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Effects of Engagement with Different Authentic Audiovisual Stimuli on the Listening Proficiency of Higher-level and General Second Language (L2) Learners

By Tianyi (Tina) Zhang

AUTHOR BIO

Tianyi (Tina) Zhang is a senior at Syosset High School in New York. She found her passion in linguistics when she found herself loving the process of learning different languages in school and at home. She is fluent in English and Mandarin Chinese and semi-proficient in French and Japanese. She plans to study linguistics in college with the ultimate goal of becoming a linguist, translator, or diplomat. Outside of school, she is a nationally ranked fencer who has been fencing competitively for seven years. She is an only child in her family and has a mini brown pet poodle named Frankie. During her free time, she enjoys hiking and knitting.

ABSTRACT

The term “audiovisual” pertains to a combination of both the hearing and sight senses, and different audiovisual stimuli have diverse effects on listening proficiency. Establishing the effectiveness of various audiovisual stimuli on language learners is essential to optimizing secondary language acquisition. This study examines how engagement with audiovisual programs impacts the listening proficiency of second language (L2) learners, and which type of audiovisual program is optimal for higher-level learners to improve their proficiency. By reviewing relevant studies and comparing their results, this study finds that engagement with audiovisual stimuli significantly enhances the listening proficiency of L2 learners. Moreover, there is no strict hierarchy of sources that best help higher-level learners because of the variable interplay of factors such as speech styles, the learners’ first languages and the languages being learned, their topic familiarity, and their level of interest. However, there is a widespread preference for TV news as the optimal material for higher-level L2 classrooms, because they contain a high degree of redundancy that facilitates listeners’ understanding of vocabulary. Furthermore, the TV news has been suggested to be most helpful for building higher-level L2 comprehension if certain features could be adjusted: effectively juxtapose spoken and visual texts, present less ambient noises and clear enunciations, and include more disfluencies as well as greater combinations of voiceovers and visuals instead of talking heads. Teachers are suggested to incorporate more audiovisual sources, especially the TV news, into L2 classroom learning.

Keywords: Audiovisual stimuli; Listening proficiency; Second language acquisition; TV news; Higher-level learners; Second language classroom; Authentic audiovisual sources; EFL/ ESL; Features that influence listening comprehension

INTRODUCTION

It is not uncommon for non-native speakers to attempt to learn English by watching American TV shows. For instance, Korean rapper RM from the boy group BTS attributes his English proficiency to the sitcom *Friends* (Pirnia). However, TV shows are not the only audiovisual sources available. The term “audiovisual” pertains to a combination of both the hearing and sight senses. There are many different mass media programs, and they have presumptively variable effects on second language acquisition. Establishing the effectiveness of various audiovisual stimuli on language learners is essential to optimizing secondary language acquisition. This study will examine how engagement with audiovisual mass media programs impacts the listening proficiency of second language (L2) learners, and which type of audiovisual program is optimal for higher-level learners to improve their proficiency.

Studies show that engagement with audiovisual mass media programs significantly enhances the listening proficiency of L2 learners. Moreover, some research has concluded that there is no strict ranking of sources that best help higher-level learners because of the variable interplay of factors such as speech styles, the learners’ first languages and the languages being learned, their topic familiarity, and their level of interest. However, there is also a widespread preference for TV news as the optimal material for higher-level L2 classrooms, because they contain a high degree of redundancy that may facilitate listeners’ understanding of vocabulary. Furthermore, research has suggested that TV news is most helpful for building higher-level L2 comprehension if spoken and visual texts are juxtaposed effectively, and if more narrative text and a combination of voiceovers and visuals are included.

Since this study will focus on audiovisual stimuli, it is important to understand how to analyze and measure their effects. There are four primary skill sets that can be used as empirical indicators of language proficiency: reading, writing, speaking, and listening (Rubin 198). According to Rubin, listening is the least thoroughly researched of these variables due to studies’ traditional overemphasis on reading and writing (198). Rubin also demonstrates that more attention needs to be paid to listening as an important skill in evaluating the language proficiency of second language learners (196). Interlocutor, task, listener, process, and text characteristics in audio are the five

