastards the Other Day:
Injustice on Sacco and Vanzetti By Asher Friedland**

On April 15th, 1920, a shoe factory in South Braintree, Massachusetts was robbed of \$16,000, and two of the men working in the factory were shot by the perpetrators. Eyewitnesses said they saw two Italian men commit the crime, but none of the testimonies were convincing for one suspect or another. Weeks later, on the night of May 5th, Nicola Sacco and Bartolomeo Vanzetti were arrested as primary suspects of the crime. The two men were tried and convicted despite meager evidence. Sacco and Vanzetti waited in jail for the next seven years, and filed for retrial many times, only to be executed in the seventh year. Sacco and Vanzetti were anarchists, a political group whose primary belief is that any form of governmental power is undesirable, and it is widely accepted that they were executed based on their support of these beliefs rather than the facts of their case. In a time where immigrants were feared and even hated, the American judicial system allowed this prejudice to dictate the outcome of this high-profile case. The biased and unfair treatment of the defendants by the court was a clear violation of the 6th Amendment on several counts. The injustice was made possible by biased court officials, a divisive political climate, and the U.S.'s intolerance to criticism.

Although the 6th Amendment, which protects the right to a fair trial, mandates that “[i]n all criminal prosecutions, the accused shall enjoy the right to...an impartial jury... and to be informed of the nature and cause of the accusation,” Sacco and Vanzetti did not receive the benefit of these safeguards. The first violation of the defendants’ 6th Amendment rights occurred on the night of their arrest when no one informed them why they were being arrested. Vanzetti’s testimony during the trial affirms this failure by law enforcement at the time of his arrest:

Question: Did either Chief Stewart at the Brockton police station or Mr. Katzmann tell you that you were suspected of robberies and murder?

Vanzetti: No.

Question: What did you understand, in view of the questions asked of you, what did you understand you were being detained for at the Brockton police station?

Vanzetti: I understand they arrested me for a political matter...[b]ecause I was asked if I am a Socialist, if I am I.W.W., if I am a Communist, if I am a Radical.

Sacco faced a similar line of questioning in a direct examination:

Question: You were not informed as to what the charge was?

Answer: I thought it was a Radical charge. (Mass.gov, 1)

Without being informed of their perceived crimes, the defendants were in a much worse position to defend themselves, thus on their way to falling victim to a system stacked against them. The next factor that cut against the defendants receiving a fair trial in accordance with the 6th Amendment was the personal bias of the judge in their case. By the time he was assigned to the trial, Massachusetts Superior Court Judge Webster Thayer already had a reputation for perpetuating xenophobia. For example, Judge Thayer presided over the case of Sergis Zakoff, a man charged with advocating anarchy. Following the not guilty verdict in that case, Judge Thayer had a myriad of questions for the jury, including, “[D]id you take into consideration the testimony... that the defendant told them that he was a Bolshevik and that he believed in the overthrow of the Government? [Upon the evidence] how did you arrive at the verdict that you announce?” (Mass.gov, 1). With this line of questioning, Judge Thayer revealed his personal conviction that all anarchists should be imprisoned. Regardless of the jury’s decision, the judge was driven to send these left extremists to jail, or worse.

As Sacco and Vanzetti’s trial began just one year after Zakoff’s case, the defendants appeared doomed from the start. During the trial, Judge Thayer made multiple statements displaying prejudice against anarchists. After sentencing the two men to death, Thayer said to friends outside the courtroom, “Did you see what I did with those anarchist bastards the other day?” (libcom, 1) This statement highlights that the verdict was based on Thayer’s bigotry rather than impartial application of the law to the facts. The final verdict of the case was rendered with the goal of setting a precedent within the country; the court was issuing a warning to all anarchists and radical leftists. Thayer stated, “Although this man [Sacco] may not have committed the crime attributed to him, he is nonetheless culpable because he is the enemy of our existing institutions” (SocialistWorker.org, 1). Thayer made it unequivocally clear that whether Sacco actually committed the crime did not influence his decision. What did matter was that Sacco was an anarchist, which Thayer believed made him the enemy. By settling on such a harsh verdict, the court made a statement to the country that any anarchist activity would be met with direct opposition.

In addition to a biased judge, several other factors prevented Sacco and Vanzetti from receiving a fair trial, including a nationalist district attorney, a homogeneous jury, and a patriotic jury foreman. During the trial, District Attorney Frederick Katzmann repeatedly focused on Sacco and Vanzetti's relocation to Mexico in 1917 to avoid registering for the draft (Mass.gov, 4). Avoiding the draft, however, was consistent with the defendants' publicly known anarchistic values, that any government was unjust and evil in all aspects. While Vanzetti was in jail in 1924, he stated in a letter, "men have risen as tyrants, deceiters and exploiters of other men...we have lost our capacity of liberty and we are making life evermore miserable," (Vanzetti, 2) which shows the moral distance between Vanzetti and the United States. The DA was attempting to illuminate how un-American Sacco, Vanzetti and their ideological refusal to fight for America were. Katzmann further revealed his prejudice against outsiders in his instructions to the jury. He told them: "Gentlemen of the jury, do your duty. Do it like men. Stand together you men of Norfolk" (Mass.gov, 4). This statement reveals Katzmann's "patriotism." He felt it was the duty of native-born, white Americans to prevent the corruption of the country by immigrants. Katzmann's request seemed to resonate with the jury, which comprised entirely of white, native-born, American men. The makeup of the jury was an egregious violation of the 6th Amendment because it was not "an impartial jury." Further muddying the waters, the jury foreman was a former police chief who saluted the American flag every time he entered the courtroom (SocialistWorker.org, 2). In a case that appeared to be white American men versus immigrants, this gesture could imply a level of patriotism consistent with bigotry or a message to those present to protect their country from all foreign threats. A historian named Richard Alba stated that "those in power will generally do what they deem necessary to protect and established order in which they occupy positions of privilege" (33), just as the jury foreman may have been doing each time he saluted the flag.

When examining the evidence used to convict Sacco and Vanzetti, or the lack thereof, the bias of the court and Judge Thayer becomes ever clearer. Vanzetti had twelve people testify on his behalf, stating that he was selling fish at the time of the robbery. Sacco, likewise, was said to be obtaining a new passport at the time (libcom, 3). Several inconclusive testimonies were given, yet the court only focused on what made the defendants appear guilty. For example, a witness named Louis Pelser identified the license plate of the getaway car and provided a description of Sacco. However, co workers of Pelser's stated that he hid under a bench when the shooting

began, and his line of sight was surely obscured. Another witness, Mary Splaine, also testified to Sacco's presence at the scene. However, again, the witness did not get an adequate view of Sacco; Splaine was approximately seventy feet away from a moving vehicle that was only in her line of sight for three seconds (Constitutional Rights Foundation, 8). The court also relied on a flier Sacco possessed at the time of his arrest, which stated that Vanzetti would be speaking at an anarchist rally; even though there was nothing illegal about this, it further emphasized their commitment to the anarchist cause (Mass.gov, 3). The flier simply reinforced the court's bias towards Sacco and Vanzetti. Additionally, this flier showed that Vanzetti was not just a believer of anarchism, but also an active participant in the movement, incentivizing the court to silence these men.

The court's bias can be further discerned by its refusal to consider other relevant evidence, like another suspect. The shoe robbery was consistent with crimes committed by another group of suspects, the Morelli gang. The Morellis had already stolen from that specific shoe factory, giving them an advantage to plan a repeat crime. Not only did many of the gang members' alibis contradict each other, Joe Morelli and Sacco had an uncanny resemblance to each other. Several pictures of Joe Morelli were shown to the court, elucidating why witnesses placed Sacco at the crime scene. The most unequivocal evidence against the gang came from a direct confession from Celestino Madeiros, a member of the gang, following Sacco and Vanzetti's arrest. Unfortunately, after Sacco and Vanzetti were arrested, the police department terminated the investigation into the gang, even disregarding Madeiros's confession (Evidence and Conclusions Concerning the Medeiros Confession, 1-4). However, not everyone was finished accusing the gang of the murder. Herbert Ehrmann, an attorney representing Sacco and Vanzetti, placed all of his efforts into having the Morelli gang convicted and freeing Sacco and Vanzetti. After meticulously developing his case, Ehrmann filed for a retrial. Despite Ehrmann's convincing evidence, Judge Thayer immediately denied the request, extinguishing all hope for Sacco and Vanzetti (Constitutional Rights Foundation, 9-10).

Yet another trail of evidence casting doubt on Sacco and Vanzetti's culpability was South Braintree law enforcement's initial suspicion that the crime had been committed by a different Italian man, Mike Boda. The car identified at the crime scene was found abandoned in the woods several days after the crime, and the evidence in the car pointed squarely at Boda as the criminal. However, Boda fled to Italy before he was found. Since the perpetrators were identified as

“Italian-looking,” and Boda was gone, the police arrested Boda’s friends, Sacco and Vanzetti (History.com, 1). Even though the stolen money was never linked to Sacco and Vanzetti, the police stopped investigating other possibilities.

Judge Thayer and the jury’s decision to disregard evidence was largely based on the political climate in the country at the time. Following World War One, a period of extreme anti-immigrant sentiment known as the Red Scare, grew in the United States. Sacco and Vanzetti’s political belief system, anarchism, was one of the ideologies feared most by the United States, presenting a reason for the country to try to eliminate them (Mass.gov, 1).

Post-war economics was another driving factor that may have influenced the judge and kept the American public from standing up for Sacco and Vanzetti. During World War One, many Americans were drafted into the army, leaving factories in need of workers. One of the many groups who stepped up during this time of high demand, were immigrants. After the war, demand fell, and factories no longer needed so many workers. Many immigrants were fired and joined labor unions. The native-born Americans viewed the growth of labor unions as the beginning of a leftist revolution. This fear of a revolution kept citizens silent as the court blatantly ignored the 6th Amendment (Mass.gov, 1).

It was not only American citizens who worried about the Red Scare, but also the American government. In a letter Vanzetti wrote while he was in jail, he described Judge Thayer, saying that “At the time of our arrest and trials, his peers were seeing red all around, and he saw red more than his peers” (Vanzetti, 1). The United States was arresting many immigrants for their leftist beliefs, and judges were being inundated with cases regarding immigrants’ political views. However, according to Vanzetti, Judge Thayer was more involved in the fight against immigrants than any of his peers. Vanzetti added that, “He was ready to kill us even before the trials, for he deadly hates the subversive” (Vanzetti, 1). As shown from Zakoff’s case above, Judge Thayer already loathed people with views like Vanzetti’s, and then to become oversaturated with cases against these immigrants caused Thayer to be “ready to kill us even before the trials.”

While the Red Scare and political climate at the time of Sacco and Vanzetti’s case helped the court get away with violating the 6th Amendment, the international commentary of the case further inflamed the court’s bias and created more anti-immigrant sentiment throughout the country. Throughout the world, intellectuals, newspapers, and journalists wrote on the hot topic of Sacco and Vanzetti, often arguing that the U.S. was immoral. In particular, author Moshik

Temkin stated that “Italian newspapers did not hesitate to criticize the American’s treatment of Sacco and Vanzetti” (Temkin, 44). It was not just the public in Italy supporting Sacco and Vanzetti from abroad. The leader of Italy, “Mussolini, perhaps surprisingly, adopted the Sacco-Vanzetti cause” (Temkin, 42). While Italy was a primary critic of the case, other countries, such as Britain, also voiced their opinions. British academics had easy access to American news because of a preexisting level of professional intimacy. Open access to information, coupled with Britain and America speaking the same language, created a “quickness and volume with which British intellectuals wrote critically about the Sacco-Vanzetti case...and second the touchiness that many American readers...demonstrated on reading them” (Temkin, 81-82). America was angered by other countries writing about the case, but it was not just the quality of these writings that enraged the U.S., it was also the quantity. America was getting berated by other countries, leading them to assert their power by following through on their controversial prosecution of Sacco and Vanzetti.

In reaction to America’s continued mistreatment of Sacco and Vanzetti, the larger world criticized Thayer especially. Temkin included in his book academic H.G. Wells’s writings of Thayer, whom he called “‘tremendously normal,’ typical of Americans of the day. He wrote contemptuously of ‘Thayerism,’ a mindset that had ‘taken over American society.’” Wells also added that, “‘They have under-developed minds; the minds of lumpish over-grown children. They have had no fine moral and intellectual training’” (Temkin, Wells, 82). After an examination of Wells’s commentary, Temkin added, “In reading his comments, it is worth imagining the ways in which American readers with a developed sense of national pride might have reacted to them” (83). Temkin acknowledged that with the world characterizing the American population as ignorant, immoral failures, outrage from the American people seemed on par. Temkin writes further that there was “American ‘over-sensitivity’ to foreign criticism. This touchiness, [Wells] charges, had ultimately doomed the two Italians” (Temkin, 85). Temkin and Wells examined how sensitive the U.S. was to critiques from around the world and determined that it was these critiques that inflamed the courts bias and enraged the public enough to turn a blind eye to the violation of the 6th Amendment. This reaction from the U.S. was unacceptable, Temkin argues, because the country should have expected and accepted this criticism (Temkin, 86). Wells rhetorically posed the question, “Are Americans a sacred people?” to illuminate how poorly the country reacted to a critique of its morals (Temkin, 85).

The claims that America was short-tempered bore out as the country began censoring the media to make sure less was said about the injustice of the case and to allow for the continuing violation of the 6th Amendment. In Temkin's research, he found that, The editorial of *La tribuna* the day after the execution argued, '[Thus] concludes shamefully one of the blackest judicial events that man can recall'; this sentence was removed from the later edition of that day's paper. The rest of the piece, however, was left untouched: 'This tragedy has happened in a country which calls itself democratic and free.' (Temkin, 44)

America's over-sensitivity is clearly portrayed here. When the country was accused of true injustice, the media was censored and therefore not nearly as many people were able to witness the true injustice of the case or advocate for Sacco and Vanzetti. Temkin highlights the irony of this: When the U.S. was accused of being over-sensitive, the country got offended and shut down these comments, vindicating all of the critics.

What doomed Sacco and Vanzetti more than anything, however, was anarchist protests for the defendants. Through violent protests, anarchists proved to the government that they were a dangerous group of radicals who needed to be stopped, just as the government thought. Days after Sacco and Vanzetti's arrest, one of their best friends in America, Mario Buda, felt the need to retaliate at the U.S. government. Buda, just like many other anarchists, became violent and bombed Wall Street (Cannistraro, 39). While Buda may have thought he was protesting to help his friends, he only made the situation worse. Buda proved to the government that anarchists were volatile, and too violent to roam free in the United States. The government, in the form of Judge Thayer, continued to violate the 6th Amendment in an effort to protect the country, as a result of this life-threatening behavior.

The belief that anarchists were violent and needed to be contained, even at the expense of safeguarded constitutional rights, began as early as 1919. In that year, anarchists were responsible for a spree of bombings in major cities and upon major political figures. Bombs were sent in the mail to politicians, killing them or inducing permanent physical impairment. After a bomb was sent to a U.S. senator, a postal worker in New York City intercepted 16 packages addressed to politicians. Approximately one month later, there were coordinated bombings in eight cities nationwide on political figures, including Attorney General Palmer. The anarchist responsible for this bomb, however, mistimed the explosion of the bomb, blasting the front of the house and killing himself (FBI, 1). Each bomb was delivered with several copies of a flyer titled

“Plain Words” that printed, War, Class war, and you were the first to wage it under the cover of the powerful institutions you call order, in the darkness of your laws. There will have to be bloodshed; we will not dodge; there will have to be murder: we will kill because it is necessary; there will have to be destruction; we will destroy to rid the world of your tyrannical institutions. (Legends of America, 3)

Anarchists were saying that they were prepared to kill more people because they felt it was necessary to free the country from the oppressive governing power. These violent acts made the entire country especially wary of anarchists and encouraged the court in its executing of Sacco and Vanzetti. Public protection was paramount. With American citizens living in fear of violent anarchists, there was a limit to the number of Americans who spoke out to help Sacco and Vanzetti in their time of need, allowing the court to carry out a great act of injustice.

In response to the bombings by anarchists and other radical groups, Attorney General Palmer headed the Palmer Raids, in which the government used “legally questionable force and tactics” and “thousands of suspected anarchists and communists were arrested and hundreds deported during the Palmer Raids.” Less than six months after Palmer’s house was bombed, his first series of raids was launched, arresting over 200 radicals (Library of Congress, 1-2). The Palmer Raids foreshadowed the case of Sacco and Vanzetti. The government would no longer allow any infractions from immigrants, especially violent anarchists. With Sacco and Vanzetti being accused of murder, and already being known as anarchists, little could have stopped Thayer and the court from extinguishing Sacco and Vanzetti as a threat.

The primary belief of anarchism is that government should cease to exist. This pit Sacco and Vanzetti against the U.S. government from the day they arrived in America, causing the U.S. government to feel threatened by these men and their accomplices. In one of Vanzetti’s letters from jail, he ridiculed the existence of power, saying, “Authority, Power and Privilege would not last a day upon the face of the earth, were it not because those who possess them...do suppress, repress, mercilessly and inescapable every efforts of liberation of each and all the rebels” (Vanzetti, 1). Vanzetti’s opinion of a hierarchy of power is that it is corrupt in all places, and that those in power will forever oppress those without it. Vanzetti even spoke of the government as the enemy, stating that the “enemy has no scruples nor pity” (Vanzetti, 2). Here, Vanzetti was not focused on authority as a social construct. Rather, he was focused on the U.S. government in specific, waging a war on them by insulting their treatment of immigrants and outright labeling

them the enemy. With all anarchists acting as though the government was the enemy, even before the case of Sacco and Vanzetti, the court felt justified in its treatment of Sacco and Vanzetti. The U.S. government felt a need to put an end to this potential takedown of government. Those in authority simply watched as judge Thayer and the nationalist jury blatantly violated the 6th Amendment.

While many factors played into the conviction of Sacco and Vanzetti, there is a possibility that the evidence against Sacco and Vanzetti was convincing, and the judge and jury indeed acted on true facts. For example, on the night of Vanzetti's arrest, he was caught with a gun extremely similar to the one owned by Berardelli, one of the workers killed in the shoe factory. The guns were so similar that the prosecution argued that Vanzetti stole the gun Berardelli had on him when he was murdered. There was other incriminating evidence for Sacco as well. A grey cap with a torn lining was found near Berardelli's dead body, and it resembled Sacco's cap. Sacco would hang his cap on a nail all day at work, which prosecutors used to explain the rip in the cap (Mass.gov, 1-2). With even more incriminating evidence, it is not certain that Sacco and Vanzetti were guilt-free, and Thayer and the jury's decision very well may have been based in the facts they were presented.

That being said, the egregious violation of Sacco and Vanzetti's 6th Amendment rights were made possible by rampant anti-immigrant sentiment, a bigoted judge, and a violent anarchist party that the government felt a need to defeat. The 6th Amendment has long been interpreted as embodying the right to a fair trial, but the treatment that Sacco and Vanzetti received in the American court system was anything but fair. The manner in which the American government treated these two defendants will forever be a stain on our nation's history.

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Fabricating a False Consciousness: Fanon and the Struggle for Colonial Identity By Isaiah Glick

Frantz Fanon's 1962 book *Wretched of the Earth* is a vivid critique of the systems of oppression that maintain the colonial order and the violence necessary to both defend and dislodge it. In the chapter 'On Violence,' Fanon discusses the psychological dynamics that are essential to those systems. "It is the colonist who fabricated and continues to fabricate the colonized subject," Fanon writes.¹ This quote describes the creation and perpetration of colonial identity on colonized people by the colonists who oppress them. This concept has roots in the Marxist idea of the false consciousness, the process by which classes adopt ideologies and identities that are manufactured by the mode of production but are counter-productive to their rational economic interests. By applying this notion to the colonial struggle, Fanon seeks to explain why Africans tolerate a system contrary to their human needs. Because the absorption of colonial identity is psychological and deeply entrenched, Fanon argued, echoing Marx, that the only way to disrupt it was through revolutionary violence. Only then would Africans be able to create their own true consciousness free from European interests.

By referring to *fabrication*, Fanon is pointing out that the identity of the colonial subject is one created by the colonizer to suit their position in the colonial order. It is the intention of this overall ideology to make the colonial system impossible to escape by the colonized. The Philcox translation illuminates a Marxist depth to Fanon's thesis. In the original French, the verb 'faire' translates to 'make,' thus, 'the colonist who makes and continues to make the colonized subject.' Philcox translates 'faire' as 'fabricate.' This is evocative for two reasons. First, 'fabricate' can refer to someone lying and creating a fiction. 'Fabricate' can also allude to manufacturing a product in the industrial process. The translator did this most likely to connect the quote to Fanon's Marxist ideology² and the idea of the 'false consciousness.'

By the 20th century, a growing number of radical thinkers like Fanon began considering why oppressive systems were so enduring. One explanation, grounded in the Marxist idea of false consciousness, was that the oppressed were subject to the ideological underpinnings of their own oppression. Karl Marx's collaborator Friedrich Engels first introduced the idea of the

¹ Frantz Fanon, trans. Richard Philcox. *The Wretched of the Earth*. (New York: Grove Press, 2004): 2.

² Dennis Forsythe. "Frantz Fanon -- The Marx of the Third World." (Phylon (1960-) 34, no. 2 1973): 162.

false consciousness in an 1883 letter to Franz Mehring. Engels wrote that people incorrectly assume that ideologies and identities are invented and improved through political progress, and therefore worthy of acceptance. In fact, all aspects of political consciousness are created by and to serve the current economic order.³ In the colonial context, the self-conceptions of the colonized are fabricated by the economic system that forced them into a position of servitude and gratitude. This allows the colonizer to efficiently dominate them. The colonizer is in turn shaped by that same process, and the way they view each other emerges from it.

The process of colonialism requires the colonizer to create an identity for the colonized. The Europeans viewed the Africans as lower, which was crucial in the project of enforcing white supremacy using denigrating terms. “The term ‘native’ usually connotes a person of lower order... Yet this term is still applied to Africans without regard to their national and ethnic origins.”⁴ Other racist ideas rationalized European treatment of Africans with barbarism and cruelty. Europeans working in the Congo Free State viewed the Africans as savages, justifying barbarity and cruelty towards their workers, often done by Africans on other Africans.⁵ It became a “psychological violence inflicted on the native to keep him in his place by convincing him of his unworthiness.”⁶

Eventually, as the colonial identity was firmly implanted into the psyche of the colonized, they developed their own perception of their oppressors. Fanon himself recognized the foreign nature of the colonizer to the colonized as much as the colonized were foreign to the colonizer. “Despite the success of his pacification, in spite of his appropriation, the colonist always remains a foreigner.”⁷ The identity of the colonizer becomes associated with their power and status, with the colonized people understanding that the colonizer is “rich because [they] are white, [they] are white because [they] are rich.”⁸ Some of the colonized understand their status and obey their colonizer overlords. They “[adopt] the colonizer’s ideology, even with regard to their own values and their own lives... To refuse means... withdrawing physically from those conditions.”⁹

³ Friedrich Engels, “Engels to Franz Mehring,” Marxists, 2000.

⁴ Harris, Joseph E. *Africans and Their History*. (New York: Meridian, 1998): 9.

⁵ Adam Hochschild, *King Leopold's Ghost: A Study of Greed, Terror, and Heroism in Colonial Africa* (London: Papermac, 2000): 119-120.

⁶ Burke, Edmund. “Frantz Fanon’s ‘The Wretched of the Earth.’” (Daedalus 105, no. 1 1976): 132.

⁷ Fanon. *Wretched of the Earth*. 5.

⁸ Ibid.

⁹ Albert Memmi. *The Colonizer and the Colonized*. (Beacon, 1991): 6-19.

Indeed, the identities of the colonizer and colonized are so inextricably linked, to the extent that the psychology of the colonized must be changed. The only way to disrupt this relationship is through violence, as it is the only way to express one's freedom and agency.¹⁰ The colonized citizen's identity is built on their status as oppressed, so the struggle of decolonization is redefining the colonized as a free person capable of forming their own identity. It "transforms the spectator crushed to a nonessential state into a privileged actor, captured in virtually grandiose fashion by the spotlight of History."¹¹

Frantz Fanon understood that the oppressive systems maintaining the colonial order fabricated identities for the colonized that would help keep the colonizer in power. In doing so, the colonized developed an identity for the colonizer of superiority that further maintained colonial dominance. To Fanon, a psychologist, the only way to reverse these psychologically ingrained identities was to use violence. However, it is unclear that these wars of independence secure a better future over countries that achieved independence gradually. Perhaps it was a result of the fabricated identities and ideologies being too firmly entrenched for any violence to reverse.

¹⁰ Neil Roberts. "Fanon, Sartre, Violence, and Freedom." (Sartre Studies International 10, no. 2 2004): 144.

¹¹ Fanon. *Wretched of the Earth*. 2.

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Trapped in the Dragon's Grip: China's Economic Influence in Hungary By Tanush Reddy

Abstract

This paper examines Chinese investment in Hungary using statistical and data analysis. The study focuses on identifying patterns in Chinese investment in Hungary and analyzes the factors that drive this investment. The data used in my study includes information on the sectors the PRC is investing in, and whether or not it constitutes economic entrapment. My study examines the potential consequences of Chinese investment on Hungary's economy, including the country's dependence on Chinese funds, and the potential loss of Hungarian control of key economic areas. The results of my research determined that while there may be significant economic benefits from Chinese investment in Hungary, the Hungarian Government must be concerned about the potential negative consequences Chinese investment may have on Hungary's economy and sovereignty.

Introduction

The People's Republic of China has seen a remarkable transformation in the last several decades, with an average GDP growth rate of over 9% since 1978. During this time, China has transformed from a nation of destitute poverty to one of the richest nations in world history (World Bank). However, like the rise of many global superpowers, China does not want its influence to remain regional. The Chinese Communist Party seeks to use its strong economy to expand its cultural and economic influence. One way China has sought to achieve this is through the administration of loans for infrastructure in Central and Eastern Europe. This capstone examines the ulterior motives behind China's investment in Hungary and why Hungary specifically has been a point of interest for the Chinese Government. The Hungarian Nation must acknowledge the negative effects that the Belt and Road Initiative has had on other countries in order to determine whether Chinese Investment in Hungary is a method of economic entrapment or a way to break loose from EU chains.

Hungary's Weak Economy

Hungary has one of the weakest economies in the European Union. As of 2021, its Gross Domestic Product is 182.28 million dollars while the GDP per capita is 18,722 dollars

(Hungary). While these numbers are not weak globally, it still puts Hungary in the lower rung of EU nations. Compared to its EU neighbors, Hungary has the second weakest economy, only ahead of Romania. However, it appears stronger when compared to non-EU countries. For example, Hungary has a higher GDP than the majority of its Eastern European and Central Asian neighbors. The only non-EU country which has a higher GDP than Hungary is Andorra. According to the United Nations (UN) Human Development Report, the HDI of Hungary has also been decreasing over the last 3 years. For example, in 2020 the HDI fell from .853 in 2019 to .849; furthermore, by 2022 the HDI fell from .849 to .846. (UN Human Development Reports). 12.7 percent of the Hungarian economy lives below the poverty line (Hungary). The weakness of the Hungarian economy can also be traced back to a broader shift in Hungarian society. Due to a bleak job market, many young Hungarians are leaving the country via the EU open border policy to live in more prosperous European nations. This has created a brain drain in Hungary's population where the youngest and brightest Hungarians are leaving in large numbers. According to data from the Hungarian Central Statistical Office, "44% of migrants are under 30 years old and 77% are under 40" (Mayo 6). The majority of migrants leave Hungary because of the limited job market in Hungary. Additionally, 75% of the migrants leaving settled for the long term and have no intention of returning to Hungary (Mayo 6). This pattern can be seen in the migration of Hungarian physicians. Between January 2003 and December 2011, 12% of practicing physicians in Hungary left the country because of the low pay Hungarian physicians receive compared to the rest of Europe. The average wage for a physician in Hungary is around 1,516 Euros per month, which is lower than the wage in surrounding EU countries. In Germany, the wage for physicians is around 5,416 to 6,667 Euros per month (Mayo 6). The migration of physicians is just one example of how the brain drain is readily destroying the Hungarian economy. More broadly speaking, the job market in Hungary has been difficult for recent graduates. According to a survey conducted on young Hungarians by Eliza Plous, several respondents blamed the Hungarian government for failing to acknowledge the problem of brain drain at the same time. Suggestions given by respondents included tax reductions for recent graduates, job growth, and factory expansion (Plous). The Hungarian government must take action to address these issues and improve the country's economic situation, in order to prevent further migration and economic stagnation.

One of the primary culprits of the massive decrease in Hungary's economic output is the rise of Viktor Orban. The year Orban was elected, the Hungarian government had shrunk by 6.6%. However, by 2015, the Hungarian economy grew by 4.6%. While some may attribute this minimal economic growth to Orban, "a study by KPMG and the Hungarian economic research firm GKI estimated that without EU funds, the economy would have shrunk by 1.8 percent" (Krastev 5). Furthermore, in 2010, Orban resisted international demands to further austerity measures and instead lowered flat income tax. However, this was not the only policy Orban enacted that hurt the Hungarian economy. His government also ruled that 8% of contributions for private pension funds should go directly to the Hungarian treasury. The main reason was to evade EU penalties for countries with excessive budget deficits (Heinrich 124). The gap between Hungary and its EU neighbors has continued to widen under Orban's leadership. Hungary, which once was the second most prosperous of the Visegrad countries, now has the weakest economy in the EU. (Drajić 21). More recently, the Hungarian Central Bank has projected the slowest economic growth in any other year since 2010, the year Orban came to power (Central Statistical Office). Additionally, according to data from the World Bank, GDP growth in Hungary has decreased from 7.1% in 2021 to 5.2% in 2022. By 2023, the GDP growth of the country is expected to decrease to 2.1% (Hungary). Orban's influence has clearly contributed to the weakening of the Hungarian economy and the widening gap between Hungary and its EU neighbors.

The Hungarian economy has also been plagued with excessive inflation over the past few months. Strong domestic demand, wage growth, rising commodity prices, and currency depreciation have all recently contributed to rising inflation in Hungary (European Economic Commission). The HICP inflation rate in Hungary is projected to increase from 5.2% in 2021 to 11.8% in 2022. Inflation is anticipated to stay high in 2023 at 7.6%. Moreover, the COVID-19 pandemic's aftermath and rising fuel prices are all contributing to Hungary's severe financial problems (Végh p.3). In comparison to the Euro and the Dollar, the Hungarian forint has reached new lows. According to data from the European Central Bank, in November 2021 the Forint had a conversion rate of 359.5 Forints to one Euro. By November 2022, the conversion rate had risen to 406.9 Forint to one Euro. Furthermore, the Hungarian Central Bank reports that inflation is currently at about 20%, and is rising (Central Statistical Office). The seriousness of rapid

inflation is reflected by the government's measures, which include imposing extraordinary tax levies and abandoning its policy of controlling home power rates.

Hungarian Relationship and Tension with EU

Hungary has been a member of the European Union since May 1, 2004. Hungary currently uses its own currency, the Hungarian Forint, but it has been preparing to adopt the Euro. The nation is also a part of the Schengen area and has been a member since December 21, 2007. Hungary's membership in the EU has had an extremely positive impact on its economy. Hungary has access to 22.5 Billion Euros from the European Structural and Cohesion Funds. Since joining the European Union, Hungary has received 6.5 billion Euros of payment assistance from the EU and 8.7 billion Euros from the international monetary fund. One example of the impact that joining the European Union had on the Hungarian economy can be seen through its rise in GDP. In 2003, a year before the country had joined the EU, its GDP was at 85.3 billion dollars. By 2007, the Hungarian GDP had risen to 140.23 Billion dollars (Hungary). Because of these clear economic benefits, the relationship between Hungary and the European Union has historically been strong, however, since the rise of Prime Minister Viktor Orban, their relationship has soured. One of the primary causes of this tension is their differing views on immigration. Orban's ruling Fidesz party "poses as a stout defender of a Christian Europe against an imagined Islamic threat: "We can say, that as long as the national government is in charge, we will work wisely, quietly and without opportunism to preserve the Christian and Magyar culture of our homeland. We will do everything we can to preserve Europe as Europe" (Heinrich 104).

Orban views the European Union as an economic power in decline, with an absolutely disgraceful foreign policy. Orban's government has repeatedly clashed with the EU on the issue of democratic governance, after several years of the Orban government tightening its control on power. For example, Orbán has been successful in assuming an informal leadership position within the group of the four Visegrad nations over the refugee and migrant crisis (the Czech Republic, Hungary, Poland, and Slovakia). During the migrant crisis of 2015, Hungary responded by building fences to prevent and halt undocumented immigration. This was in stark contrast to the open-door policy embraced by countries like Germany and Sweden. (Alkopher 1389). Hungary's blatant xenophobia and far-right shift are the primary reasons for tension with the European Union. Following the terrorist assault on the Charlie Hebdo headquarters in Paris

in 2015, the Hungarian government launched an anti-immigration campaign. In a nationally televised interview for Hungary, Orbán shared his desire for a stricter policy on European immigration and advocated for a more ‘open and honest’ discussion about the issues of immigration. (Bocskor 557). In Orbán’s interview, he explicitly says “Economic immigration is bad for Europe [...] It should not be viewed as having any benefits, because it only brings trouble and danger for the European man [sic], therefore immigration has to be stopped: this is the Hungarian standpoint” (index. hu, 2015, translated by the author). Orbán’s rhetoric on immigration has caused the EU to respond swiftly to condemn such blatant xenophobia. For example, the European Court of Human Rights ruled that Hungary’s xenophobic practice of not taking in refugees and moving them to other European countries was unlawful (Stahl 4). Orbán’s xenophobia and his undemocratic government have raised tensions with the European Union.

Orbán’s election has also led to Hungary’s shift towards authoritarianism. Hungary’s political system has changed since Viktor Orbán’s administration took power in April 2010. It is drifting away from liberal constitutional state ideals. For example, the Hungarian government has reduced the separation of powers, centralized the state, and increased the power of the prime minister in the name of “majority democracy.” Since assuming power, Orbán has morphed Hungary into an “illiberal democracy” (Bozóki 426). Orbán has used fear-mongering and other authoritarian tactics in order to accomplish this. Orbán asserts that there are enemies both domestically and abroad which pose an economic and political threat to Hungary. Orbán’s worldview mixes victimization and an image of romantic and revolutionary nationalism. These tactics are clearly causing alarm because they also served as the foundation for both German and Italian Fascism. (Koenen p. 426). Orbán’s Fidesz party has crafted laws with extreme precision for both friends and enemies. Fidesz has made intimidation, blackmail, and character assassination key components of their domestic policy (Magyar 426). The EU has noticed Hungary’s shift towards authoritarianism and has tried to enact certain economic measures to mitigate rising authoritarianism in the nation. The EU does not have a large arsenal of foreign policy, and its primary method for coercion is economic influence. However, having only one active foreign policy tool raises the risk of overusing it. Under Article 7 of the Treaty on the European Union, the EU has the ability to sanction other member states. The requirements for imposing economic sanctions under Article 7 are so heavy that it is typically assumed that it is impossible to happen. This seems to be the case in Orbán’s Hungary. One reason why is the

current Polish administration's public support for the Orbán administration and its explicit statement that it will vote against the implementation of sanctions on Hungary (Ding 9). This is already enough to block the implementation of economic sanctions on Hungary because it requires unanimous support from all EU member states in order to do so.

Despite not directly implementing any economic sanctions on Hungary via Article 7, the EU has sought to punish Hungary's undemocratic shift by reducing the administration of EU loans to the country. According to the European Council on Foreign Relations, the European Commission has recently proposed a €7.5 billion suspension of funding for Hungary. The proposal is in response to the country's alleged misappropriation of EU money. The commission has decided to utilize the new rule of law conditionality mechanism of the European Union against the nation. The ruling Fidesz party and Orbán now have until November of 2022 to convince the EU to lift its suspension of funds. The EU's primary motivation for enacting such harsh funding cuts to the nation is because of the country's increasingly hostile relationship with the European Union. In her September assessment on the condition of Hungarian democracy, MEP Gwendoline Delbos-Corfield said that the nation had deteriorated into an "electoral autocrat" despite years of scrutiny and calls for reform. In other words, the current hybrid government of Orbán's Hungary hides an authoritarian administration under a democratic guise. (Végh p. 2). The culmination of tensions between Hungary and the European Union has led to Hungary seeking an unusual partner for financial loans, the People's Republic of China.

Chinese Belt and Road Initiative

The Belt and Road Initiative is a plan by China to expand its economic influence in other countries. The Chinese president, Xi Jinping, delivered a speech on September 7, 2013, while in Astana, the capital of Kazakhstan. In his speech, Xi expressed a desire to strengthen cooperation between the economies of Asia and Europe, and bring them much closer together. The initial presentations of the Chinese Belt and Road Initiative touted it as a cutting-edge method of economic cooperation between China and the rest of the world. (Fang p. 3). China's primary motivation for incorporating the Belt and Road Initiative is to escape the middle-income trap and become a global superpower. Some of the obstacles which China aims to tackle via the Belt and Road Initiative include, creating new export markets, securing access to natural resources, and finding uses for excess funds which have all been cited as major difficulties for the country. The

Belt and Road Initiative places emphasis on infrastructure development in order to help “alleviate the supply glut at home while aiding less developed countries to build up their industrial bases” (Clarke p. 74). China seeks to achieve its core geopolitical, domestic, and economic interests through BRI (Clark p.75). The Belt and Road Initiative consists of the Maritime Silk Road and the Silk Road Economic Belt. The Silk Road Economic Belt consists of six land corridors: the China-Pakistan Economic Corridor, Bangladesh-China-India-Myanmar Economic Corridor, the China-Central Asia-West Asia Economic Corridor, the China-Indochina Peninsula Economic Corridor, and the New Eurasia Land Bridge Economic Corridor (YAĞCI 75). The MRS consists of three maritime routes: China and the Indian Ocean, the Africa-Mediterranean Sea, China-Oceania-South Pacific, and the Europe-Arctic Ocean.

The Belt and Road Initiative encompass a number of investments in railroads, gas and oil pipelines, ports, and economic corridors, without being confined to them. A few of the ongoing projects are the China-Belarus Industrial Park, the Gwadar Port Free Zone in Pakistan, Colombo Port City in Sri Lanka, the China Railway Express to Europe, the Mombasa-Nairobi Railway, the Addis Ababa-Adama Expressway, the China-Laos Railway, and the Karot Hydropower Project in Pakistan. These projects call for a record amount of investment funds. Between 2016 and 2018, the Bank of China is anticipated to lend around \$100 billion USD, and China is currently reviewing over 130 projects with a combined USD value of 159 billion. The scope of the BRI becomes much more apparent when these figures are contrasted with the 103.4 billion USD, or its modern equivalent, cost of the Marshall Plan, which provided aid to 16 European nations in the wake of World War 2 (YAĞCI 75). Comparing the Belt and Road Initiative to the Marshall Plan can help reveal some of China’s underlying motivations for investment. The Belt and Road Initiative’s focus on development in Central and Eastern Europe is particularly interesting. The majority of nations prioritize their relationships with their neighbors when it comes to their foreign relations. However, China does not seem to care about this at all. One reason why China may be so keen on developing relationships with Central Europe is because of its geopolitical significance. One reason China seems so focused on Central and Eastern Europe is that it is in the heart of Europe and provides China with an entryway in which they can economically and culturally influence Europe (Fang p. 7). European nations must acknowledge this reality because the dangerous repercussions of being unable to repay China can already be seen in South Asia.