main factors which affect L2 listening comprehension (Rubin 198). Interlocutor characteristics are primarily concerned with gender bias and perceived language proficiency of the speaker by listeners. Rubin’s account of Markham’s study asserts that L2 learners tend to exhibit higher recall when listening to a male speaker than a female speaker in a sample of intermediate and advanced university level ESL students (205). Task characteristics are concerned with the nature of the task, e.g., whether the task includes multiple choice, choose-a-picture, matching, or free response questions (Rubin 204). Listener characteristics deal with the extent to which the listener’s language proficiency level, ability to recall, amount and span of attention, age, gender, background knowledge of the topic, and the possibilities of learning disabilities have a considerable impact on listening proficiency (Rubin 206). Process characteristics influence how listeners interpret the audio in terms of what they know or identify what they don’t know (Rubin 211). Lastly, text characteristics are time-related variables, such as speech rate, pauses, and hesitation; perceptions of stress and rhythmic patterns; differences in syntax, such as the length of each sentence; prevalence of redundancies; and the order of the words. There could also be different types of audios involved, such as a news broadcast monologue or a dialogue between two people (Rubin 202).

However, the news broadcast monologue is not the only available audiovisual source. Figure 1 displays the main types of audiovisual sources, ranging from weather reports and ads to short documentaries and discussions (Philips 348). These audiovisual programs differ in the proportions of text/speech and image components and may have correspondingly varying effects on L2 learners’ listening proficiency over time (Philips 349). During my research, I conducted a literature review of studies on the effectiveness of various audiovisual sources in L2 acquisition and proficiency, using JSTOR and Google Scholar. I also evaluated the relevant studies and compared their results and conclusions. Over the course of my paper, I will first explore the effects of general audiovisual mass media programs on L2 learners’ listening proficiency; then I will delve into which audiovisual sources are most helpful in improving their listening skills. Subsequently, I will examine specific source and listener features — speech styles, learners’ L1 and L2 languages, their topic familiarity, and interest — that influence L2 learners’ listening comprehension and further focus on the TV news as a type of audiovisual program while detailing

certain elements in the news that could be adjusted to help the learners better enhance their listening comprehension.

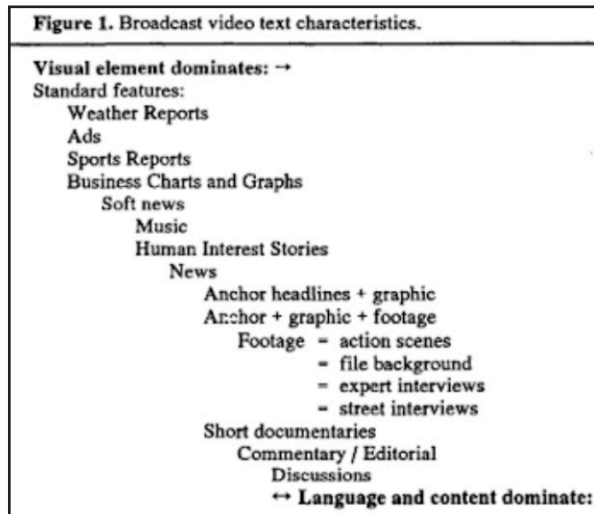


Figure 1. From Philips, June K. Georgetown University Round Table on Languages and Linguistics

ANALYSIS

Effects of Audiovisual Programs on L2 Learners

To determine the relationship between listening ability and general foreign language proficiency, Feyten assayed a group of students enrolled in a summer intensive language learning program of the Department of Romance Languages at the University of Tennessee and requested them to respond to a video version of the Watson-Barker Listening Test (WBLT) in the beginning and end of the program (176). Feyten finds statistically significant positive correlations between listening ability and overall foreign language proficiency (French, $r = .41$; Spanish, $r = .39$; $p < .05$) (Feyten Table I, 177). Her results indicate that advances in listening proficiency results in improvements in overall language proficiency. Graham & Zhang's study further supports this conclusion by showing that Chinese L2 learners of English with little preexisting vocabulary knowledge (PVK) and high listening proficiency gain expertise in English the most, arguing that listening proficiency influences vocabulary input, thereby impacting foreign language proficiency (1042).