Chinese Belt and Road Initiative a tool for Global Leverage

The Belt and Road Initiative has been called a method of economic entrapment by many scholars. The main reason for this accusation is the aftermath of Chinese investment in Sri Lanka and Africa. The Belt and Road Initiative has caused China to actively expand its influence throughout South Asia, primarily Sri Lanka, its southern neighbor, and a key participant in the Belt and Road; Sri Lanka has received billions of dollars worth of Chinese investment. Much of the funding given to Sri Lanka has been focused on the Hambantota Port project, China's largest project in the country (Chaudhury 154). The Hambantota Port holds regional significance to China because of its strategic location in the Indian Ocean. The Indian Ocean serves China's economic interests because of its size and location. The Indian Ocean stretches from the eastern edge of Africa to western Australia, links 34 significant different nations, and also has some significant naval choke points. Moreover, the Indian Ocean is the center of the global oil trade in addition to its geographic location (Hassan 78). The building of the Hambantota Port sought to lessen traffic at Colombo, Sri Lanka, which now handles 6,000 ships annually. Furthermore, the China Communication Construction Company (CCCC) stated that this investment would result in the creation of 83,000 new jobs, which fueled the Sri Lankan government's expectations that the port would, among other things, lessen poverty in the southern part of the country (Chaudhury 157). However, the Sri Lankan Government was unable to repay the Chinese government the massive loans it took in order to construct the port. Sri Lanka instead chose to hand up control of the port to the Chinese Government; China leased the port, 15,000 acres of surrounding land, and Mattala Rajapaksa International Airport for 99 years (Chaudhury 154). China now has an economic stronghold in South Asia where it now controls and maintains a high-traffic and profitable port.

The Chinese Government's administration of loans in Sri Lanka is deliberate; China aims to further expand its use of economic entrapment in order to gain geopolitical and economic influence throughout the world. One region at the front of the mind of Chinese economic strategists is Eastern and Central Europe. In the past decade, China has rapidly increased its investment in Central and Eastern Europe. The reasons for doing so are suspiciously similar to China's motivation to administer loans in Sri Lanka, China is seeking to expand its geopolitical influence. China's activities in Central and Eastern Europe are not confined to investment in infrastructure unlike in Sri Lanka. China's primary goal for investment in Eastern Europe is to

establish a dense network of relationships in the region. Some areas the Chinese Communist Party is attempting to influence are representatives of Hungarian cities and regions, journalists, academics, and more. Eastern and Central European countries can benefit from China's increased engagement in the region because much of the money provided by China can upgrade the outdated infrastructure in those countries. However, they seem to be blind to possible Chinese intentions and whether or not they are able to repay them (Pleschová p.26). Central and Eastern European countries must be wary of Chinese motivations behind administering loans, as they may end up in a similar situation to Sri Lanka. One country, in particular, seems to be a country of interest for the PRC, Hungary.

Impact of the Belt and Road Initiative on Hungary and the EU

Hungary has received 1.79 billion dollars in Chinese funding from the period 2004-2022. After Hungary joined the EU in 2004, Chinese investment in Hungary increased dramatically. It jumped from 650,000 dollars in 2005 to over 370 million dollars in 2010. According to figures, Hungary received 89 percent of total Chinese investment in Central and Eastern Europe in 2010. The amount invested in Hungary climbed even greater in 2014 - jumping to 556 million US dollars. Some analysts predict that this number is also much higher and the data is under-reported (Szunomár 68). By 2012, China's share in Hungarian imports had increased by more than 2.5 times. For example, between 2003 and 2008 Chinese imports rose by an average of 24%. Furthermore, the value of Hungary's exports to China is much lower than the imports it is receiving from China (Szunomár 67). In other words, Hungary is much more dependent on China than China is on Hungary.

Chinese funding is primarily going to infrastructure projects and the construction of Chinese cultural institutions in Hungary. One example of an infrastructure project funded by the Chinese is the Belgrade Budapest Highway. The Belgrade Budapest Highway is worth over 2 billion Euros and is part of the Chinese Belt and Road Initiative. The railway seeks to achieve China's goal of linking the Greek port of Piraeus to Central Europe (Drajić p. 5). The majority of the funding is distributed between Serbia and Hungary and it is funded primarily by Chinese financial institutions. However, the details of the project are classified by the Hungarian Government. This further creates an aura of distrust between the Hungarian government and its citizens (Drajić p. 5). However, China's activities in Hungary are not confined to investment in

infrastructure. China's primary goal is to establish a dense network of relationships in the country. In some areas of Hungary, the Chinese Communist Party is attempting to influence representatives of cities and regions, journalists, academics, and more. China's primary goal with these relationships is to expand Chinese influence not just economically but culturally (Pleschová 24). One way China has already begun spreading its cultural influence in Hungary is through the construction of Chinese Universities. Since the presence of Chinese loans in Hungary, the number of Chinese university students in Hungary has been growing rapidly. In 2019, when this article was published, there had already been 5 Confucious Institutes built in Hungary. Furthermore, Fudan University in China has announced the establishment of its first independent university in Hungary. (Matura p. 49). The shift from satellite campuses to full Chinese universities is significant and is tangible evidence of Chinese expansion in Hungary. Additionally, China may also use its investments in Hungarian education to influence the curriculum in Hungarian schools and universities to promote its own viewpoints on cultural and political issues (Pleschová p.26). While Hungary can benefit from China's increased engagement in the region, it must not be blind to China's intentions and whether or not they are able to repay them.

China's economic activity in Hungary has already led to visible shifts in Hungary's viewpoint of the Chinese Government. For example, "The ruling party, Fidesz, was a vocal supporter of human rights and a critic of China for decades, only to make a major turn following its election victory in 2010" (Matura 51). China clearly uses the leverage gained through its investments to improve its geopolitical standing among other countries. China's investments also give it more soft power in Eastern Europe through the tactic of divide and rule. Scholars have argued that these investments could give China leverage over Hungary's political and economic decisions and that they may be intended to divide the European Union by creating divisions between EU members and non-members. Since the EU does not as quickly give loans to countries with weaker economies like Hungary, the Hungarian Government is more likely to take Chinese loans. While Central and Eastern European countries may benefit from Chinese loans in the short term, they need to come to the realization that they most likely are not capable of repaying back those loans and that they will face repercussions for it. One potential consequence Hungary may face is financial penalties, such as higher interest rates on future loans or difficulty obtaining loans from other international lenders. Additionally, if Hungary defaults on its loans, it

could harm its credit rating, making it more difficult and expensive for the country to borrow money in the future from countries other than China (Godement 69). Hungary must learn from the tactic of divide and rule and understand the potential repercussions of being unable to repay Chinese loans.

China's investment in Hungary is strategic because it provides China leverage and allows China to mold Hungary according to its needs. If Hungary is dependent on China economically it can be more easily controlled. China has a direct link to the EU through Hungary and therefore has cultivated a strong relationship with the Hungarian government. Because of this, China can count on the support of Hungary on many China-related issues brought up by the European Union. For example, the Hungarian Government has blocked EU decisions to condemn China multiple times. Furthermore, the funding of media outlets or cultural institutions enables China to exert control over the content that is produced and disseminated. Hungarian media sources are now believed to publish more positive content about the Chinese Communist Party. (Pleschová 13). Another reason for China's particular interest in Hungary is because it is well positioned geographically to handle the transit traffic between China and Central and Eastern Europe. China's funding of the construction of the Belgrade-Budapest Railway also is a clear example of China's use of debt entrapment. In terms of numbers, the total capital invested in this project is estimated to cost over 3 billion USD. (Agnes Szunomár 73). As mentioned above, the rapidly declining Hungarian economy does not seem poised to repay the Chinese Government. However, what will happen next is unknown.

What has the EU Done in Response

The economic powerhouses in Europe understand the implications of what China in Europe could mean. One way the European Union is trying to combat this is through a process called economic screening. European investment screening rules will now cover the member states' more extensive security needs, ranging from future economic security to public order and essential technologies. The creation of economic screening rules represents a profound change in European foreign policy (Godement 14). Moreover, Germany, whose biggest international market is China, now pushes for anti-dumping and investment screening by the EU (Vasellier 17). Germany's suspicion regarding Chinese investment came after an influx of Chinese investment in the country. Germany changed the national FDI screening procedure twice in just

18 months as a direct response to Chinese attempts to invest in key infrastructure (Gehrke 1). The EU has clearly shown that it will take the necessary steps to stop China from gaining too much economic power in the region. However Chinese investment in Hungary is not just unfavorably looked upon by other EU member states, the population of Hungary also objects to the growing influence of China in their country. For example, thousands of Hungarians protested against the proposed Fudan University branch campus in Hungary at the beginning of June 2021. The construction of the University was seen as “totalitarian China” expanding its borders into Hungary. Hungarians believed that the construction University represents and embodies China’s authoritarian values. The protest was successful in getting the Hungarian government to put the issue up for a vote (Bing 224). The outcome of the vote is yet to be determined but this clearly reveals suspicion towards China on the part of ordinary Hungarian citizens.

Conclusion

Hungary must look extremely hard at the underlying motivations behind China’s investment in their nation. While Chinese funding may greatly improve the economy of Hungary and the lives of ordinary Hungarians, Hungarians must be wary of China’s ulterior motives. Hungarian legislators must look beyond bitter feuds with the European Union and examine and learn from the impact that Chinese investment has had in countries like Sri Lanka. The Chinese Government’s aspiration for global dominance is obvious and the Hungarian state’s key strategic position may hold the key to unlocking the rest of Europe. Hungarian legislators must carefully examine whether their country is financially capable of repaying the massive loans administered by China; they also must consider what the repercussions of defaulting on these loans may be. Will China’s investment in Hungary lead to Hungary being freed from EU tyranny? Or will Hungary become a Chinese colony as a result?

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A Comprehensive Review of Non-Magnifying Assistive Technology for Low Vision

Individual By Robert Miles Chong

Abstract

Currently, the most common form of assistive technology to alleviate low vision is magnifying aid. Examples of magnifying aid would be spectacles with convex lenses, or wearable devices that help individuals view objects in detail. There are currently reviews on magnifying aid for low vision individuals, but these reviews exclude other forms of assistance [2]. The purpose of this paper is to review other forms of assistive technology apart from magnifying aid for individuals with low vision and compare such devices using metrics such as availability, the cost for patients, power consumption, portability, size of the user base, and accessibility. A goal would be to include 11 research papers describing devices apart from magnifying aid. Examples of such research papers include research papers exploring the field of Augmented Reality and how it could be used to help individuals with low vision navigate different spaces, or smart glasses providing audio feedback that could assist low vision individuals in wayfinding. Exploring and comparing such research papers can improve our current understanding of what assistive technology is available to individuals with low vision, and also help us understand to what extent these technologies will be able to help low vision individuals. After reading and analyzing 11 research papers regarding assistive devices for low vision individuals, there were three main findings. The first finding is that all devices attempted to help low vision individuals by either assisting them in specific tasks, such as sign reading, or it could aid users in any daily task that requires vision to complete successfully. The second finding is that factors like high cost hinder the ability of low vision users to access assistive devices, while other factors like short battery life and weight may affect the device's ability to fully assist a low vision user. The last finding relates to social implication: social acceptance of devices and how comfortable users feel when using the device affect user experience and usage rate either positively or negatively.

1. Introduction

By 2015, more than 246 million individuals in the world suffer from low vision [1]. Low vision is untreatable and affects many aspects of an individual's life. Individuals with low vision

find completing certain daily tasks difficult or even impossible, tasks such as walking down the stairs, reading, driving a car, or navigating an unfamiliar environment. Individuals with low vision also often cannot access public spaces easily without assistance. Conventional aids such as guide dogs and canes help low vision individuals navigate different environments, but these aids often cannot aid individuals in more nuanced tasks such as shopping or recognizing different signs. Such limitations give rise to Assistive Technology (AT) aimed at helping low vision individuals.

AT can come in many forms, but when used to help low vision individuals it can be generally categorized into two areas. One area would concern ATs used to enhance a low vision user's existing but limited vision. Examples of such ATs would be the commercialized eSight device, an HMD (Head Mounted Device) that allows low vision users to see objects clearer through magnification, and an expanded Field of Vision (FOV) [7]. Another example would be the ForeSee device, similar to eSight since it is also an HMD, but it provides other functions to further enhance the vision of a low vision individual [12]. Functions such as contrast enhancement and Black-White Reversal help users especially when reading.

The other category of AT would be ATs that supplement one's vision through engaging with a user's other senses, such as hearing and touch. An example of this kind of device would be a belt that detects objects and warns users through vibrations and voice feedback if an obstacle/object is nearby [8]. This device does not enhance the existing visual capabilities of the user, rather it provides users with an understanding of the nearby environment through audio and haptic cues.

This paper will discuss ATs mostly in the two categories mentioned above: vision enhancing and vision supplementing. Another two categories, devices for general use and for specialized use will also be mentioned within the paper. A device can be designed to help a user with one specific task; for example, a device can be designed to help users read signs. Another kind of device would be useful in all kinds of daily tasks, such as the eSight device that is able to provide better vision throughout the day [13].

Finally, the social implications of ATs will also be discussed. Although not mentioned in most papers that will be presented in this paper, social implications provide insight into the usability of the device and whether users will be comfortable using ATs.

1.1. Definitions:

This paper will analyze different assistive devices/ATs for low vision individuals through 5 metrics: availability, the cost for patients, power consumption, portability, and user base. Some metrics may not apply to certain devices, such as the fact that availability and cost for patients might not apply to a prototype device that is still in its testing phase. These 5 metrics are defined as follows:

- 1. Availability. Availability refers to the ability of low vision individuals to obtain the device. Availability is an important metric to consider since it directly indicates how much impact a device is able to make on the low vision community, or how many people the device is able to reach.
- 2. Cost for patients. Cost refers to the price of devices or the amount of money that needs to be paid in order to acquire the device. If the device costs a lot to purchase, it can block out many low-income low vision users with less purchasing power from accessing it. Or it requires low vision users to sacrifice other items in order to purchase the device (ex. Sell a car).
- 3. Power consumption. Power consumption refers to how long it will take for the device to run out of power. Considering how low vision individuals might need the assistive device for long periods of continuous time throughout the day, it is important devices are designed to last long enough to satisfy user needs.
- 4. Portability. Portability can be measured by looking at the weight and size of the device. Portability can be important since most devices are either HMDs or devices that users wear on other parts of their bodies. Thus, portability of the device directly affects the physical comfort of the low vision individual using it, and also how low vision users of the device are perceived socially by people around them.
- 5. User base. User base refers to the number of users who have used the device and it shows how accessible the device is. Apart from the size of the user base, the makeup of the user base presented in each paper will also be analyzed. Many papers included demographic information of users, information such as type of visual disability (not all users had low vision, some had other visual disabilities such as complete blindness), the region in which users reside, how the users accessed the device, etc. Some papers did not

include low vision users, which meant that the results presented within these papers might not be representative of the low vision population.

	Is it purchasable?	Does it use custom components?	Purpose
Vtrain [3]	No	Yes	Used to train low vision individuals: stimulate walking in an unfamiliar environment.
Stairvision [4]	No	No	Projects visuals onto stairs to help low vision individuals identify and move up/down staircases better.
Wayfinder [5]	No	No	Shows low vision users direction they need to walk in to reach designated destination in unfamiliar environment.
SignSee [6]	No	No	Identifies and enlarges signs for low vision users.
Aira [7]	Yes	No	Aid low vision users in daily difficulties.
Radar [8]	No	Yes	Alert low vision individuals of nearby obstacles.
NavCane [9]	No	Yes	Helps low vision users avoid obstacles and navigate environments.
CueSee [10]	No	No	Aid low vision users in identifying certain products during shopping.
iSight [11]	No	Yes	Helps low vision users identify objects through computer vision.
ForeSee [12]	No	No	Aid low vision users in daily tasks through enhancing their vision.
eSight [13]	Yes	No	Aid low vision users in daily tasks through enhancing their vision.

Figure 1: Overview of the low vision assistive technology devices reviewed throughout this paper.

2. Devices enhancing vision

Devices enhancing vision will be analyzed in this section through two categories: devices for specific use and devices for general use. It should be noted here that although devices in these two categories have different functions, one major similarity is that most of these devices come

in the form of an HMD. HMDs allow the direct enhancement of a user's vision, whether it is through the projection of visuals onto the user's screen, or if it is the development of different functions on the HMD itself such as color contrast.

2.1. Devices for specific uses

All 3 papers belonging to this category attempted to create a device that enhances vision to solve a specific problem low vision individuals face during their daily lives. The four problems/scenarios are walking down the stairs, navigating an unknown environment, reading signs, and shopping. The devices that are created for each scenario help low vision users complete the designated task better to a certain degree, but the device is not optimized for other scenarios. For example, a device created to help low vision users read signs would not necessarily be convenient in helping users navigate the environment better.

The first device is smart glasses that use projection-based AR to help low vision individuals navigate stairs better [4]. The device wasn't named by the researchers who authored the paper, but it will be referred to as Stairvision for conciseness purposes. Stairvision comes in two forms: a user can either use their phone to project chosen visuals onto stairs that indicate the location of each step, or the user can wear Microsoft HoloLens, a pair of smart glasses, and be able to see the visuals through the glasses. Both forms include audio assistance, indicating the direction of the stairs and also the number of stairs. Researchers tested Stairvision on 12 low vision individuals, and the test results showed that users took less time to walk down the stairs when using smartphone projected visuals. However, when the users used the second form of projection-based AR using HoloLens, the time taken to walk down the stairs increased. Individuals also indicated that they felt less psychological safety when wearing HoloLens, an HMD. Psychological safety, according to the paper, refers to the user's confidence when using Stairvision; low psychological security when using HMDs explains why it took more time for users to navigate stairs when using HoloLens. A similar trend can be observed in a device named Wayfinder, an HMD used to help individuals navigate unfamiliar environments, where the paper reported that there were no significant differences in the speed at which low vision users navigated the environment with Wayfinder compared to the control, despite differences in other metrics such as errors made during navigation task [5].

In terms of accessibility and cost, smartphones are more accessible and also lower in cost than HoloLens-based solutions. Since HoloLens is a newly developed device, the price given on the official website is \$3,500, which is significantly more compared to regular smartphones. Considering how many individuals own a smartphone already, it is costless for them to access the AR system, while users pursuing HoloLens would have to pay an extra price. High prices are a common characteristic of HMDs such as HoloLens, and many assistive technology devices for low vision people rely on HMDs. Specifically, in the context of low vision individuals who often struggle financially due to a lack of job opportunities, HMDs are unaffordable for many.

SignSee (name made up for conciseness purposes) also relies on Microsoft HoloLens, but the function is primarily used for sign identification [6]. A low vision user using the device can point their HoloLens at the sign they want to identify, and the device would generate an enlarged version of the text onto the FOV of the user. In a situation where there are multiple signs, SignSee would identify all signs and allow the user to choose which sign to enlarge. The control presented within the paper is sighted users identifying signs with a low vision simulator but without the SignSee device. Users ranked SignSee higher than the control in three different aspects: ease, comfort, and confidence. However, similar to the Stairvision, the time taken for users to complete a sign identification task was not faster compared to the control. The group of users who used SignSee on average “walked at a slower speed and needed substantially more time to complete the task” [6]. It is worthwhile to note here that the users that took part in this experiment were not low vision individuals, they were individuals who wore a low vision simulator. In terms of accessibility, similar to the first device it can be hard for many low-income low vision users to purchase it due to its cost. Additionally, the device can exclude users in regions with unstable internet connections. The device relies on a cloud-based service, and it requires an internet connection for its sign identification function to work. For users living in regions without stable internet connection, the device might not work best, meaning that the time taken for users to identify signs would be even longer due to lag. This is a problem that can extend to all devices that need a stable internet connection to function. Furthermore, it can be inconvenient for users to set up Wi-Fi for every building they enter.