The positive correlations found between listening ability and overall foreign language proficiency enables us to better understand how auditory and visual stimuli interact to produce the effects of audiovisual programs on L2 learners. Rubin, who investigated the listening comprehension of beginner Spanish students who watched dramas on video compared to that of their counterparts who didn't receive any videos to support their listening training, learns that the listening proficiency of beginner Spanish students who watched the videos improved significantly over the students who did not watch them during the period of the study (102). Her findings signify that auditory input augmented with visual support may enhance listening proficiency. Rubin's conclusion is further supported by Herron et al., who, while exploring the impact of video on listening comprehension of first-year university students with various degrees of knowledge in French, discovers that listening proficiency improves more after exposure to an audiovisual source than to a text and audio-only source (Herron et al., Table IV, 786). Based on these results, we can conclude that exposure to audiovisual programs may significantly enhance L2 learners' listening proficiency.

Hierarchies in the Effectiveness of Different Audiovisual Sources

In her paper, Philips contrasts the French A2/TF1 weather forecasts that consistently visualize what is said with mobile graphics, gestures, and speech, with the Noticias ECO (Empresa de Comunicaciones Orbitales) weather forecast programs, also known as ECO News, in Mexico which show stationary maps, while the discussions go into much greater detail. Philips' comparison illustrates that different countries have their own ways of balancing the visuals with language in audiovisual programs (348; 349). As Philips' examples demonstrate, the same type of audiovisual program may have varying degrees of correspondences between visuals and texts depending on the country. In addition, it has been previously established (Meinhof; Arnold & Brooks) that the greater the correspondence between the visuals and texts in an audiovisual program, the likelier that the source will improve L2 learners' listening proficiency. Hence, it would be difficult to generalize which blanket category of audiovisual source might best

¹ The Watson-Barker Listening Test (WBLT) is an exam intended to measure five facets of adult listening behavior—interpretation of meaning, interpretation of emotion, understanding, recall, and the ability to follow instructions (Worthington 193).

enhance L2 learners' listening proficiency, since this improvement relies on variable internal features of the auditory and visual components of a given source. Philips raises advertisements as another example (349). Advertisements could also have different combinations of the visual, musical, and language components, which insinuates once again that there may be "no strict hierarchy" of audiovisual sources in terms of how much they help L2 learners to improve their listening skills (Philips 351). This is the case because listening proficiency has been revealed to partly rely on how much the text and the visuals complement each other, and the degrees of correspondences between the two components differ across the same audiovisual program (advertisements).

Philips' position is further supported by Bell, who finds that news broadcasts often conduct street interviews with the *vox populi*, who display a great variation of "accents based on region, age, socio-economic, class, race, and ethnic identity" and the use of slang or in-group language (8). Bell finds that familiarity with the *vox populi*'s accents facilitates comprehension, while a lack of it creates greater processing difficulties (8). On that account, the extent to which L2 learners understand a news broadcast varies based on their familiarity and own experiences with the speaker's accent, and seems to be random. It would be very difficult to determine which audiovisual mass media program is most effective for improving L2 learners' listening proficiency because as exemplified by the TV news, a single type of audiovisual program has varying impacts on the listener according to their own experiences and familiarity. Furthermore, Bell finds that the amount of time that "talking heads" versus voiceovers occupy on TV news broadcasts differs across American network news (9). Notably, according to Bell's coverage of Gunter's study, listening comprehension is the lowest for "talking head" segments. Thus, since TV news broadcasts have differing amounts of time that display talking heads and mixed formats of video presentation and audio, L2 learners' listening proficiency may rely on a variety of particular features of audiovisual mass media programs, as exemplified by the *vox populi*'s accents and the amount of time covered on "talking heads" versus voiceovers in TV news. Consequently,

it is not likely that there is a particular hierarchy of audiovisual sources.

Audiovisual and Listener Features that Influence Listening Comprehension

In her paper, Philips asserts that combination of "formats and speakers highlighted factors not previously apparent," suggesting that the matter of ascertaining a type of audiovisual program that best benefits the L2 learners' listening proficiency is not simple (351). One factor, for instance, is individual speech styles in the programs. Rubin finds that the speaker's pause phenomena, speech rate, and hesitation in audiovisual sources all play a role in listening comprehension (199). She cites Blau, who finds that blank pauses and hesitation in speech in the audiovisual programs facilitate listening comprehension more than speed, and that speech rate plays a part as well (9). The trend described may be reflected on many other kinds of audiovisual sources because many of them have a variety of speech styles that affect L2 learners differently depending on the frequencies of pauses and hesitation, and speech rate. Consequently, it would be very hard to determine which type of audiovisual source is best for improving L2 learners' listening proficiency.

Furthermore, according to Glisan, who examines the effect of Spanish word order patterns in listening comprehension of English-speaking students learning Spanish, there is a hierarchy of comprehension difficulty associated with word order (465). Glisan finds that subject-verb-object sentences may yield lower comprehension compared to verb-subject-object and object-verb-subject sentences (Glisan Table 3, 460). Her study reveals that various word orders spoken in audiovisual programs have differing effects on L2 listening comprehension. Hence, since each type of audiovisual source is composed of multiple sentence structures and word orders, it would be very hard to ascertain which specific kind best benefits L2 listening proficiency. As a result, it is highly likely that there would be no strict ranking of audiovisual sources.

² The term "vox populi" is used to refer to the popular sentiment or opinion and the voice of the people. The TV news often interviews people on the streets (Bell 8).

Another factor that influences listening proficiency of L2 learners is their familiarity with the topic discussed in the audiovisual sources. Long, as summarized by Rubin, finds that participants who had prior knowledge about the topic displayed higher comprehension and scored better on the test. These results show a positive correlation between background knowledge and listening comprehension (209). Moreover, according to Rubin's account of Schmidt-Rinehart's study, L2 learners recall significantly more information from listening to a familiar topic, and their improvement in listening comprehension is higher compared to that after listening to an unfamiliar topic (209). Their research conveys that topic familiarity in any audiovisual program can be seen as random and seems to be dependent on the L2 learners' own knowledge and experiences, which also denotes that improvements in the learners' listening proficiencies vary based on them. Therefore, the type of audiovisual program does not play a significant role in enhancing their listening proficiencies.

An individual learner's interest in the topic is also a significant variable affecting comprehension. L2 learners' interest determines the amount of attention they pay to audiovisual sources, which affects their comprehension to a larger degree than the type of audiovisual source. According to Rubin's account of O'Malley et al.'s study, more interested listeners "seemed to be aware when they stopped attending and made an effort to redirect their attention to the task" while less interested readers "usually just stopped listening or failed to be aware of their inattention" after encountering an unknown word or phrase in a listening text. These observations pinpoint that the level of interest affects attention which, in turn, affects how much information the second language learners absorb and recall (428). These findings imply that different types of audiovisual programs may not really affect the listening proficiency improvements of L2 learners when the level of interest and attention depends on the L2 learner. Moreover, according to Schwartzstein, the phenomenon of selective attention can lead a listener to consistently fail to recognize important sentences or words and hold incorrect beliefs about certain things because they have absorbed only partial information (1449). Taken together, the studies done by both O'Malley et al. and Schwartzstein support the conclusion that inattention or selective attention is harmful to L2 learners' language acquisition and

listening proficiency. Since their improvements in listening proficiency vary based on the level of attention they give to each topic, it is likely that there is no strict order of audiovisual sources.

Finally, the linguistic relationship between their first and new languages affects second language learners' listening proficiency. Philips claims that improvements in listening proficiency rely on how the language the learners are trying to master relates to their own linguistic background, specifically the degree of similarity between an individual's L1 and L2 (351). This variable implies that improvements in the L2 learners' listening proficiencies may vary based on their L1: the closer their L1 is to their L2 linguistically, the more accessible or easier those improvements are. Furthermore, according to Nation, the L1 provides a familiar and effective way of "quickly getting to grips with the meaning and content of what needs to be used in the L2" when the languages are relative to each other, further expressing that having similar L1 and L2 may help the learners to enhance their foreign language and listening proficiency (5). Both studies illustrate that there is a significant positive relationship between proficiency in L1 and L2, especially when they are interrelated or similar to each other. As a result, it would be difficult to determine a ranking of audiovisual sources when there are numerous variations in the L2 learners' L1 backgrounds.

NEWS: The Optimal Audiovisual Source for Higher-level Language Learners?