The third device is also a device developed using HoloLens, and it will be referred to as Wayfinder [5]. Wayfinder helps low vision individuals navigate unfamiliar environments by providing different visuals. There are different visuals individuals can choose from, all of which

show the path the user needs to follow to arrive at the destination. For this device, the researchers also developed an audio system that users can choose to include. A survey of the 16 low vision users that participated in testing found that although users preferred visuals over the audio system for presenting information related to the environment, most users preferred a combination of both audio and visual systems. The researchers noted that the learning time for visual cues fluctuated according to the user's visual capabilities, however, the learning time for audio cues was stable and shorter compared to the learning time for visual cues. The ability to switch between modes, or combine modes (visual and audio) is important for low vision individuals, as they can have varying visual capabilities, which can lead to different preferences. In the context of Wayfinder, low vision users with limited FOV would prefer the audio system over the visual system due to difficulties seeing visual cues. Although Wayfinder did not have a significant effect on wayfinding, users made fewer mistakes when using Wayfinder. Avoiding mistakes in navigation can be useful for low vision users, as individuals can save previously wasted time. It might be difficult for low vision users to use Wayfinder for long periods of time throughout the day, though, when considering metrics such as power consumption and portability. Wayfinder relies on Microsoft HoloLens, which lasts 2-5 hours when full. HoloLens also weighs roughly 500 grams, a weight that can be uncomfortable especially when it is a weight that is felt on a user's head, where HMDs are strapped onto. Finally, it is unclear if Wayfinder's pathfinding system can be applied to all unfamiliar environments since the device was only tested out in one building.

The final device in this category is CueSee, an AR application on the Oculus Rift that helps low vision users search for products in a shop or supermarket [10]. The application works by identifying the desired product and then highlighting the product through different visual filters. Some visual filters include color contrast, spotlight (a box that surrounds the device), and sunrays (red lines that extend from the product). Users can choose to combine different visual cues to enhance their search experience. According to the paper, different individuals found some visual cues more effective than others, highlighting the importance of flexibility to the user experience. StairVision, SignSee, Wayfinder, and CueSee all offer users a wide variety of choices for visual enhancements. CueSee yielded positive results in regard to accuracy: all 12 low vision users had an accuracy of 100%, meaning that users were able to find the correct product in all trials. It is unclear though if CueSee can still achieve the same results in a larger, open

environment different from the experimental environment with only one shelf that the researchers tested on. For the device itself, the cost is a lot cheaper compared to Microsoft HoloLens, with the Oculus Rift DK2 costing around \$300. The comparatively lower cost means many more low vision individuals are able to access CueSee. In terms of portability, researchers who authored the paper claim that the device is “big”, “heavy” and impractical for real due to discomfort. For HMDs especially, if the device is too heavy and large, users will not be able to carry the device around. Considering how the devices are used in specific scenarios, however, portability as a factor might not be as important as it is in devices for daily use. Discomfort during use can still negatively affect user experience and even lead to many choosing not to use the device completely.

2.2 Devices for daily use

Devices for daily use refer to devices that can help low vision users complete a variety of daily tasks requiring vision, unlike devices for specific uses which are designed to be applied in specific situations. There are two devices that fit into this category.

The first device is ForeSee, an HMD aimed at enhancing vision [12]. The physical device is an Oculus Rift DK2 combined with a video camera. It has 5 enhancement methods that are similar to CueSee: magnification, contrast enhancement, edge enhancement, black and white reversal, and text extraction. The difference between ForeSee and CueSee is that the enhancements of ForeSee are designed to improve a user’s shopping experience, while the enhancements provided in ForeSee can be applied to any situation. For example, a visual provided in the ForeSee paper shows a low vision user reading the time on a watch while using the device’s magnification functions. Individuals are able to choose what visual enhancement they would like to use for each task, and according to the paper, each user’s preferences varied. No individual had the same preference, which shows that the ability to customize is important to the specialized needs of each individual. Although all users were low vision individuals, their remaining vision can vary according to the cause of their low vision. The researchers emphasized that they do not expect users to use the device in real life considering its weight and bulkiness. The lack of portability negatively impacts the benefits the device can bring to low vision individuals, since users may not be able to use the device for long uninterrupted periods of time during the day to satisfy their daily needs.

The second device is eSight, a commercialized HMD that has similar functions to ForeSee [13]. The ForeSee researchers made a direct comparison with eSight, claiming that ForeSee has more visual enhancements compared with eSight. However, eSight has an advantage in terms of portability. The eSight device does not use Oculus Rifts or HoloLens, instead, it uses its own smart glasses that weigh less than both the Oculus Rift and the HoloLens as seen in figure 2. A lighter HMD can ensure that users will feel comfortable wearing it for the majority of the day. Since eSight is a device that is purchasable, extra steps were taken to transform the device from a research-quality device into a market-quality device, and an example of these extra steps can be seen in the lighter weight of the eSight device. The eSight device weighs 200 grams, less than the 500-gram weight of HoloLens and Oculus Rift. Although the researchers did not discuss the functions of the device extensively, the researchers did present information about how eSight users felt about the device, and also the social implications of the device. For example, users of eSight were asked about their experience with the device. A user described eSight as life-changing, and though the price for purchasing the eSight device is higher compared to other HMDs (when the paper was written, the cost of eSight was 15,000 dollars), none of the participants expressed regret about purchasing the device. Though eSight users did initially have concerns about the cost, and the cost might be one of the reasons the device might not be accessible for many low vision individuals. Some users talked about how they had to sell their possessions in order to purchase eSight or start campaigns on donation websites. Apart from cost, researchers also collected users' opinions on social acceptance. Some users described eSight as a device that contributed positively to their sense of self-worth and social value since they can use eSight to complete daily tasks, interact with family members, and even pursue job opportunities. While other users talked about the device's bulkiness inhibiting natural, face-to-face interactions with others. One user specifically talked about how HMDs prevent eye-to-eye contact, thus people felt less trust when talking to them.

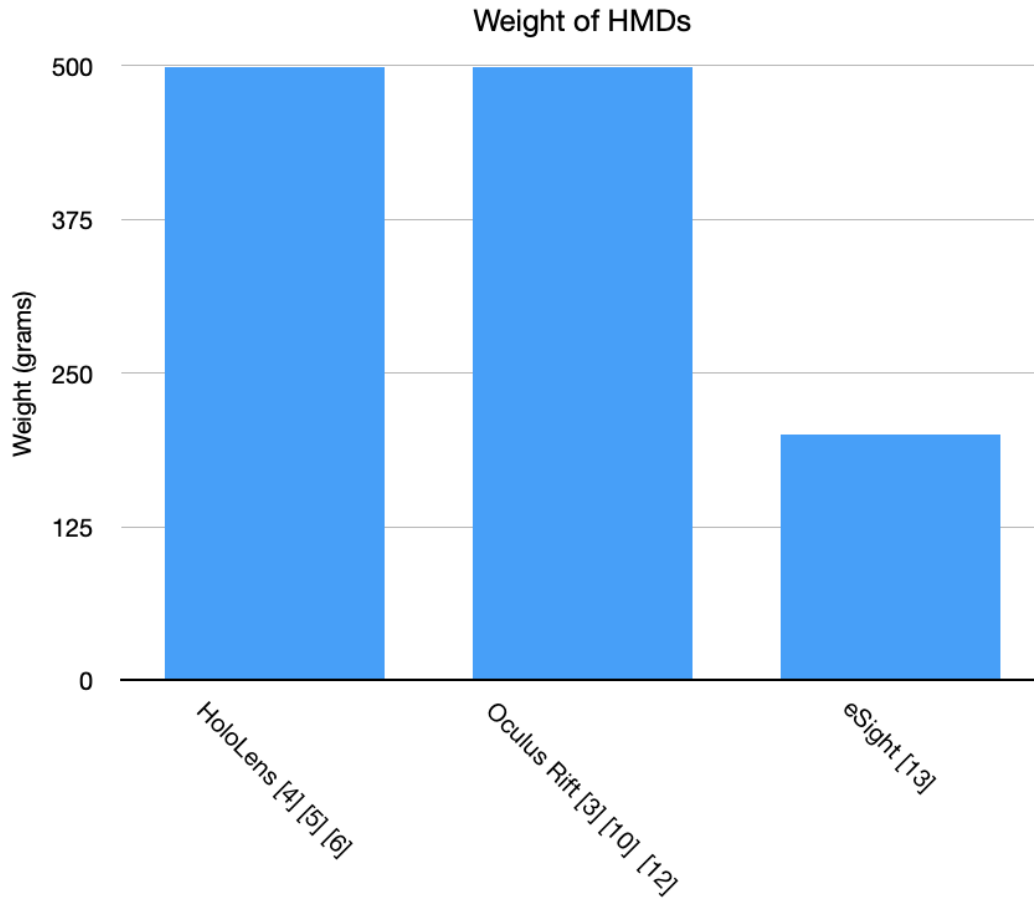


Figure 2: Weight of HMDs

Finally, ISight is a device that utilizes computer vision to help low vision individuals recognize objects better [11]. The device works by pointing either a tablet computer or a mobile phone at an object. The application running on the camera device would then identify the object, and present an enhanced image of the object. There are three different modes low vision users can choose from when attempting to identify an object: icon, enhance, and cartoon. Both the icon and cartoon mode attempt to simplify the object into an easy to recognize image. For example, when the camera is pointed at a car positioned far away from the user, iSight would show the user a large, generic image of a red car. The other mode, enhance, directly magnifies the object. The accuracy of the iSight device, or how accurate it is at identifying objects is at around 70 percent. The iSight paper doesn't include much information about the device related to the metrics mentioned in this paper, but the technology of computer vision can definitely be applied to other HMDs to identify objects better.

3. Devices supplementing vision

Devices supplementing vision refer to devices that not only enhance one's vision but also interact with the user's other senses, such as hearing and touch. Another key difference between the two categories would be the makeup of devices. Whereas devices that enhance vision mainly consist of HMDs, devices that supplement vision are more diverse in their appearance and also in the technological aspects utilized within the device.

3.1 Devices for a specified use

The first and only device in this category, Vtrain (named for conciseness purposes) helps low-vision individuals train to navigate in unfamiliar environments. Virtual Reality (VR) is used to design virtual environments with different obstacles that are similar to those in real life. Users train within the virtual environment by wearing an Oculus Rift headset, which is connected to a computer that the user carries around throughout the training session. The system also consists of a tracking system to track the user's movement, a pair of headphones to provide audio feedback, and two vibration motors to provide haptic feedback. The vibration motors and the headphones are part of an alert system that warns users of obstacles within the virtual environment since users are not shown the virtual environment. The alert system is designed to alert users more frequently when they get closer to an obstacle. When Vtrain was tested in different environments with varying amounts of obstacles, the researchers found that although test subjects were able to navigate the virtual environments, the 13 users experienced 147 collisions in total. The users were not low vision individuals, rather they were sighted, potentially explaining why they might not be as accustomed to using audio or haptic feedback to avoid obstacles. Since Vtrain was not tested on low-vision individuals, one cannot conclude that low-vision users would collide with obstacles less compared to sighted users simply due to their familiarity with methods of feedback. In terms of cost and portability, Vtrain is slightly more expensive and a lot heavier than the radar device above, considering how users have to carry a computer around during training. Training sessions are less time-consuming and frequent compared to daily activities; thus, the negative impacts of the Vtrain's weight are less compared to other HMDs.

3.2 Devices for daily use

The Aira assistive technology is a pair of smart glasses that connects an Aira human operator with a user [7]. The human operator would guide the low vision users and assist them in any task with which they need help. The main uses of the device, according to the paper, include reading, home management, navigation, shopping, etc. A human operator can help low vision users by connecting with the front-facing video camera installed on the glasses, after which the operator can see what the low vision user wants help with and assist them by giving instructions, or in some cases helping them complete the task itself (e.g., reading a book out loud for a low vision user). The paper collected data from more than 800 individuals with visual disabilities and analyzed more than 10,000 calls. From the data collection, researchers who authored the paper found that although the device had above 70 percent success rate for all popular uses (reading, home management, family, social, instructions, navigation, shopping, the arts, employment assistance), about 40 percent of low vision individuals used the Aira device only once throughout the entire experiment. Other groups of individuals, such as individuals from the light perception or blind group had slightly higher frequencies of use. Researchers also pointed out that their study's included user base might not be representative of the entire low vision population, as these are individuals who have the financial resources to purchase the subscription as well as the technological literacy to operate the device. The cost of the device itself was not specified within the paper, but the call time costs \$99 for 120 minutes of call time, and \$199 for 300 minutes. On average 27.5 percent of low vision users call for more than 9 minutes per day, and the cost goes up along with more frequent use of the device. The Aira device also only is accessible currently to individuals living in the US, Canada, and Australia. Even if Aira manages to expand its reach to more locations, it is unclear if users in other regions can have stable connections with human operators who are in faraway locations. Connection problems also severely disadvantage users living in less developed areas.

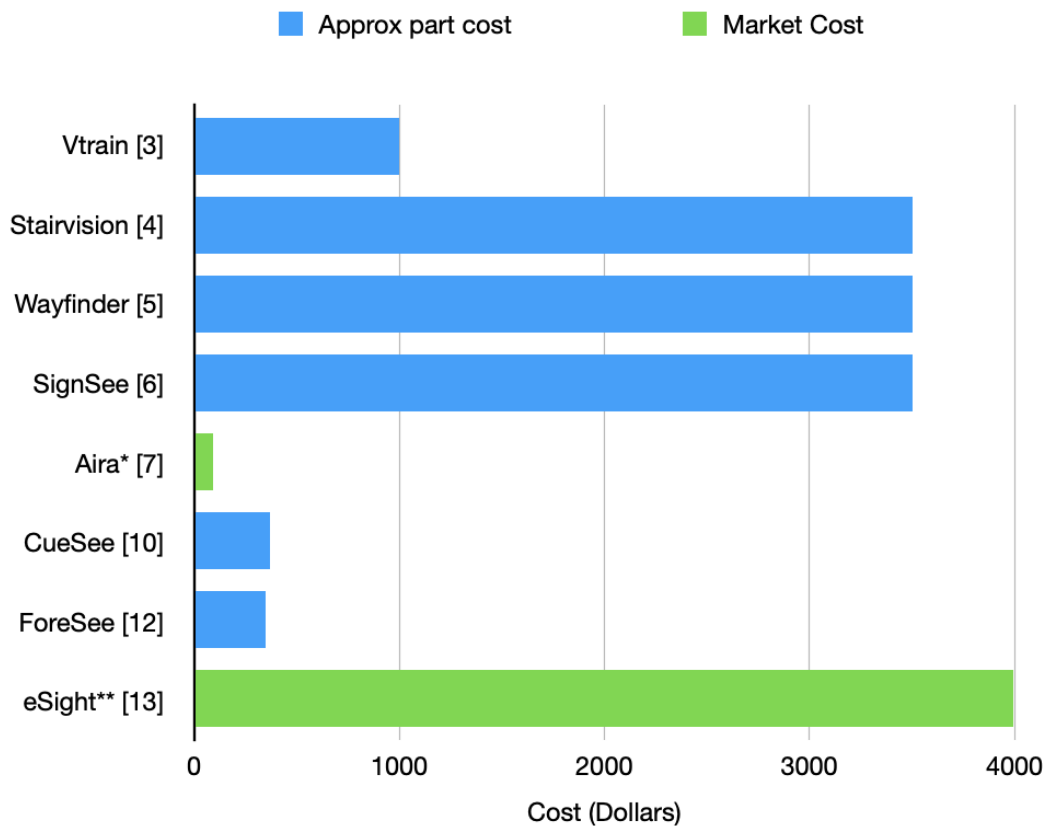


Figure 3: Cost of devices in dollars

The second device is called NavCane [9]. The device is a white cane used mostly by blind and low vision individuals to avoid obstacles, but with extra components that allow it to help low vision individuals beyond the navigation help a regular cane can provide. Although the ultimate goal of NavCane is still to help low-vision individuals identify obstacles and paths, it has more nuanced methods of helping individuals achieve that result. NavCane contains several components: a radio frequency identification reader, ultrasonic sensors, a GPS module, vibration motors, a gyroscope, and a wet floor sensor. Five ultrasonic sensors are placed on different parts of the cane to detect objects at different heights, combined with vibration motors and a sound device to form an alert system. The wet floor sensor prevents users from stepping into wet floors, and if a user does fall the GPS module sends the user's location to family members so they can assist the potentially injured user. The gyroscope/accelerometer helps detect the tilt of the cane to ensure that distance calculations made by the ultrasonic sensors are correct. The researchers who created the device were able to achieve good results with low-cost components: 80 low vision,

blind, or old age users using the device were able to navigate an unfamiliar environment faster and experience fewer collisions with objects that had varying heights. Using the cane can be difficult for users, however. The cane has lots of components on it to ensure that it can achieve a variety of functions, and it also needs to be held in an upright position to ensure the accuracy of distance measurements. Nevertheless, NavCane is still able to build onto a traditional assistive device that many are familiar with, and even with the multiple electrical components on it NavCane's battery can last for 6 hours 40 minutes to 10 hours on average, which is long compared to other devices seen in figure 3. Long battery lives ensure that users will be able to use the device throughout the day, and especially for an assistive device like a cane that will be used in all settings NavCane's battery suits the requirement well.

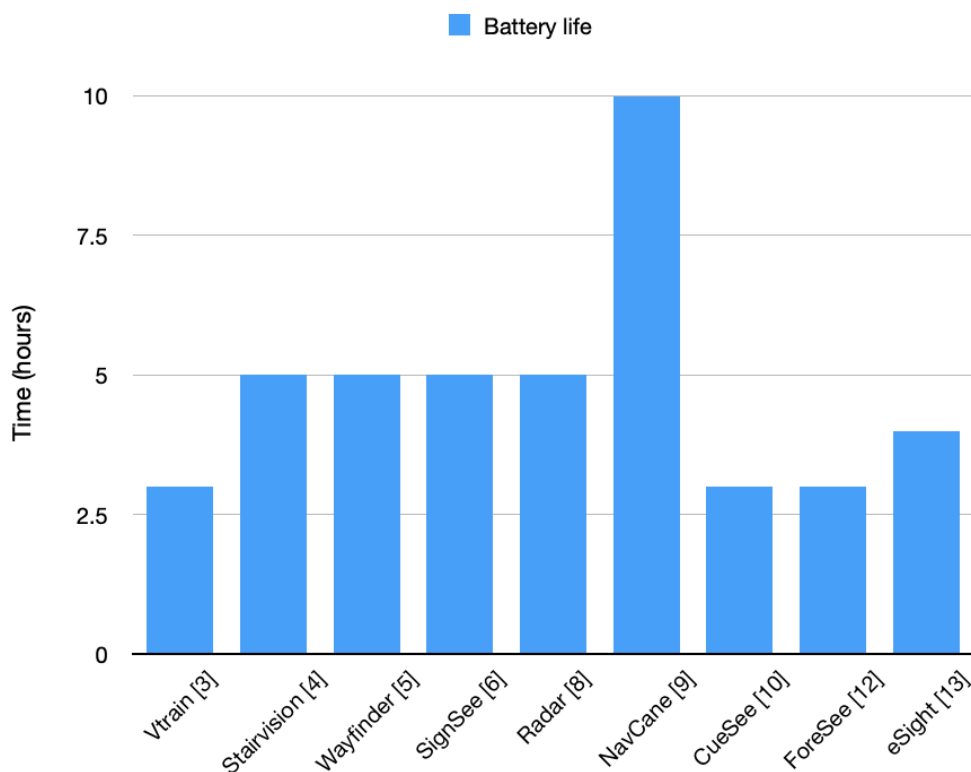


Figure 3: Battery life of all devices.