These complexities notwithstanding, several studies suggest that TV news may be a more effective audiovisual source to improve higher-level language learners' listening proficiency than other audiovisual stimuli. For example, Bahrani and Tam Sim find strong correlations between listening proficiency improvement of upper-intermediate-level learners with exposure to their preferred type of program (news broadcasts: correlation coefficient = 0.334, p-value = 0.004), but no correlations between low-level L2 learners' language proficiency improvement and amount of exposure to their preferred audiovisual source (cartoons: correlation coefficient = 0.122, p-value = 0.906), connoting that news broadcasts may be more effective in helping higher-level L2 learners and cartoons less effective for lower-level L2 learners (Bahrani & Tam Sim 2012a, 56). In a second article,

Bahrani finds statistically significant improvements in all four areas of language proficiency with the second greatest difference in listening proficiency for higher-level L2 learners of English who are exposed to TV news in Malaysia (Bahrani 2013, 155). He requested the participants to take a sample of the International English Language Testing System (IELTS) tests, which includes a listening comprehension portion. He then used the Pairwise comparison with Bonferroni correction to learn that the improvement in the listening skill ($M = 0.50$, $SD = 0.72$) is statistically significant ($p = 0.01 < 0.05$) (Bahrani 2013 Table 4.28, 153). On the other hand, he finds that the amount of improvement for listening proficiency is not considerably significant for lower-level L2 learners who are exposed to cartoons. By employing a Greenhouse-Geisser correction test, Bahrani notes that the improvement did not differ significantly across the four skills ($F(2.088, 50.116) = 2.182$, $p = 0.121 > 0.05$, $\eta^2 = 0.083$), denoting that for the participants in the low proficiency group, there is improvement in all the skills but the amount of improvement is not significant (Bahrani 2013 Table 4.25, 150). His findings reveal that TV news may be an effective medium for higher-level L2 learners to use to enhance their listening comprehension skills.

These findings correspond with a third article by Bahrani and Tam Sim, where the lower-level L2 learners spent a total of 18,038 minutes watching cartoons (most time), and higher-level L2 learners spent a total of 16,648 minutes watching news (most time) during the period of their study (Bahrani & Tam Sim 2012b Table 2; 3, 356). Moreover, they find that the amount of exposure to news broadcasts significantly correlates with the upper-intermediate level's language (listening) proficiency improvement (t statistic = -3.20 , p -value < 0.05), yet the same does not occur for the low-level L2 learners with cartoons (t statistic = -0.25 , p -value > 0.05) (Bahrani & Tam Sim 2012b Table 5, 358). Their findings contend once again that lower-level L2 learners tend not to improve their listening proficiency with their preferred type of audiovisual program, while it may be different

for higher-level L2 learners who tend to prefer news programs.

Further evidence in support of these studies is provided by Bell, who states that a particular news item may be "suitable pedagogical material for the second language classroom" because they contain details which are likely to enhance second language learners' improve their listening proficiency (15). According to Bell, general TV news and news items in particular contain a high degree of redundancy, and he uses the example of the Carry-on Luggage TV news item that contains a number of repetitions and synonyms: carry-on baggage, carry-on bags, bags, carry-on luggage, luggage, and carry-on to prove his point (9). Bell's claim insinuates that TV news may be useful in the L2 classroom because this redundancy feature is generally understood to help L2 comprehension according to Chiang & Dunkel, who find that repetition, paraphrase, and synonyms help higher-level L2 learners the best to improve their language proficiencies (373). Moreover, according to Brinton & Gaskill, the "amount of recycling of vocabulary in episodic news items" and the use of high-frequency idioms used by anchors and correspondents lead their participants to comprehend more and get used to more specialized vocabulary (410). Therefore, it is very plausible that higher-level L2 learners' vocabulary development may be enhanced significantly when they are exposed to TV news because of the large degree of vocabulary redundancy displayed. These developments indicate that the TV news is beneficial for higher-level language learners.

Enhancing the Effectiveness of News as an Authentic Audiovisual Stimulus

According to Bell, it may be possible to adjust specific formal features of TV news, to make it more effective at enhancing the listening proficiency of L2 learners (15). One element is the juxtaposition of spoken and visual texts. There are three ways that text and images are said to interrelate: overlap, when words and pictures are identical; displacement, when words

³ The International English Language Testing System (IELTS) is designed to assess the test taker's ability to listen, read, write and speak in English. IELTS is graded on a scale of 1-9 (Bahrani 143).

⁴ A Bonferroni Correction refers to the process of adjusting the alpha (α) level for a family of statistical tests so that we control for the probability of committing a type I error, which is the miscalculation we make when we claim there is a statistically significant effect, but there actually isn't. (Bobbitt).

⁵ The Greenhouse-Geisser correction test is an adjustment technique in repeated measures analysis of variance that corrects for violations of the sphericity assumption, which is the supposition in data analysis that when a person is measured on more than one occasion the answers will be the same (Psychology Dictionary).

and pictures mark cause and effect of an action, or when images are used to comment or draw inferences from the text; and dichotomy, where words and images refer to different actions altogether, and the input may be misleading or unhelpful (Bell 10). Of the three ways text and images interrelate, the overlap relation is established to be most effective in improving L2 learners' language (listening) proficiency (Bell 11). The overlapping relationship is most effective in allowing L2 learners to map the visuals shown on TV to the meaning of the words, since it best enables learners to acquire new vocabulary and improve their listening comprehension (Bell 11). Further evidence is provided by Philips, who finds that the more the visuals correspond with the text in audiovisual programs, the more likely it is for the L2 learners' listening proficiency to improve (351). These findings demonstrate that in order to make TV news items more effective in the L2 classroom, it is important to engage more with the ones with higher degrees of correspondences between texts and images.

Another important detail subject to change is the amount of exposure to narrative text versus non-narrative text. Bell's coverage of Brown's study proves that narrative texts are easier for L2 learners to listen to and recall than expository events. Moreover, the reportage suggests that stories with a clear narrative story line tend to be easier processed than those without it for L2 learners. The findings connote that the TV news may need to shift their main focus from a narrative text to a more non-narrative text in order to improve L2 learners' listening proficiency (9). Additional support is provided by Bullock et al., who find that because of narratives' more basic organization compared to non-narratives, the content is more structured and easy to understand, making narratives useful devices for organizing events, illustrating relationships, and providing examples (10). Moreover, Bullock et al. discover that since narrative texts are processed more easily, they could be more influential in persuading L2 learners, which conveys that narrative texts could not only be easier to understand, but they could also play a role in persuasion. Consequently, increasing the exposure to narrative texts in the TV news is likely to produce beneficial effects on learners.

Furthermore, the clarity of enunciation and absence of ambient noise could be adjusted as well. According to Bell, some vox populi interviewed in

the TV news may not enunciate every word clearly, creating difficulties for the L2 listeners to understand. In addition to less clear enunciations, most interviews with vox populi take place on the streets with various background noises, which could render speech more difficult to comprehend for viewers including L2 listeners, because the noises in the background may overpower the vox populi's words. Moreover, Sarampalis et al. finds that noise reduction in programs reduces listening effort and allows cognitive resources for other tasks, which includes performance on the word-memory task and responses in visual reaction times. Their finding hints that noise reduction in the TV news may prompt better L2 listener recall on words and quicker responses to visuals. Consequently, it becomes crucial for the TV news programs to effectively eliminate background noises and improve the clarity of the vox populi's enunciations during the editing procedure to improve L2 learners' listening proficiency.

Additionally, the amount of hesitation and disfluency shown in the TV news could be changed. Bell observes that the anchors and correspondents on the TV news tend to have planned discourses, resulting in an absence of hesitations and repairs. Although this tendency may serve to make the TV news seem more smooth and easier to predict, the absence of pauses and hesitations may lessen L2 listeners' comprehension (Rubin 201). Rubin indicates that hesitations and pauses tend to lead listeners to focus great attention on the source, which could result in better L2 listening proficiency. Therefore, the lack of those disfluencies could lead to less comprehension and enhancement. Corley et al. further supports Rubin's finding by discovering that disfluencies are more likely to be remembered by listeners, implying that the TV news could incorporate greater occasions of disfluencies to lead to better recall by the L2 learners. The study also demonstrates that hesitation affects the way in which listeners process spoken language, and that these changes are associated with longer-term consequences for the representation of the message. Therefore, it is important to depict more hesitations and pauses in the TV news in order to enhance L2 listening proficiency.