The last device that belongs in this category is a radar device, Quest 2.0, that helps individuals identify objects within an environment [8]. The device is wearable, and it is strapped onto the user's abdomen. The miniaturized radar within the device sends signals in the user's walking direction, and if the signals reach an object the signals would reflect off the object and

be detected by the radar. The radar sensor detects a 0.9-meter-wide area up to 2 meters in front of the user, and it can provide haptic and voice feedback if the radar detects an object within that area. Out of the 25 individuals who participated in the experiment, 92 percent of the users answered that the device improved their environmental perception, and 80 percent of test users reported that the device improved their confidence in independent mobility at least to some extent. Although not all users were low vision users, with 7 low vision users out of 25 total users, the paper did state that the results indicated people with low vision were one of the groups that benefited the most from this device. The paper also stated that many of the test users “would be willing to obtain this device if it was commercialized”. Perhaps the main advantage of this device, Quest 2.0, as compared to other devices is its portability. The device can be strapped onto a user, and the average user satisfaction with the weight of the device is 4.1/5, which belongs in the “quite satisfied” category. HMDs are also hands-free devices that can be strapped onto a user’s head, but the weight of the device poses a problem for users who would like to use HMDs for long periods of time. Finally, although the device has not been commercialized, the cost of the device is likely to be lower compared to HMDs. The device only consists of a 3D printed case, a miniature radar, a vibration motor, and a speaker for sound feedback, which all can be cheaply acquired.

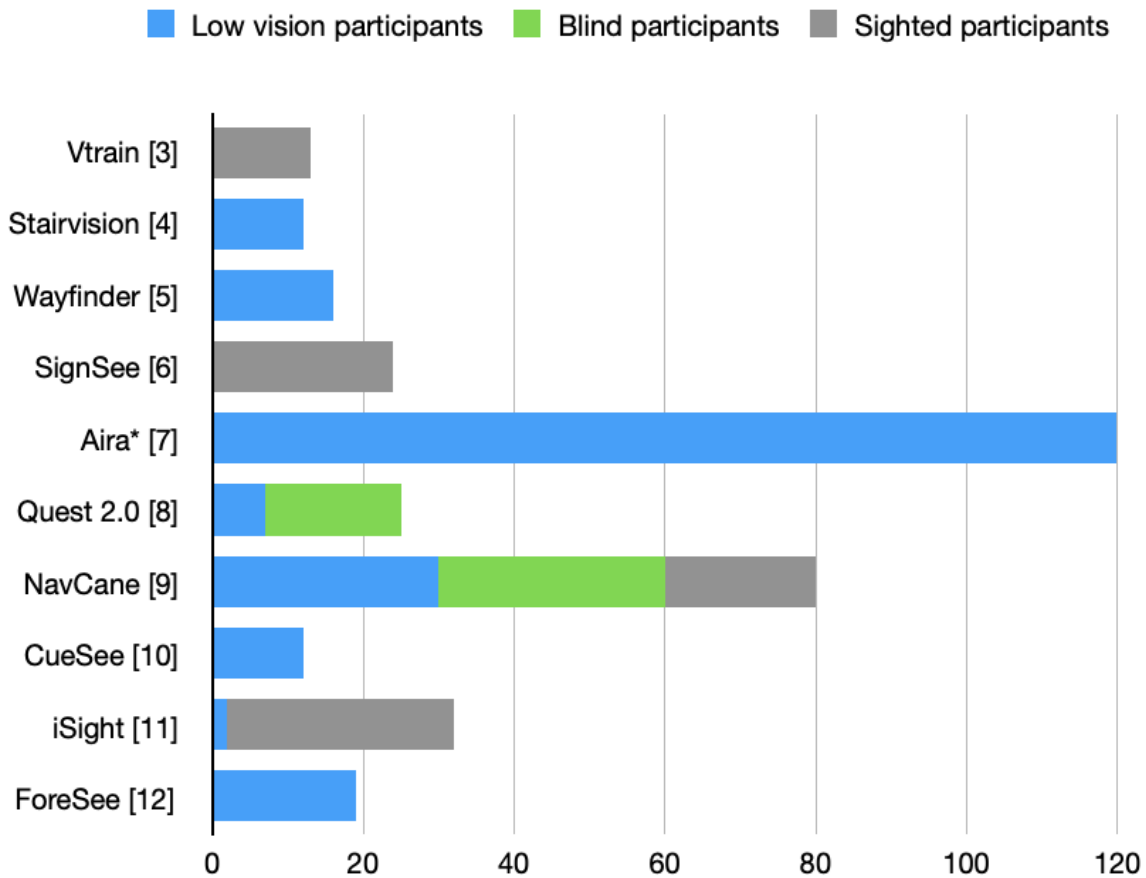


Figure 3: Makeup of participants who tested out devices. Participants are categorized according to their vision: low vision, blind, and sighted.

Conclusion:

There are a few areas devices mentioned above can improve on to potentially better help low-vision individuals. Since many devices are prototypes, researchers mentioned some of the following areas within their papers as areas they will be focusing on for future prototypes.

1. **Weight and Size.** Future devices can be lighter to improve user experience. Since HMDs and their weight apply pressure to the user's head, HMDs especially need to consider decreasing weight in future products/prototypes. As seen in figure 2, eSight, the only assistive device for low vision individuals on the market out of the 11 mentioned in this paper weighs the lightest compared to other devices. It would be best if devices can retain their functions, but decrease the weight of parts or potentially eliminate unnecessary parts

that contribute to the weight of the device. Devices like Quest 2.0 that strap around one's torso might be more comfortable than HMDs with the same weight, but researchers who developed Quest 2.0 did point out that they will try to create lighter prototypes in the future [8]. Devices could also be smaller in size, as researchers have claimed that the bulkiness of HMDs has prevented real-life use of devices for low-vision individuals [10].

1. **Price.** Future devices can be less costly for users to purchase to reach more low-vision individuals. A positive trend of decreasing prices can already be observed in the status quo: new HoloLens and Oculus devices are less costly compared to earlier models. HMDs such as the HoloLens were relatively new when some of the devices mentioned above were developed, which explains why the prices might be higher compared to recent models. Apart from increased accessibility, lower costs also ensure that low vision users aren't sacrificing much financially to purchase a device.
2. **Battery life.** It would be beneficial if future devices could have longer battery lives. Longer battery life for devices means that users can use the device throughout the day without having to fear that the device would run out of battery in the middle of use.
3. **Customization.** Many devices already contain multiple choices for features and allow users to combine different features for the best experience. Multiple features and the freedom of choice caters especially to the low vision population, as users have varying visual capabilities. One feature might be better suited for a specific condition, such as audio cues for low-vision individuals with limited FOV [5].
4. **User base.** When testing devices, the majority of the users should be low vision participants to ensure that experimental results are representative of the low vision population. It is also important to understand the actual needs of low-vision individuals to improve assistive devices aimed at bettering their lives.
5. **Social implications.** According to users mentioned in the eSight paper, eSight improved their sense of self-worth and social value. However, a user claimed that eSight impacted them negatively since they felt like they couldn't naturally socialize with others wearing an HMD [13].

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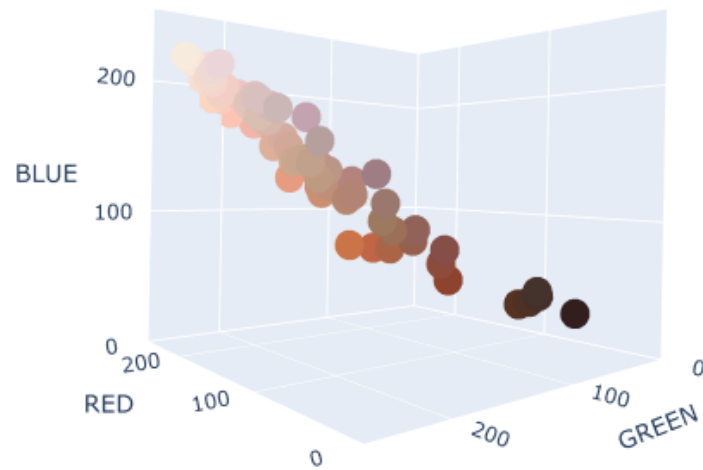
Colorism in Magazines By Eduino Lopez

Every magazine we see always has people, people of many colors. But many magazines have been unfair in the use of people of different colors. Those magazines may have used colorism. Colorism is something seen in our everyday life, unfortunately, it is used in a bad way. In magazines, people pick certain people to get their pictures taken to sponsor or be in the magazine overall, but sometimes the creators and editors of the magazines are biased in a way that they use people in a certain category in skin tone. Another bias is that the editors can photoshop people's skin tones and make them lighter or darker. Bias is a form of inaccurate work using preferences rather than facts. Though my group and others have researched some magazines to see how much colorism is used in our daily magazines, and what skin tones were mainly selected.

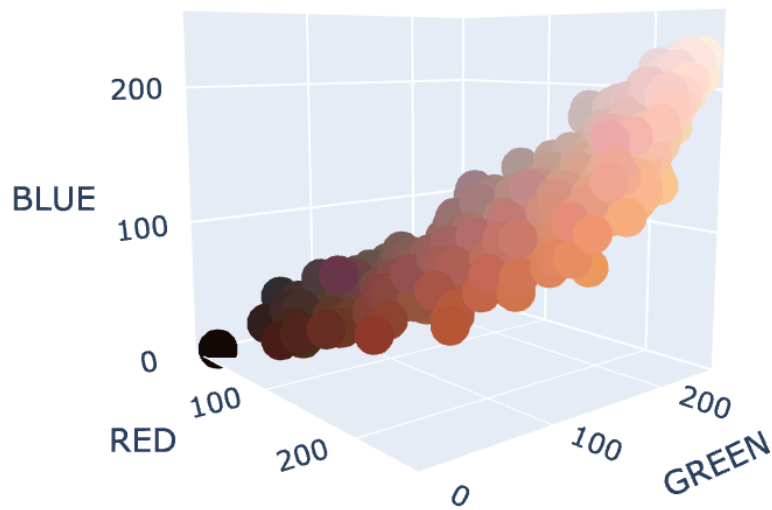
This is a 3D graph of the magazine that my group and I did. This Magazine is named sunset living and these were the types of skin tones we collected. We have picked the colors of people in the photos and every 3 colors is a person. In this photo, it was a combination of both the ads and the article's skin tones.

The next photo is the entire data of all the groups combined into one 3D model with both ads and the articles. This is only one angle of the model. And this data shows us that more medium to medium-light-skinned are used most in these magazines.

Unfortunately, this data shows us that the colors primarily used in these magazine ads and the articles themselves use more medium to medium-light-skinned colors. Even though we have had a lot of research on this topic there, of course, there will not be perfect precision in the options given, and the same for the results. There are two types of biases that were in the experimentation, the first one is something we could not control. This bias is availability bias and this bias is when we are only able to pick from only a given amount and not that much free roaming. The second bias is called selective bias, for this bias, it was all about us meaning what pictures we picked and how we categorized them as some of our selections would either be biased too. There may be more to research and find out about the colorisms used in magazines, articles, and ads but with this information produced then so far articles and ads have been biased in using mostly medium-skinned people to medium-light-skinned people.



Group data organized by “Sadie Gibberd, Ryan Turner, and Eduardo Lopez” accessed February 27, 2023, Made on February 10, 2023



Entire research groups organizations by “Racheal Griffin” accessed February 27, 2023, Made in February 20 2023

Current Research and Implications Regarding the Role of pH in Eczema Development By Yastika Singh

Introduction

Eczema is a common skin condition characterized by severe itching and inflammation of the skin. However, as common as it is, the exact cause of eczema has not been pinpointed. Instead, a range of factors including genetics have been studied in relation to eczema. In particular, the relationship between eczema and pH has been studied considerably. There are many promising and exciting avenues of study in this field. The implications of this research include guidelines for products eczema patients use. It has been shown that many products commonly marketed as “gentle” and for “sensitive skin” are very alkaline which could have harmful effects on the skin⁷. This review will present an overview of the research done to determine the relationship between eczema and pH and the future of this field of study.

The pH scale is a scale from 0 to 14 that measures the concentration of hydrogen ions in a solution. 7 is neutral, meaning the concentration of hydrogen ions equals the concentration of hydroxide ions which neutralizes the positive charge of the hydrogen ions. Anything below 7 is considered acidic, meaning the concentration of hydrogen ions is more than that of hydroxide ions. Anything above 7 is considered basic, meaning the concentration of hydrogen ions is less than that of hydroxide ions.

Increased skin pH, meaning more basic pH, has been associated with increased dryness, increased skin roughness, and decreased stratum corneum hydration²¹. pH is especially important in the uppermost layer of the skin which is called the epidermis. The epidermis contains something known as the “acid mantle” which has a normal pH of between 4 and 6. This acid mantle protects the skin’s native microbiota, leads to healthy desquamation (flaking) of the skin, and maintains proper lipid biosynthesis¹¹. Atopic dermatitis, more commonly known as eczema, has been correlated with an alkaline skin pH. One study found that a pH of 4 had a small but detectable increase on the mobility of the stratum corneum, the uppermost layer of the epidermis, in pigs’ ears because keratin and the lipids in the SC have the best mobility at pH 4¹⁹. The effects of a higher skin pH are far ranging and will be discussed in depth in the later sections. One of the most impactful effects is that higher pH leads to increased skin permeability. Increased skin

permeability causes more particles to be able to pass through the skin surface which can irritate the skin and cause eczema.

Therefore, research on the origin of the acid mantle is important. The origin of the acid mantle has been studied and found to be a combination of diffusion of acidic material from the surface and cornification-related organic acids. Specifically, in a study done on ichthyosis, it was found that a decrease in acidic products from the breakdown of profilaggrin and accumulated cholesterol sulfate both contributed to a higher pH and abnormal function²². Understanding the mechanisms of the acid mantle of the skin is important to creating treatments that target these mechanisms.

Many factors including the methods of measurement affect pH. The most common way to measure skin pH is using a flat glass electrode but this method can produce different results than a dry pH meter²⁰. Thus, more accurate measurement methods of pH may be necessary so there are no discrepancies over the readings. pH itself is unique to different parts of the body. The environment can also have a significant impact on skin pH. One study compares skin pH and other skin factors in two Indonesian cities, Jakarta, which sits at a low altitude, and Bandung, which sits at a high altitude. It was found that low altitude caused more redness, higher sebum level (secretion of oils from the sebaceous gland through pores on the skin) in the forehead, and lower pH. At high altitudes, there was higher pH, greater elasticity, and brighter skin¹⁶. Another study found that outdoor exposure lowers pH in the summer because sweat-derived lactic acid acidifies the stratum corneum¹⁴. Thus, the implications of pH in personalized medicine are important to treating eczema and other skin conditions with a person's unique pH levels in mind.

Microbial and Fungal Growth Caused by Increased Skin pH

Increased skin pH has been found to allow harmful microbes and fungi to proliferate on the skin. These microbes and fungi can be triggers for itching, causing eczema. In one study, the effects of surgical dressings were observed. Participants wore an occlusion on their forearm for three days. After removal, skin moisture increased from 20% to 75%, skin pH increased from 4.9 to 7.1, and staph bacteria and *Corynebacterium* increased 4-5 logs due to the occlusion¹⁰. The increased skin moisture and pH allowed the bacteria to proliferate.

A similar phenomenon occurs with yeast. For example, the opportunistic yeast, *Malassezia sympodialis*, a trigger factor for eczema, is almost nine times more expressed when

skin pH is 6.1 than when skin pH is 5.5²⁴. A similar study tested occluded forearms for *C. albicans*, another opportunistic yeast, using buffers of 4.5 and 6.0. Lesions resulting from the yeast were more pronounced in the arms buffered at 6.0, suggesting that higher skin pH provided a more ideal environment for the *C. albicans* to proliferate²³. Thus, an alkaline skin pH can irritate the skin and trigger an eczematous attack.

Filaggrin's Role in Eczema

The FLG gene is of particular importance in the case of eczema. FLG codes for a protein in the epidermis of the skin called profilaggrin which breaks down into smaller filaggrin molecules. These filaggrin molecules further break down into their amino acids which are hygroscopic, meaning they absorb water from the atmosphere. These hygroscopic amino acids are NMFs, or natural moisturizing factors²⁸ so they help moisturize the skin. Furthermore, one of the amino acids is histidine, whose role is to further help make urocanic acid and pyrrolidone 5 carboxylic acid which acidify the stratum corneum²⁸. Thus, the FLG gene has a starring role in the maintenance of healthy skin pH.

One experiment compared a FLG-deficient skin construct with a healthy skin construct because filaggrin deficiency or mutations in FLG have been associated with atopic dermatitis²⁸. As expected, the levels of urocanic acid and pyrrolidone 5 carboxylic acid were significantly less in the FLG-deficient construct. Initially in the FLG-deficient skin construct, NHE1, officially known as the sodium and hydrogen exchanger 1, was upregulated to compensate for the lack of acidic filaggrin breakdown products. This allowed the construct to maintain a healthy skin pH of 5.5. At day 14 of the study, secretory phospholipase A₂ (sPLA₂), whose role is to convert phospholipids into fatty acids, was significantly more active in the FLG-deficient construct. This caused an accumulation of fatty acids in this construct which led to less organization of lipids in the skin. Disorganization of the skin barrier caused increased skin permeability and barrier dysfunction, a possible explanation for one of the mechanisms that leads to sensitivity to eczema. The FLG-deficient construct had a more hexagonal assembly of lipids rather than the normal lateral structure. The absorption of testosterone was observed to test skin permeability because testosterone is lipophilic. There was increased testosterone absorption in the FLG-deficient construct, meaning that there were less phospholipids and more fatty acids, leading to increased barrier permeability. The increased free fatty acids contributed to barrier dysfunction and

inflammation. The trigger for the disorganization of lipids and barrier dysfunction could have been triggered by localized changes in pH or a response to the abnormal levels of certain products²⁸.

Another study had conflicting conclusions about the role of filaggrin deficiency in the development of eczema. The spontaneous development of eczema in newborn mice in conventional conditions was observed while no eczema development was observed in mice placed in specific-pathogen-free conditions¹². Over time, the pH of the eczematic mice increased while the pH of the mice in the specific-pathogen-free conditions decreased to normal levels. The alkalization of the eczematic mice in the conventional conditions resulted in more kallikrein 5 and activated protease activated receptor 2 which secrete thymic stromal lymphopoietin. Simply, this causes T-cell proliferation, leading to inflammation and trans epidermal water loss. The pathway identified is known as the KLK5-PAR2-TSLP pathway. Weak acidification via a treatment of 2.5% or 5% lactobionic acid led to a reduction in eczema via a reduction in TSLP, PAR2, and KLK5. Notably, there was no noted filaggrin deficiency in the eczematic mice though. However, there was impaired function of NHE1, which is a pH regulator, in these mice. The eczematic mice did not have increased NHE1 to compensate for the alkalization. The study concludes that prolonged alkalization of eczema patients could be due to the suppression of NHE1 by an overactive immune system.

Clearly, further research must be conducted to identify the degree to which FLG and NHE1 function contribute to the development of eczema. However, it is evident that while impaired function of one or the other may not definitively cause eczema, each can be a trigger or contributor of eczema.