Lastly, the TV news could adjust the amount of time covered on talking heads versus voiceovers. From Bell's coverage of Gunter's study, less coverage of talking heads and more voiceovers on the TV news may lead to more recall and comprehension by L2

learners (9). Bell hints that talking heads may lead to less viewer concentration in general due to a lack of enticing features and consequently less recall and comprehension. On the other hand, voiceovers paired with visuals could result in more concentration and recall due to the engrossing visuals, and even audios only could lead to better L2 listening comprehension, because the learners only need to focus on one sensory element: listening. Brosius' study further elaborates on the ineffectiveness of talking heads and proposes a new suggestion to improve comprehension. Brosius finds that the understanding of the TV news is enhanced by the "use of film as opposed to 'talking heads' only and by mixing up formats", entailing that less time on talking heads and more combinations of film items with mixed format news broadcasts may best benefit L2 learners and help them to improve their listening proficiencies (399). As a result, L2 listeners' proficiency may improve more if less time is covered on talking heads and more time is dedicated to film items or voiceovers with visuals combined with mixed formats.

Identifying L2 Students Who May Benefit Most From TV News

It has been shown that higher-level L2 learners significantly benefit from TV news (Bahrani & Tam Sim; Bell; Brinton & Gaskill). Additionally, it has been proposed that L2 learners with higher vocabulary may benefit the most from TV news. According to Saraswatys, many students tend to report that they do not have sufficient vocabulary in listening comprehension and a small number complains that their vocabulary is too poor to understand (146). Saraswatys' finding suggests that the lack of vocabulary may lead to more difficulties for L2 learners in improving their listening proficiency. Additionally, Bell explains that since the TV news tends to have greater vocabulary than cartoons and films, it is crucial for the listeners to have knowledge of at least some of the words. L2 teachers could try to activate students' vocabulary by asking them to guess the meaning of words used in the listening context before explaining the meaning to them, since whenever students are able to relate what they have already known to what they are supposed to listen for, they are likely to listen better or more effectively (Saraswatys 146). On top of this, it is no surprise that higher-level learners tend to benefit more than lower-level learners from the TV news, since they tend to have greater vocabulary.

Furthermore, knowledge of precise pronunciations of words by native speakers may be another criterion for determining the type of L2 students who may benefit most from TV news. Saraswatys indicates that incorrect pronunciation hinders many students from listening comprehension and that students' own accurate pronunciation of words is of great help for them in listening acquisition (146). Saraswatys' finding communicates that without knowledge of the proper pronunciation of words, it is very difficult for the listener to determine the meaning of the text. Therefore, L2 learners who are knowledgeable in true pronunciations could greatly benefit from the TV news.

Lastly, it has been suggested that the L2 learners who do not get easily distracted by visuals may benefit more from TV news than those who do. According to Bell, although audiovisual sources such as the TV news could help to facilitate and improve listening proficiency, it may be possible that some L2 listeners get distracted by the visuals (7). When they are distracted by the visual component of the TV news, they tend to focus less on comprehending speech, which may hinder or have no effect on the improvement in their listening proficiency. Therefore, L2 learners who exhibit great attention to the text and do not face distraction by visuals may benefit the most from TV news.

CONCLUSION

Engagement with general audiovisual mass media programs could significantly improve the listening proficiency of L2 learners. Furthermore, it is likely that there is no strict hierarchy of the types of audiovisual stimuli that most effectively enhance the listening comprehension of higher-level L2 learners, because the speech styles presented, the relationship between the learners' L1 and L2 languages, the learners' topic familiarity, and their interest and attention tend to vary for each type of audiovisual source and differs from person to person. This finding indicates that enhancement of listening proficiency seems to depend more on internal factors in the individual listener or audiovisual program instead of which type of program it is. Nevertheless, there has begun a widespread preference for TV news as the optimal material for higher-level L2 classrooms

due to its high degree of redundancy that is shown to facilitate L2 listeners' understanding of vocabulary. Moreover, if certain features of the TV news could be adjusted to display more narrative texts, effectively juxtapose spoken and visual texts, present a lack of ambient noises and clear enunciations, and include more disfluencies as well as greater combinations of voiceovers and visuals, they could be the most helpful for building L2 comprehension. Furthermore, as noted by Bell, there has begun a general trend of American TV news leaning towards framing news stories dramatically and conversationalizing TV news discourse, which is likely to produce beneficial effects for L2 learners and their listening proficiency (9).

Overall, this paper's findings have implications for foreign language classroom learning. This paper suggests that teachers could start by incorporating more audiovisual mass media programs into L2 classroom learning to better their students' listening comprehension. Furthermore, although there may not be a strict hierarchy of audiovisual sources, certain features of TV news may render it a more useful medium for L2 classroom learning, especially for higher-level learners. As a result, teachers could use a checklist to ascertain some of the factors in the TV news in order to select the most appropriate and helpful ones for L2 language learning and listening proficiency enhancements. The same thing can be done for individual study.