Neonatal Acidification and the Origins of the Acid Mantle

The acid mantle of the skin is not present immediately after birth. In fact, mammals have a neutral pH at birth but gradually, acidification occurs. The acidification process occurs as the skin barrier forms through the processing of lipid products that act as a structural barrier. Allergies and atopic dermatitis have been known to set in while the stratum corneum is undergoing acidification. One study observed the developing acid mantle in neonatal rats using fluorescence lifetime imaging. There was a periderm layer on the newborn rats' skin the first few days after birth that eventually acidified in the first three days and then disappeared on day 4.

This is a remnant of the periderm of the uterus which is a barrier between the epidermis and the amniotic fluid in the uterus. This layer acts as a barrier between the baby's epidermis and its environment the first few days of life, and could potentially be important in the development of healthy skin. Acidification of the lower stratum corneum occurred three days after birth and the acidification spread outward to the surface along with the construction of mature extracellular lamellar membranes, otherwise called the skin barrier². Within one week, the rats' skin surface had adult pH levels. The acidification process takes several weeks in human babies, which implies that the first few weeks of a baby's life are crucial to the development of a healthy skin barrier. This study also highlights the potential significance of the periderm layer in babies in the development of eczema.

Treatments have also been studied for neonatal skin in the prevention of eczema. One study¹⁵ looked at the effect of oil baths and facial fat creams as treatments for xerosis, or dry skin, for babies aged six months in Norway. Babies with dry skin from a well-baby clinic were involved in the treatment while babies from five other clinics served as controls. Oil baths were given between 2-7 times a week. The results showed that the treatments improved the skin of the babies with xerosis by restoring the defective lipid bilayer. The defective lipid bilayer was attributed to increased skin surface pH due to a Western lifestyle of excessive soap use.

Another interesting area of research regarding eczema and infant pH is umbilical artery pH. The umbilical artery is found in the umbilical cord between the mother and baby. A study¹³ conducted of two hundred twenty-two asthmatic Finnish children and one hundred eighty-three Finnish children studied the correlation between umbilical artery pH at birth and the development of asthma, allergic rhinitis, and eczema at the age of 5-6. Babies that had an umbilical artery pH greater than 7.30 had a 0.41-fold lower risk of eczema than those with a pH between 7.26 and 7.30. This study shows that while acidified skin may be healthier, a more basic umbilical artery could be healthier for babies. The implications of umbilical artery pH must be studied in greater depth.

The link between skin wetness, skin pH, and diaper dermatitis has also been studied³. Diaper dermatitis is a rash caused by increased skin hydration due to diaper wear. Increases in skin wetness and skin pH of the diaper covered area were correlated with increased diaper dermatitis through statistical analysis. The difference in pH between healthy skin and diaper dermatitis- affected skin was pH 5.3 and pH 5.9. This difference resulted in increased

permeability and increased activity of fecal enzymes which irritate the skin. Enzyme activity is known to be pH dependent, another important implication of skin surface pH in the development of eczema.

Eczema Treatments Related to pH

Finding the mechanisms of the acid mantle is interesting but equally exciting are the applications of pH-focused treatments for eczema. One of these treatments involves electron ionized water. One such treatment was used for a patient in her late twenties who came to the hospital with severe face and body eczema²⁶. The reason this novel treatment was used was because infection had set in as well because of the exposed skin wounds. The patient was given an herbal medicine tablet and an oral antihistamine, a steroid ointment, and vitamins E and A topically, allergy injections, and electrolyzed water and electrolytic reduction ion water lotion for disinfection and skin care. ERI and electrolyzed water were applied twice a day and emulsified the patient's skin. The patient's swelling, redness and lesions improved greatly over the next few months even as the steroid was decreased. The electrolyzed water had a pH of 2-3 and is considered very safe because it is used in the food industry and the dental industry as a sterilizer, and promisingly in the medical field in wound healing.

Another line of treatment is hyper-acidification. One study⁵ tested skin buffered skin products with pH below 4.5 in the acidification and hydration of the skin of subjects over 50. Vitamin C Spheres, Collagen Spray, and Collagen Mask were tested. The criteria measured were skin surface pH, skin hydration, and barrier integrity over the course of four weeks. The Vitamin C Spheres acidified the skin while the other two products maintained the physiological skin pH. In subjects with a higher-than-normal pH, the products acidified their skin. This is important because with age, the pH of the skin increases, raising the risk of eczema. Acidification of the skin could aid in preventing eczema with age.

The buffering capacity of the skin itself has also been explored. In one study³⁰, the buffering capacities of the stratum corneum, epidermis, and dermis were observed. The skin was obtained from a skin bank. Each layer was injected with solutions of NaOH, a common base, and HCl, a common acid, at different concentrations and were washed with deionized water after 30 minutes. pH and trans epidermal water loss were measured at intervals between the injections and the washings. The dermis demonstrated the best immediate buffering capacity, meaning the

pH did not increase as much as in the other layers, but over time, the stratum corneum was better at buffering because it reestablished the basal pH the fastest. The dermis had the greatest trans epidermal water loss while the SC had the least. Interestingly, it was found that buffering was faster after HCl was applied than after NaOH was applied. This shows that alkalinization of the skin is dangerous because it takes a while for the skin to reestablish basal pH, allowing time for eczema to set in. This study is important because it emphasizes that buffering of the stratum corneum does not occur immediately after an induced change in pH. This draws attention to the need for an immediate application or treatment if a patient's skin has been alkalinized, such as after the shower.

Models for Studying Eczema and pH

There are many models that are used to study the mechanisms behind pH and eczema. One such model⁶ found that a specific peptide amphiphile in the skin is flat and tape-shaped at pH 3 and pH 7, twisted and right-angled at pH 4, and circular at pH 2. An amphiphile is water loving at one end and fat loving at the other. The twisted structures which occur at pH 4 are likely the “normal” structures because the normal skin pH is between 4 and 6. Hydrophobic and electrostatic interactions determine the self-assembly of this peptide amphiphile, which is derived from collagen. Thus, this model provides an interpretation for some of the physical changes created by a diversion from the normal skin pH. In biology, pH is important to the shapes of proteins because specific R-groups are acidic or basic and this influences the shape of the protein. If there is a change in pH, as in this study, the shape of the protein changes, just as the peptide amphiphile did.

Many models that study eczema and pH are animal models, particularly mice. In one study⁹, hyper acidification of mouse stratum corneum with two polyhydroxy acids, lactobionic acid and gluconolactone was tested. Hyper acidification proved beneficial because the skin barrier was able to maintain homeostasis better and some of the deeper layers of the stratum corneum were acidified. In addition, ceramide generated enzymes and lipid processing enzymes in the stratum corneum were activated by hyper acidification. This caused the maturation of lamellar bilayers, the lipid structures that make up the skin barrier. Accordingly, the integrity of the stratum corneum improved because of the acidification. Most importantly, though, the acidification did not cause irritation of the mice. This study highlights the potential for hyper

acidification of layers of the stratum corneum as a treatment to help strengthen the skin barrier of eczematic patients.

Outside of animal testing, other models are used to study eczema as outlined in one review article¹⁷. For example, 2D cultures of cells like keratinocytes are used for basic studies and 3D skin disease models are used for more complex ones. Co-cultures can also be used; for example, skin cells and immune cells can be co-cultured to see the relationship between eczema and the immune system. Reconstructed human epidermis is another approach to studying eczema without live patients.

To take research on eczema and pH to the next level though, requires looking for other viable options. For example, microfluidic body-on-a-chip systems have been explored and need to be further explored for studying eczema. These devices can study the relationship of the skin to other organs in the body. Specifically to pH, one angle of research could be studying the effects of changes in pH of other organs or internal pH on eczema. Microfluidic systems could be the medium of research for such a field of inquiry. The review article mentioned also highlighted the need for skin models with vasculature and models that include shear stress and mechanical stresses. These novel methods of studying skin could open a larger field of questions that can be asked about eczema and pH.

New Wearable Technologies

Wearable technologies are a rapidly growing field of research. There have been studies on wearable technologies to monitor skin pH for eczema and related conditions. One way to determine skin surface pH via wearable technology is through the monitoring of skin volatile emissions. A study tested wearable colorimetric sensors that monitored volatile emissions of nitrogen compounds like ammonia from the skin¹⁸. This was a novel approach because it did not involve microneedles that could irritate the skin, as had been used previously. The sensors had bromocresol green pH indicator dye which changed color when it sensed a volatile emission from the skin. The color changes had a strong correlation with skin surface pH. Ammonia is produced when bacteria in the intestine break down proteins. The ammonia is transported by the blood to the liver where it is converted to urea and excreted. However, the remaining ammonia in the blood diffuses to the stratum corneum where it is emitted in eccrine sweat as ammonia or the ammonium ion. The volatile emission of gaseous ammonia was measured because the

equilibrium between ammonia and the ammonium ion is pH dependent since the ammonium ion just has an extra hydrogen ion. Thus, low emission of ammonia was correlated with low skin pH because that means that there was more ammonium ion, and therefore more hydrogen ions. This study highlighted that skin surface pH greatly differs between males and females and between different parts of the body, emphasizing the need for a holistic approach to skin conditions that considers these multiple factors.

Another investigation studied volatile skin emissions, but this time of fatty acids²⁵. The relationship between volatile fatty acid (VFA) emissions and skin surface acidity was found to be that the lower the pH, the greater the VFA emissions. In addition, peaks of VFA emission were correlated with the hydrogen ion concentration at a specific site. The proposed reason for this phenomenon was that the more ordered structure of fatty acids under low pH conditions leads to greater VFA emission. This study also used colorimetric sensors with bromocresol green dye.

Another approach to wearable technologies for eczema is bandages that monitor skin pH to direct treatment of the wound. A low-cost, bandage potentiometric sensor was developed to monitor skin pH by monitoring the levels of common ions⁸. The bandage can handle mechanical stress that would occur from day-to-day activities. This technology is based on the fact that wounds have a neutral to basic pH, but different pH levels are necessary at different stages of the wound healing process. Thus, continuous monitoring of the wound's pH would be useful for customizing the treatment of the wound. Wound conditions were simulated in the experiment using human sebum buffers at different pH values. A noteworthy anion that would affect the wound pH is SO_4^{2-} so this anion was tested. The bandage was able to sense rapid changes in pH of the wound without getting cross contaminated. One of the issues that came up was that sterilization of the wound affected the pH sensing, so this is an area that needs to be addressed.

A sustainable bandage has also been developed using red cabbage extract inside alginate nanoparticles¹. Red cabbage extract is a natural pH sensor because it changes color with pH changes. A solution was used to simulate a wound a decrease in pH caused a change of color from purple to pink. It also has antifungal, antiviral, anti-inflammatory, and antioxidant properties so it is a beneficial contribution to the wound environment. The four stages of wound healing- haemostasia, inflammation, proliferation, and remodeling- each have a different ideal pH. pH monitoring is especially important in wounds because it can alert of bacterial contamination.

Artificial skin grafts with an acidic pH have also been studied. One such skin graft was made using a chitosan/agarose film²⁹. Chitosan, which is obtained from chitin (found in plant cell walls), and agarose (found in seaweed) are carbohydrates. The combination of these two carbohydrates was used to develop a regenerative skin graft that could substitute skin. A new method to combine the two using agarose in sodium hydroxide and chitosan in acetic acid was used to obtain a pH of 5.98 which is known to support regeneration. This pH value was obtained because it allows for fibroblasts to be cultured on the film for regeneration of the skin. The film is also biodegradable in the enzymatic wound environment. The film showed promising characteristics of a skin substitute including elasticity comparable to human skin. This study is important in exploring the importance of considering pH for skin regeneration and wound healing.

Next Steps

It is evident that pH plays a major role in the cause for eczema. This field of study has a lot of research from different angles, and yet, there is still so much to be learned about skin pH and its role in eczema. There are some key areas of research that could lead to valuable discoveries on the pathogenesis of eczema. One takeaway is that more skin constructs and microfluidic systems should be used in research related to eczema. This will reduce the use of animal testing which is often harmful to the animals. Microfluidic systems are particularly intriguing because they can analyze the intersection between the skin and other body parts. Specifically related to pH and eczema, some internal body parts of interest are the liver, the stomach, and the blood. It was found that stomach extract of cod and other fish effectively degrades human epidermal keratin which causes hand eczema in people who handle fish material⁴. Pepsin in the stomach, which degrades proteins, works optimally to degrade keratin at pH 3.3-3.4, indicating that too acidic pH can cause eczema as well. This shows that treatment based on pH can be used on an individual basis, even as far as taking occupation and location into account. In addition, a study found high hydrogen ion concentration in inflamed skin of rats. This acidic pH excites nociceptors, sensory neurons that signal pain to the brain²⁷. This study could indicate that acidic pH causes the area of skin to be more sensitive to inflammation, which could alert the body early on about if the area of skin is vulnerable to an eczematic attack. Thus, the relationship between the skin pH, neurons, and the brain is also an important area of research.

It is important to take into consideration a person's sex, the body part being considered, the environment, and other factors to develop a comprehensive and accurate view of how pH affects the person's skin. The research on skin pH and eczema also shows that skin pH should be considered for prevention of eczematic attacks by monitoring and maintaining a healthy skin pH, but also for the treatment of eczema and the wounds caused by it.

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Subject: Fusing Fine Art and Psychology By Thesis Statement By Isha Majithia

Abstract

The focal point of the research paper titled ‘Fusing Fine Art and Psychology’ by Isha Majithia is to probe the integration of areas of visual aesthetics and modern-day science --psychology. The scope of the paper is to document that practitioners of visual arts have made significant contribution in the field of psychology by developing various methods of art therapies that help the patients of chronic stress and depression. These therapies are prevalently prescribed by psychiatrists and psychologists for its proven efficacy. The paper microscopically analyses practice of visual artists following Tantric approaches and illuminates how the fields of theology, visual arts and psychology are intertwined. It documents that by fusing of the elements from varied disciplines of psychology, theology and visual aesthetics, the modern-day practitioners have created an effective antidote to tackle depressive disorders.

The Main Essay

Painting, sculpting or process of creation boosts emotional well-being and healing. It enhances concentration and sharpens communication skills. Often psychologists have prescribed art therapy for its proven efficacy as an anti-depressant.

According to World Health Organization’s (WHO) latest research stress and depression are the most pronounced wellbeing risks in today’s times. Simultaneously, the latest discoveries in the field of psychology, now accepted as a finer science, that can treat and tackle stress and depression, have established that art indulgence is cathartic and restorative.

Some clairvoyant fine art practitioners in India believed in and did experience the magic of visual art and developed distinct approaches which gave birth to various types of analytic art psychotherapies. The practice includes offering multi-sensory mix-media art experience to the client and delving deeper into inner recesses of the client’s mind. This therapeutic art experience aims to help the client improve cognitive and sensory functions, self-esteem, self-awareness and emotional resilience.

To make the analytic art psychotherapy socially, culturally and spiritually more relevant, some Indian visual artists pioneered focus on Hindu theology, Vedic principles and began employing Tantric imagery in their artworks that inspire clarity of thought and boost healing.

These artists believed that human body is a miraculous microscopic piece of the entire universe. They worked on basic Vedic principles and employed cosmic metaphors including Bindu, Triangle, Straight Line, Lotus, Chakra etc. in their artworks to boost concentration and emotional well-being.

What is 'Tantra'

Tantra is a unique spiritual discipline that can resolve the mystery of being and its relationship with the world. The term Tantra is trapped in the cobwebs of misconceptions and misled beliefs and is often misinterpreted as primitive, unscientific beliefs, which promote blind faith and exploit the less privileged.

However, in fact Tantra is the simple truth. It is beyond the religions and the "moral". The Western theory of 'sin' has no place in the domain of Tantra. It does not deal with models, social or individual. Not 'what should be', the primary concern of Tantra is -- 'what it is'. It is an honest acceptance of oneself and one's surroundings. It is rather a spiritual science that examines experiences of 'self' with the surroundings and explores the human being's inherent elements, spiritual and physical, methods to expand them, and his/her place and relevance in the cosmos.

According to The Tantra, the human body is a 'yantra' – an instrument, which when in absolute command of elements within, helps command elements of the entire cosmos.

What is Yantra

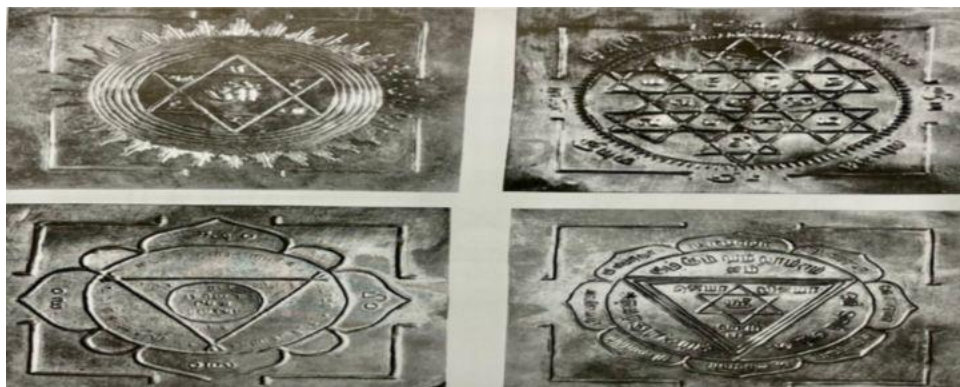
The Sanskrit word '*yantra*' derives from the root '*yam*' meaning to sustain or support the energy inherent in a particular element, object or concept. In its primary meaning, yantra may refer to any kind of mechanical device which is used to aid an enterprise. A yantra in these contexts, is a sort of device which is used in architecture, astronomy, alchemy, chemistry, warfare or recreation. The meaning of the term yantra later expanded to refer to religious enterprises, and concurrently acquired a special theological significance. Mystic yantras then were known as the chief instruments of meditative practices.

Basically, a yantra used in this context and for meditative purpose is an abstract geometrical design intended as a 'tool' for meditation and expansion of awareness. Yantra is essentially a geometrical composition. It also represents a particular configuration whose power increases in proportion to the abstraction and precision of the diagram. Yantras vary according to

their use. The selection of the yantra with its appropriate mantra is a highly complex process, and the spiritual guide alone can help the aspirant to do it. It arouses the inner life-force to its fullest, and its dedication to the yantra's chief deity. Its action can be seen as a physical, psychological and spiritual awareness and a deeper understanding of the self and cosmic mystery.

The study of Hindu yantras or power diagrams shows how each elementary geometrical form can generate a series of linear and multi-dimensional figures of the same shape, regardless of its original size. Common to such permutations are certain recurring linearities: the bindu or dot, the triangle, the square, and the circle. In the yantra, these forms function as 'thought-forms' that are so constructed that the seeker understands by them particular patterns of divine force.

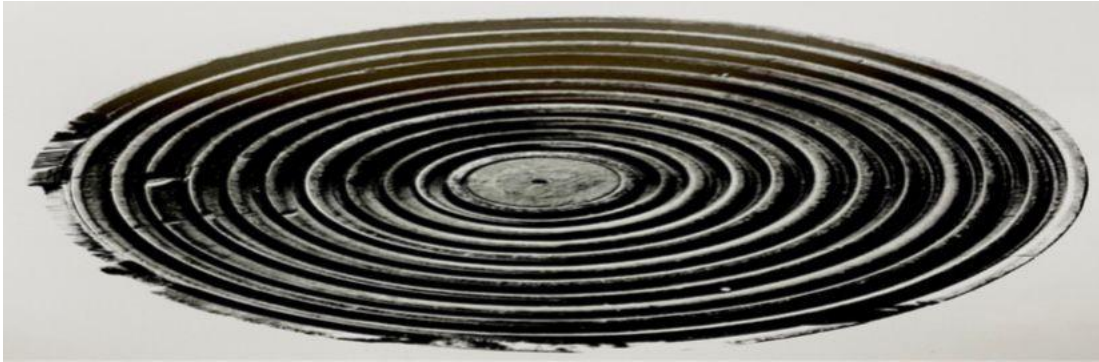
To identify completely with the configuration is to 'realize' or to release the inherent forces that each form represents. Each yantra makes visible the patterns of force that can be heard in the mantra sound-syllable, and each yantra reciprocally encloses its own unique power-pattern. Together, yantra-mantra are said to build unique vibrations and form – firstly, by the act of configuration; secondly, the configuration itself and finally, dissolving the form created via that configuration. And in doing so, the seeker comprehends its inner meaning and rises beyond it.



Types of Yantras: Yantras are often embossed on small copper plates, when it is to be used in ritual worship. There are various forms including - Sudarshana Yantra, symbolizing Vishnu's power and radiance. Vishnu and Lakshmi Yantra symbolizing the unity of the male and female principles; yantra of Vishnu, the preserver of the cosmos; and Kala Bhairava Chakra, an auspicious yantra of one of the epithets of Lord Shiva.

Contemporary images are based on traditional forms found in Tamil Nadu.

The Bindu or Dot as Tantric symbol



The bindu, sacred point of origin and return, with concentric circles symbolizing the eternal cycles of cosmic evolution and involution. The goal of the adept is her own involution to the center. The ultimate point of psycho-cosmic integration, where s/he discovers her link with the whole.

Found in Andra Pradesh, c. 19th century. Medium is Wood

Bindu (point or dot) is sometimes similar to a pearl. This is not just a poetic choice of words or philosophy. There literally comes a stage while doing yoga meditation in which all experiences collapse. They dissolve into a point from which all experiences arose in the first place. The Bindu is near the end of the subtlest aspect of mind itself, after which one travels beyond or transcends the mind and its matter. It is near the end of time, space, and is the doorway to the Absolute.

To understand this principle is extremely useful, if not essential to advanced meditation. Bindu is beyond the senses and thoughts. It is important to understand that the actual Bindu is far beyond the senses and thoughts in the usual sense of thinking processes involving strings of words and images or to use a psychology jargon coined by William James; 'stream of consciousness'. This means transcending not only the senses as they operate through the body, but also the inner or mental experience of sensation. For example, one not only closes the eyes, but also goes beyond all manner of inner visualization. When attention on all of the gross and

subtle objects and processes collapses and moves inward towards the Bindu, there is a convergence on one point, which is the real meaning of the phrase - 'one-pointedness of the mind'. There may be an extremely intense awareness of the nature of pure sound and light, but this is very different from what we experience by mental visualization or imagination. The journey to the Bindu starts to become the experience of the source of light and the source of sound, as well as being the source out of which other sensation, mental processes emerge.

Analysis of the Bindu

The point of divergence and convergence is called Bindu, which means point or dot, and is also linked to a seed. The Sanskrit root of Bindu is to break through or to burst through. The Bindu or dot symbol has been used in a variety of ways, including the following:

Sri Yantra: The highest, most advanced symbol of Tantra has a dot or bindu in the center, which also symbolizes this point of divergence and convergence.

The dot as a symbol: The point or dot has been often used as a symbol in which both the worlds, the physical and the metaphysical coexist at all times.

Yin-Yang: The Dot shows two fundamental forces of static and active, with the seed of one lying within the other, manifesting as other the thousands of things, while ever remaining one.

Dot and crescent: The Point is an ancient symbol of the un-manifest matter and the manifest reality both, while crescent is seen as a five-pointed star which stands only for visible matter.

Light and a tunnel: People having near-death experiences may report seeing light at the end of a tunnel. The Tunnel is the subtle channel called *Brahma Nadi* and the light emerges from *Bindu*.

The Bindu Experience

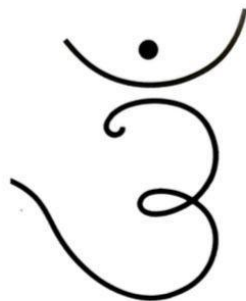
The culmination of yantra meditation is reached when the seeker begins to internalize the bindu in the yantra as an inner, still center. S/he may then contemplate an imaginary point in the subtle body. The spiritual experience of the bindu marks the end of spiritual involution.

The 'bindu-state' experience is unique. Psychically, it implies the seeker's awareness of her wholeness, which is spontaneously discovered through inward illumination. All the outward directed energies of the phenomenal ego are brought together to an inward state of rest and unity by the ultimate realization of Atman. Neutrality of the senses has superseded the creative play of Maya Shakti, and s/he is now the silent seer, no longer attached to the world of phenomena. S/he

neither laughs nor weeps, loves nor hates, because s/he has transcended all the dualities. The adept attains precisely the state, mentally and spiritually, that the symbol of the bindu denotes, an ideal mid-point, the balancing of all the polarities. But this is not the end, the aspirant is still to soar beyond the bindu-state to merge with the oneness of the Lord Shiva (static energy) and Maa Shakti (kinetic energy). This highest stage of spiritual absorption (samadhi) is achieved through yantra ritual worship. At this stage, the meditation is not susceptible to any verbal analysis. It is contemplated in absolute silence, which is absence of any sound or thought.

When the seeker is able to totally re-establish herself in primordial equilibrium by retracing her steps to her original source, absorbing and reintegrating all the fragmentations and multiplicity of existence into unity, there is nothing left for her to seek. Quoting from the Hindu scriptures: “When there is duality, one sees another, one smells another, one tastes another, one speaks to another, one hears another, one touches another, one understands another. But where everything has become just one’s own self, then who can be seen by whom? Who can be smelt by what? Who can be tasted by what? Who can speak to whom? Who can think of what? Who can touch what?”

OM Mantra



The dot at the top of the OM symbolizes the Absolute Reality, or Pure Consciousness. As noted in Yoga Sutras and Vedanta, the bindu, is sacred point of origin and return as discussed above. The goal of the adept is her own involution to the center, the ultimate point of psycho-cosmic integration, where one discovers one’s link with the whole cosmos.

When a particular letter functions as a yantra it is given an abstract geometrical figuration. A characteristic graphic representation of the sacred monosyllable Om in its yantra form appears in the Orissa manuscript of Sayantra Shunya-Samhita, where it is split into five constituent parts, starting from the bindu and proceeding to curves having an element of the spiral. These five graphic forms correspond to the complete unfolding of the basic principles of the universe in its fivefold aspects, such as the five elements, five subtle essences, five deities, five seed mantras, etc.

In addition to the seed mantras, there are a number of complex mantras composed of several seed-syllables. Their number, mode and purpose, with their yantras, are mentioned in several tantric texts. The structure of certain mantras is based on the esoteric symbolism of numbers. The mantra devoted to Shiva, for instance, is composed of five letters (panchakshara)-Na/mah Shi/va/ya. In religious practice and mythology Shiva combines in himself five aspects of the universe. His eternal energies are evident in five activities: he enfolds the whole of creation, he preserves, he reabsorbs or dissolves it. He conceals the world of phenomena in his Tatpurusha aspect; and finally, as Ishana, he grants boons and bestows grace which leads towards final liberation. These five aspects are correlated with important and fundamental sets of five psycho-cosmic principles. This is one of the reasons why the pentagon is associated with Shiva. The five syllables of the Shiva mantra are an attempt to illustrate his immanence in his five aspects, and when his mantra is inscribed in the yantra, it symbolically recapitulates the five-fold Shaivite tenets. Similarly, the mantra devoted to another god of the Hindu trinity, Vishnu, has twelve syllables. And Vishnu mantra is Om Namo Bhagvate Vasudevaya.

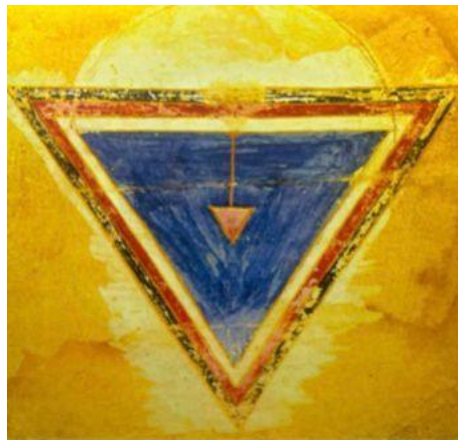
The Lotus as Tantric Symbol

In tantric art the lotus is a symbol of the expanding consciousness, which ultimately elevates the aspirant from the dark depths of ignorance to the radiance of inner awakening. Because of its greasy surface, the lotus is not affected by the soiled water in which it grows. Hence just as the lotus plant grows in the dirty mud and gradually blossoms out to the surface of water, unsullied by the mud, similarly the inner-self transcends beyond its own material limits, unaffected by illusion and ignorance. The lotus blossom is one of the principal archetypal symbols used in yantras. Generally, centered on the axis with its petals unfolding towards the circumference, it is the appropriate image to illustrate the unfolding of power of the divine

essence. In ancient cosmology, the lotus is also associated with creation myths. It is, for example, often depicted as springing from Vishnu's navel, supporting and giving birth to Brahma, the creator. Once Brahma creates the universe, Vishnu comes to the world in one of his ten forms or incarnations, to preserve order and ensure justice. This is one of the cycles of creation. Brahma falls asleep, and the lotus closes and goes back into Vishnu's navel. Vishnu then sleeps on the serpent's coils. The process eventually begins all over again. The lotus hence here represents the unfolding of a new age; similarly, in a yantra it signifies the awakening of the inner self.

In the Hindu theology, the lotus is taken a symbol of the center of the heart. Yogis believe that there are actual spiritual centers within us whose essential nature and luminosity can be experienced during meditation. These spiritual centers are symbolically named as lotuses, and their 'blooming' implies the state of complete repose when the purpose of yogic meditation is attained. In the final analysis, though a yantra is made up of different elements, the fundamental aim of ritual and meditation is to fuse all these dimensions, and to facilitate the adept's spiritual journey. As the journey progresses, the adept encounters the various aspects of manifestation inherent in nature, symbolized by the male and female principles. These are bounded within a circle. This symbolizes that all reality is confined within these concepts.

The Triangle as Tantric symbol



The Goddess Sakti taking the form of a triangle brings forth the three worlds. The three sides of the yoni, the primordial triangle, creative matrix of the cosmos, stand for the three qualities composing material nature sattva, the ascending quality, seen as

golden-white; rajas, the kinetic quality, seen as red; and tamas, the descending quality or inertia, seen as bluish black.

Image: Found in Rajasthan, 17th century. Medium: Gouache on paper

The triangle is the archetype symbol of a sacred enclosure, since space cannot be bounded by fewer than three lines. The triangle is conceived as the first closed figure to emerge when creation emerged from chaos. In this aspect it is known as the root of all manifested nature. The rhythm of creation is crystallized in this primal form. Tantra calls the triangle the cone of fire, a reference to its shape. This is the fire of aspiration which is ever burning in the heart of the spiritual seeker. The threefold structure of the triangle is interpreted over multiple levels. Some of these visualizations are:

- 1) Creation, Preservation, and Destruction:
Brahma, Vishnu, and Shiva.
- 2) The three tendencies:
the neutral (Sattva), the positive (Rajas) and
the negative (Tamas)
- 3) The three Vedas:
Rig, Yajur, and Sam
- 4) The three measures of time:
Past, Present, and Future
- 5) The three seasons:
Spring, Summer, and Winter
- 6) The three main pilgrimages:
Prayag, Gaya, and Kashi

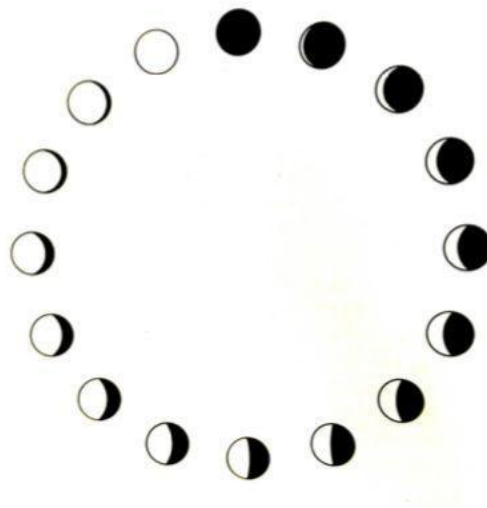
When used in a yantra, a triangle is either inverted or upright. The inverted triangle is a symbol of feminine power, the creative impulse of the universe, known as Shakti. It is the dynamism of this Shakti that gives rise to the creative impulse in nature.

This inverted triangle is generally the first enclosure surrounding the infinitesimal nucleus of most yantras. The triangle pointing upwards is symbolic of the male principle (Purusha). When the two triangles penetrate each other forming a hexagon, it symbolizes the fusion of polarities,

the union of Shiva and Shakti, male and female. This union is the cause of the manifested universe. When the triangles part at the apex, time and space cease to exist, and all creative activity comes to a standstill.

The Goddess Shakti taking the form of a triangle brings forth the three aspects. The three sides of the yoni, the primordial triangle, creative matrix of the cosmos, stand for the three qualities composing material nature sattva, the ascending quality, seen as white; rajas, the kinetic quality, seen as red; tamas, the descending quality or inertia, seen as black.

The Circle as Tantric symbol



Moon phase representing the Shakti-cluster of Nitya Shaktis

The circle occurs frequently in yantras and is derived principally from the motion of the revolution of planets. It symbolizes wholeness or totality and represents the principle which has no beginning, and no end. A perfectly symmetrical entity, equidistant from the center at all points; it indicates the realm of radiation that proceeds from the one center. In other words, a circumscribed field of action.

The circle of the Nitya Shaktis is a reservoir of delight, for they embody all those aspects of life that make existence a celebration of the spirit. They combine the all-beneficent aspects of

the divine. As partial manifestations of transcendent completeness, they are representative of life-affirming qualities and the primal founts of power to bestow worldly joys. Thus, worship of their yantras grants boons, dispels fear and brings enjoyment to the worshipper. Esoterically, their yantras may be used for higher meditation, but esoterically they are employed as wish-fulfillment charts.

Though it is true that, since the female principle gained popularity in the tantric pantheon, an immense number of yantras have been assigned to the various aspects of Shakti (Isha), nevertheless within the goddess's kinetic and pulsating nature is a point of stillness which can only be fulfilled by a counter-principle, her exact opposite represented by Shiva (Ishaan).

The Square as Tantric symbol

The square is the fundamental format of most yantras. There is a significant, well thought logic behind it. The phenomenal world extends into four directions. These four directions represent the totality of space, and they bind the earth in order.

The square too is the simplest and perfect manifestation of the number four, by virtue of the four perfect, equal lines bounding its form. Hence it is visualized as the perfect symbol to denote the terrestrial world. This mundane, physical world is the one which must be transcended by spiritual practice.

The square pattern has four gates, one in each of the cardinal directions. They are known as cosmic doors because it is through them that the aspirant symbolically enters the yantra. They represent the passage from the earthly realm to the 'inner', sacred space of the yantra. These gates are an initiatory threshold which simultaneously opposes the phenomenal and embraces the noumenal. It is further believed that these gateways themselves are guarded by divine forces which protect the sacred precinct within, from negative and disintegrating forces.

Indian Visual Aesthetics and Yantra

Traditional Indian art, which includes the yantra, is never considered a means to individual self-expression but serves as a primary focus of the spirit. The work of art reflects the divine archetype and is a bridge between the finite and infinite over which the beholder or

devotee 'travels' into another realm of being. Such an art form has its subject matter and its treatment of form from inner sources. An artist who seeks to plumb the mystery of creation within such a tradition acts as an exponent of a doctrine, a messenger who translates universal spiritual intuitions into visual terms.

These intuitions strive for revelation, to transcend the accidental aspects of form and to relate themselves to archetypal analogues. This process of emergence may involve the transfiguration of phenomenal entities, so that their ultimate form, the expression of their essential qualities, bears no likeness to their outward or real appearances. According to the Indian theology, the produced form never exists as it appears to the physical eye but it is as an object corresponding to its mental prototype.

Hence form is never valued for its own sake, but is valued for the experience of religious or metaphysical truth it offers. What is sought in form is an indwelling presence, the soul imprisoned in the material. All Indian images are 'symbols' of the Supreme Principle and vary only in degree of abstraction. Consequently, the outer form of an image should always be perceived in relation to its symbol-value. The material 'reality' of a yantra's form depends on the spiritual reality of its content; or, to put it another way, the metaphysics of yantra coincides with its aesthetics, in that form and content are inextricably related by an internal logic.

In certain instances, form-value and symbol-value are closely congruent; parallelism exists between the intrinsic nature of the shapes and their transcendental correspondents. Thus, for instance, in geometry the point is the primary principle of all figures. In the yantra, the geometry of the point is amplified into a metaphysical 'truth' in the symbolism of the bindu. The bindu, as we have seen earlier, is a natural symbol of the Supreme Principle just as the point is a fundamental principle of all shapes. Similarly, just as the point in geometry represents indivisible unity and the beginning of all dimension and concrete shape, the Supreme Principle represented by the bindu cannot be qualified in dimension because it is conceived of as uncovered, and therefore cannot be circumscribed by any measure or dimension, yet remains the basis of all spiritual dimension and empirical being.

According to tantra imagery, the triangle is the simplest planar expression of cosmic location after the point. It is thus the first sacred enclosure of the Shiva-Sakti principle. The three points of the triangle are related to certain triads of cosmic principles: sattva; rajas and tamas; creation, preservation and dissolution. Content determines form with the nine circuits of

the Sri Yantra that are related to the nine-fold division of cosmic principles; to the nine apertures of the body; to the nine psychic centers; to the nine names of the Shakti (Tripurā, Tripuresi, Tripurā-Sundari, Tripuravasini, Tripurasri, Tripuramalini, Tripurasiddha, Tripuramba, Mahātripurasundam); and to the nine planets.

The cosmic concepts relating to five principles - the five elements, for example, or the five aspects of Shiva - are associated with the pentagon; and the sixteen lotus petals which recur in several yantras are made the dwelling of sixteen divinities and, as in the Sri Yantra, are associated with the sixteen vowels of the Sanskrit language.

Similarly, the application of colour in the yantra is purely symbolic. Colour is never used arbitrarily to enhance the decorative quality of a diagram, but refers to philosophical ideas and expresses inner states of consciousness. One of the most important colour-schemes is white, red and black, which stands for the three qualities of material nature (Prakriti): sattva, rajas and tamas. The sattva or ascending quality has been given the colour of purity, white; rajas, which denotes the dynamic or creative principle, is red; tamas, which is inertia or the descending force, is black. The eight regions of space also have symbolic colours. Similarly, with the five elements: in ascending order, from gross to most subtle, earth is yellow; water is white; fire is red; air is grey; ether is misty-smoky. In a grid-square yantra, each square may be painted with a flat tone to denote one of the five elements.

The aspects of the Goddess are represented by colours in accordance with her qualities; conferring liberation she is contemplated as white; as preserver of all, she is seen as red; as destroyer she is tawny; conferring bliss she is rose-coloured; as bestower of wealth and good fortunes she is saffron-yellow. Coloured black, she withdraws the entire world into herself. Black is seen as containing all the colours, hence Kali is represented as dark-hued, as 'white and other colours disappear into black in the same way as all beings disappear in Kali.'

Traditionally, the particular goal of the yantra worship may decide the colouring used for the yantra, though not all texts prescribe the same color symbolism. Yellow (pita) and vermilion (rakta) are the two-basic auspicious colours. For temporary worship, yantras are drawn with saffron, a red powder (kum kum) or sandalwood paste. Brown, tawny colours or dark blue may be used for 'negative' yantras.

Yantras are often made of rock crystal, since within its translucent brilliance are latent all the colours of the spectrum. Gold, a vibration between saturated yellow and brilliant light, represents transcendence, and is used in some yantras for the bindu to indicate the experience of light, or spiritual bliss.

Generally speaking, then, the aesthetics of yantra would be meaningless if content and expression were separated. The yantra for meditation, both in its structure and use of colour, is not a haphazard conglomeration of percept and concept. It is directed by a philosophical content which expands and multiplies its forms. Whether the figures of the yantra appear singularly or as parts of a more complex structure they never lose their intrinsic meanings or their symbol-value.

The Construction of Power-Diagram

The symmetry is a norm to the construction of the yantra. Leaves of plants grow in tune with the nature's laws, and the yantra similarly evolves in accordance with traditional rules and in harmonious mathematical progression. The three principal modes of evolution are - straight and symmetrical (riju); the curved and asymmetrical (susama); and the quasi-symmetrical or eccentric (visama). The root principle of this mathematical descent from the bindu to the unified and orderly periphery is called ardhmatra (from the Sanskrit root, rdh=to grow, matrā = measure), or the measure that is not static but grows and evolves in accordance with the laws of harmony and rhythm.

From the source, the bindu, derives the expanding line, seen as the continuum (nada); from nada originate magnitude and dimension (parimeya); from parimeya arise the symbiotic opposites (plus-minus, male-female), centrifugal and centripetal polarities and the order of numbers (samkhya). Number provides harmony and stability, integration and unity. Thus, the number 3 gives specific location to magnitude and becomes a triangle, 4 a square, 5 a pentagon, 6 a hexagon, etc. As we have seen, these numbers are not simply summing up of integers, but have specific symbolic relationships with philosophical ideas.

The yantra-siddhais (sages to whom the powers of the yantra have been revealed) declare that if a yantra fails to become 'active' the fault lies with the person using the yantra and never with the yantra itself, for the power-diagram is never tentative or arbitrary, but is based on laws of space, vibration, number and dynamics.

In traditional Indian art, the process of creation falls into a pattern similar to worship. The ground-breaking metaphysician Ananda Coomaraswamy, quoting several Sanskrit sources, describes the various disciplines which an artist has to undergo. As the first step in the ritual which precedes creation of a sculpted image, for example, s/he goes to a solitary place. There s/he must discipline her impulses, control her physical and mental processes and suppress the chaotic world of the subconscious through penetrating concentration. Sometimes, to reach the inner depths of her consciousness, 'the imager, on the night before beginning his work and after ceremonial purification, is instructed to pray: O thou Lord, teach me in dreams how to carry out the work I have in mind.' After the artist has reached an 'inner poise and moral grace, and integrated herself emotionally and spiritually, s/he evokes the deity by the means of dhyana (trance) mantras, which provide her with a sort of mental blueprint for the execution of the image. After the work is completed a priest consecrates the image in a rite called the 'opening of the eye' which endows it with sacred power. This procedure emphasizes how far such artistic expression is from being an 'aesthetic' exercise. At no point in the whole discipline is the 'artist' separated from her art; and in the activity of creation, s/he annihilates all trace of her individuality and selfhood. The shapes and forms she creates reveal to her the macro cosmos in the same fashion that exists within herself. In this sense the created object 'prepares' its maker for a spiritual return to her primordial source.

Similarly, the construction of a yantra is a complete rite to be followed meticulously. Care is taken to choose the most propitious place and time of the day. The surface to which it is applied must bear auspicious signs and be smooth. The drawing, however, may be perfect in its proportions, correct in its brushwork, and faultless in its colourings; it may be scrupulously drawn according to all the rules of linear formation set out in the shastras (texts), and yet may fail to reflect the true significance of the yantra, unless the maker can transmit to the figure her inner life-tie with cosmic forces. Until s/he can '*feel*' the nature and substance of the cosmic bond in the deeper layers of her psyche, until s/he is able to impart the reality which s/he has intuited and is herself a part of, the yantra s/he draws will fail to reflect its participation in the transcendent. The maker pours forth an 'intensity for which there is no word'. S/he must feel the very nature of the energy to be transmitted to the yantra, affecting all who view it.

This type of creation has obviously no room for 'art for art's sake'. Indeed, this 'metaphysical aesthetics' holds that someone who views a yantra in its original environment,

whether a temple or a humble house, can know it and comprehend its inner meaning better than the person who views it in the artificial setting of a museum or gallery. The yantra exteriorizes a universal intuition, and is experienced through stages, beginning with worship and ending in reintegration.

Deity's Icon and yantra

The inseparability of form and content is only one aspect of the aesthetics of the yantra. Another concerns the radical abstraction of its symbolic forms, in contrast to the 'realism' of iconographic art. An example is the iconographic image of the tantric goddess Durga, as described in the 'Devi-Mahatmya' of the Markandeya Purana, as opposed to her yantra form prescribed in the tantric texts, an extremely bold contrast in expression.

In her iconographic form, Durga is described as having emerged from the energies of Vishnu, Shiva and all the gods who sent forth their power in the form of streams of flames, combining themselves into a mass of cloud which grew and grew until it condensed into the shape of the goddess. The verses of the Devi-Mahatmaya describe the formation of her physical body and her iconographical attributes as follows: "Born out of the bodies of all the Gods, that unique effulgence, combined into a mass of light, took the form of a woman, pervading the triple worlds with its luster. In that effulgence, the light of Shiva formed the face. The tresses were formed from the light of Yama and the arms from the light of Vishnu. The two breasts were formed from the moon's light, the waist from the light of Indra, the legs and thighs from the light of Varuna and the hips from the light of the earth. The feet from the light of Brahma and the toes from the sun's light. The fingers of the hand from the light of the Vasus and the nose from the light of Kuvera. The teeth were formed from the light of Prajapati, the lord of beings; likewise, the triad of her eyes was born from the light of fire. The eyebrows from the two Sandhyas; the ears from the light of the wind. From the light of other gods as well, the auspicious goddess was formed."

Projecting an overwhelming omnipotence, the three-eyed goddess adorned with the crescent moon emerged with her eighteen arms each holding auspicious weapons and emblems, jewels and ornaments, garments and utensils, garlands and rosaries of beads, all offered by individual gods. With her pulsating body of golden colour, shining with the splendor of a

thousand suns, standing erect on her lion-vehicle (vahana) and displaying her triumph over the dark forces, she is one of the most spectacular of all iconic personifications of cosmic energy.

In contrast, Durga's yantra form is described in the Shree Brihat Tantrasara as a composition of three triangles forming nine angles surrounded by three circles, with an eight-petalled lotus enclosed by a square with four gates, and the Goddess's seed mantra in the centre. The yantra forms a linear field of energy, without any likeness to the concrete image (murti) of Durga.

The magnificent conception of Durga, with all her complex iconographic attributes, has been resolved into a simple geometrical equation retaining the vitality and life-force of all her auspicious personifications. The overwhelming appearances and arousal of emotions of fear or reassurance characteristic of the icon are not the purpose of the yantra, whose abstraction and serene equilibrium take the viewer beyond the partial aspects of the deity to the universal.

Further, the yantra, unlike the icon, is universal in the sense that it is not subject to geographical or historical variations of style, but has maintained a common tradition throughout India. Visually, the yantra has more in common with Indian temple architecture than with icons of the deity.

The icon is the grossest manifestation of the devata; the yantra is the geometrical counterpart of the icon; and the mantra condenses the aesthetic potentiality of form as sound. In this sequence from gross to subtle, the yantra forms a link between form and formlessness, visible and invisible energy. The abstraction of the yantra is a first major step towards the resolution of dense materiality into its subtlest transformation, the monosyllabic mantra. Hence the aesthetics of yantra should never be considered as divorced from its sound dynamics.

Concrete and abstract images offer alternatives to the worshipper according to her devotional needs and temperament. The cult-bound devotee may concentrate on the divinity in concrete form, where a highly advanced adept may use only mantra and yantra. Yet icon and yantra should not be seen as separate entities; they are two ways of apprehending the Supreme Principle, two sparks of the same fire.

Tantra and Traditional abstract Indian visual art

Abstraction and simplicity as compared with representational and decorative art styles are believed by some to be alien to Indian art, yet the most significant characteristic of the yantra is

its geometrical elegance and purity of archetypal form. The art of yantra is akin to the art of the Zen painters who seek to convey the whole mystery of creation in a few brush strokes, eliminating all detail and condensing form to its root essence. Geometrical abstraction of forms has a long history in India. It can be traced back as far as Vedic times (second millennium BC) to a variety of carefully constructed fire altars whose symbolic form parallels that of yantras. Literary evidence shows that art, in the Vedic period, had reached a high level of symbolic expression. As Vedic religion was one of non-anthropomorphic nature worship, icons and temples were absent. Consequently, the place where the sacred rites were held was marked only by a sacred enclosure, the container of the ever-burning ritual fire, symbolically the point where heaven and earth met.

The Vedic altars were given simple shapes. Their plans range from circular and square to combined geometrical figures, and were purely abstract in their genesis as well as in their final form. Of celestial significance, the square is the fundamental shape of Vedic altars, as with the Ahvaniya fire, the Uttara Vedi, the Ukha; all the other shapes are either based on or derived from it. The altar represented the material elements of the cosmic being (Purusha). Its bricks were laid pointing towards the cardinal directions to symbolize the vast extension of the universe; its heart was the place where the ritual fires were kindled. The altar combined the symbolic features of the deity, i.e. fire, and the sacrificial rites, linked together by the sacred plinth. Fire was the axis mundi that united the heavens and earth, and the altar symbolically represented the pillar that held the four regions (E W N S) together: 'Upon the back of Aditi I lay thee [altar], the sky's supporter, Pillar of the Quarters. Fire ruled over the three zones of the cosmos (earth, air, sky), and the altar's construction embodied this principle: three of its five layers were arranged to represent the three levels of the Vedic cosmos.

Many yantras used for ritual worship have retained archaic characteristics of these Vedic altars, though wide variation in detail was introduced as they came under the influence of tantrism. Altar-plan and yantra equally have strong cosmic affinities and are executed according to mathematical principles without any vestige of ornamentation.

‘Centrality’ in Tantra Philosophy and ‘Wholeness’ As An Abstract Art Concept

Despite its varieties the yantra's form retains its mathematical perfection. The extension of the bindu into line suggesting direction, motion and energy, continuing with regular expansion of linear shapes creates geometric patterns of increasing complexity. The yantra emerges as a

perfect ‘hologram’, a figure of inner coherence and unity. A line can be divided to give smaller units without assuming wholeness or organic unity of composition. But when a point is placed in the centre of a given composition (as in a yantra), its spatial values begin to relate to the centre and all its parts are transfigured into a whole. Though all the concentric figures in the yantra are ‘closed’ shapes and form integral units in themselves, their inner balance is maintained, even where strongly contrasting shapes are related. No matter how it is arranged, a yantra’s centre integrates all linear flow. The cosmos is conceived as ‘holon’ (a perfect whole) or a ‘closed universe’ in which all elements of life are constantly recomposed at the end of cosmic cycles. Thus, all manifestation within this closed universe is balanced by an eternal immutable reality, the indivisible centre. A yantra is thus a geometrical paradigm of a perfect whole, and a mystical construct of the universe in which all polarities are harmoniously united.

Tantra Art for Inner Peace

The art which has evolved out of tantra reveals an abundant variety of forms, tone, colour, symbols and graphic patterns with personal and universal significance. It is especially intended to convey a knowledge evoking a higher level of perception and tapping dormant sources of our awareness. This form of expression is not pursued like detached speculation to achieve mere aesthetic delight, but has a deeper greater meaning. Apart from aesthetic value, this art styles’ real significance lies in its content, the meaning it conveys, and the psychological effect it has on a person.

Tantra Art and Psychology

To demonstrate how Tantra Art has deep psychological effect on us, let us refer to the theory of consciousness constructed by **William James** born in 1842 to an influential family in New York. James became a qualified physician in 1869 from Harvard Medical School but never practiced medicine. Later, in 1873 after conducting an in-depth research on the workings of human mind, he returned to Harvard and became professor of both philosophy and psychology. He set up the first experimental psychology courses in the USA and played a prominent role in establishing psychology as a scientific discipline. In his treatise *The Principles of Psychology* (1890) he has discussed his **theory of consciousness**. “Consciousness does not appear to itself chopped up in bits. There are no joints either. But it flows. Consciousness is of a teeming

multiplicity of objects and relations. Most importantly, consciousness is not a thing but a process. It is what the brain does to steer a nervous system grown too complex to regulate itself. It allows us to reflect upon the past, present and future to plan to adapt to circumstances and sustain....The simplest way to understand how the thoughts within the stream of consciousness work is to see that they stay combined.” To explain further, James shows the work of dots by the French Post-Impressionist painter Georges Seurat. There are separate dots of pure colours, but the brain combines these separate dots and concurrently sees a human figure and not the dots.

(Page 43 – Big Ideas : The Psychology Book)

James says that emotions and your perception play crucial role. He extends his theory of consciousness to envelop thoughts of his colleague Carl Lange. According to James-Lange Theory of Emotion, the emotions that govern the entire mind, body, actions and reactions of the humans arise from the conscious mind’s perceptions of the surroundings and occurrences. According to James’s theory, you feel happy because you are conscious to the fact that you are smiling. It is not only that you are smile because you are happy but it is vice versa. His approach is that truth emerges from the series of facts...but the facts themselves meanwhile are not true. Truth is the function of beliefs that starts inside the human brain.

Applying this theory to Tantra philosophy, we can lucidly grasp how homogenously multiplying geometrical patterns of Yantra combine into one whole and the image than becomes an archetypal symbol. How that symbol efficiently fuses the physical and metaphysical planes in the human mind, and allows the mind to transcend the matter to merge with the Bindu – the centre of the multiverses. Simply put, the Tantra philosophy when applied into art helps to develop a pragmatic outlook. It helps you rise above the tentative situations, grasp the bigger picture and lead the life in a mature way.

Similarly, applying the **Humanistic psychoanalysis** approach developed by **Erich Fromm**, a leading 20th century German Jew socio-psychologist. Fromm known for his notable ideas including; Being and Having...as modes of existence, social character and character orientation, believed that people assimilate themselves in the world (society) by acquiring, using things or skills. He believed that the man’s main task is to give birth to himself. Fromm suggests that our separation from nature originates with the growth of intellect. It is man’s ability to reason that lends him intellectual superiority over other living beings. But it also makes him aware that he is alone. His reason also makes him aware of his mortality and that of his loved

ones. This understanding and awareness creates a chronic state of tension, anxiety, hopelessness and loneliness. Togetherness of all these negative emotions often causes stress and depression. But still there is hope. Fromm insists that man can overcome sense of alienation, separation and hopelessness through finding his purpose. It is imperative, asserts Fromm, to discover one's own independent sense of self, one's personal views and value system rather than adhering to societal, conventional and authoritarian norms. The purpose of life is to define ourselves through embracing our personal uniqueness, discovering our own ideas, abilities and skills. In sharpening your skills and honing your abilities – through such creative and constructive pursuits, the man can free himself from the chronic fear, loneliness and confusion. Paradoxically, Fromm believes that the only way we can feel complete is through discovery of our passion, creativity, uniqueness and individuality. Creative urge gives courage to let go of certainties. Creative urge gives birth to love; love is nothing else but interpersonal creative capacity. Love is respecting autonomy of the other's personality. Love is having integrity of your own self; when one has strong sense of self, one can understand the world in a better way.

Fromm's Humanistic psychoanalysis approach goes hand in hand with philosophy of Tantra or Tantra Art which asks the seeker to turn within to feel complete and comprehend the cosmos. Tantra art can soothe the mind and prepares it to develop interpersonal creative capacity. The Tantra Experience through visual aesthetics can potentially liberalise one's mind and expand the inner horizons. It can become an efficacious panacea to treat stress, depression or emotional imbalances.

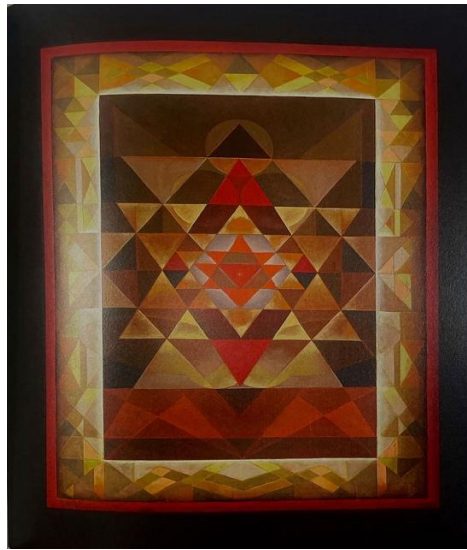
Indian Artists Practising Tantra Art

The East and the west, as we know, are inseparably linked and greatly influence each other via lifestyles, philosophies, art practices, literatures, cultures and countercultures. Notwithstanding the Victorian, colonial or Western art influences, a small group of Indian artists during 1960s wholeheartedly embraced Tantric etymology including its motifs, concepts, forms, shapes, shades and have perceptibly scripted a pathbreaking and fresh Tantra art vocabulary.

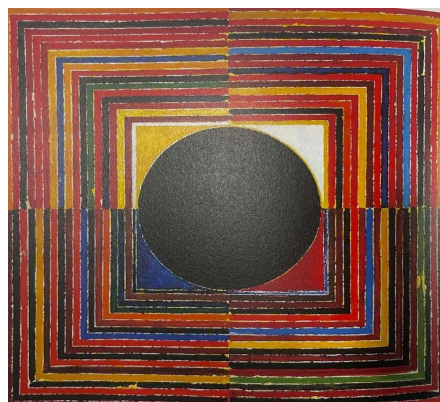
The pioneering art experiments, conducted by these clairvoyant practitioners of Indian art in the 20th century, have inspired the western clinical psychologists to develop unique and personalised Art Therapy Modules as antidotes to tackle and treat depressive disorders. In order to understand their influence on psychological practices, let us primarily examine the creation of

sixteen prominent artists who have worked under the single thematic rubric of Tantra Art. These modern icons of Tantra Art are G R Santosh, K C S Paniker, Biren De, Sohan Qadri, J Swaminathan, Prabhakar Barwe, S H Raza, Manu Parekh, V Viswanadhan, Shobha Broota, Gogi Saroj Pal, Satish Gujral, P T Reddy, Sunil Das, R B Bhaskaran and Jyoti Bhatt.

Born in 1929 in at Srinagar G R Santosh, one of the most prominent Tantric visual artist, followed philosophy of Kashmir Shaivism. In 1960s he studied mystical Tantric art and created some paintings infused with spiritual energy which have today become the best examples to explain this style.



Born in 1922 in Madhya Pradesh, renowned Indian painter S H Raza though lived in France followed austere theories of Hindu mysticism. His paintings depict the inner journey that the seekers may experience while trying to attain one-pointedness of the mind. Bindu, one of the most prominent Tantric symbol, has recurrently featured in his works.



Born in Gujarat in 1939, iconic artist Manu Parekh is known for his spiritual landscapes. His abstract paintings are rooted in tantra philosophy. He has often employed the potent tantric symbols including square, circle, bindu and lotus in his works.



Conclusion

The art which has evolved out of tantra philosophy has abundant richness of forms, tone, colour and symbols. It is especially intended to evoke pure sensibilities and higher self-awareness. Besides the aesthetic pleasure, the prime significance is in the content of these paintings and the meaning they convey. Experience of viewing the tantric art calms one's mind because the paintings perhaps embody the peace that the painter has felt in the process of creation.

This research paper is supported by a series of methodological evidences gathered during practical sessions conducted by myself at various NGOs and old-age homes working towards mental wellness of the patients of chronic illnesses like arthritis, cancer, depression, etc. The practical module of this research theory concludes that understanding and frequent exposure to tantric art soothes the minds of the beholders, elevates their mood and prepares them to tackle their psychological issues.

Works Cited

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