Moreover, this paper identifies higher-level L2 learners who have higher vocabulary, knowledge of proper pronunciations of words, and do not get easily distracted by the visuals as the students who benefit most from exposure to TV news. Consequently, teachers in L2 classrooms could start by improving and expanding their students' vocabulary to enhance their listening proficiency. Moreover, teachers could expose their students to more varieties of accents and speech styles to prepare them for audiovisual or audio-only stimuli. In addition, teachers may help their students become more familiar with the precise and correct pronunciations of native speakers. By doing so, the students' own pronunciation capacity is improved, which will help them find listening to native speakers effective and efficient.

Furthermore, L2 teachers could help their students develop listening strategies for effective listening. Listening strategies such as self-monitoring,

elaborations on what has been heard, and inferencing may lead to better listening comprehension. Actively implementing those listening strategies may also lessen the chances of getting distracted by visuals or irrelevant observations. Additionally, providing audiovisual materials corresponding to students' interests and backgrounds may also serve a purpose, because the students could feel more motivated to actively concentrate on the audiovisual source and would understand better.

This study also raises some new questions. For example, if all the internal factors in the listener or in the audiovisual program could be taken into account, could we determine if there is truly an optimal audiovisual source for L2 language learning? Moreover, in this paper, we discover that the TV news could be most helpful for higher-level L2 learners if certain features are adjusted, but what about the lower-level and intermediate-level learners? Are there types of audiovisual stimuli that could be most effective for them as well? Lastly, it would be interesting to investigate more features such as the speed of the speech in the audiovisual program as well as the age of the listener and how they could impact L2 language and listening proficiency.

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Music Therapy and Virtual Reality: The Powerful Combination of Auditory and Visual Therapy

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ABSTRACT

Music therapy has been used for hundreds of years in helping with physical pain, emotions, and other stressful situations, but could its implications stretch further than its current stance? In itself, music therapy is noninvasive, affordable, effective, and accessible by most. Virtual reality, another emerging treatment modality in clinical fields, has advanced exponentially since its initial creation. Similar to the core uses of music therapy, new forms of virtual reality are developed to be more affordable, accessible, and noninvasive. By themselves, music therapy and virtual reality are extremely powerful, but together, they could provide a symbiotic relationship that could transform the field of therapies and remedies for neurodegenerative diseases, day-to-day struggles, and mental illnesses. In this paper, the history and uses of virtual reality and music therapy will be independently discussed, and the potential of a combined technological development will also be examined. Through this paper, the ideas of accessibility and noninvasive treatments will be discussed, and the future of treatments for Alzheimer's, Parkinson's, pain relief, and neurological damage will be questioned, as this new potential medication emerges.

Keywords: Technology, Psychology, Music, Therapy, Parkinson's, Alzheimer's

INTRODUCTION

Music therapy has been used for hundreds of years in helping with physical pain, emotions, and other stressful situations, but could its implications stretch further than its current stance? Music helps in therapy because “Engaging in music has been shown to facilitate neuroplasticity, therefore positively influencing quality of life and overall functioning. Research has shown that music activates cognitive, motor, and speech centers in the brain through accessing shared neural systems” (Thaut et al. 2014). In itself, music therapy is noninvasive, affordable, effective, and accessible by most, but is there potential for future growth in this area? For its extensive use throughout history, music therapy has remained reasonably unchanged, and it has been effective thus far, but that begs the question of how this stable field of therapy can be revolutionized.

Virtual reality, another emerging treatment modality in clinical fields, has advanced exponentially since its initial creation. Similar to the core uses of music therapy, new forms of virtual reality are developed to be more affordable, accessible, and noninvasive. Already, therapy in virtual reality has worked tremendously to help patients struggling with post-traumatic stress disorder, PTSD (Tull et al. 2020). This capability, combined with music therapy, could potentially create a new field that changes the stigmas around mental health, provides new solutions for longstanding problems, and provides therapy for everyone that needs it. Using virtual reality to administer music therapy could better stimulate patients’ brains, as virtual reality helps to put patients directly in the space where the music is being played. This use of visual stimuli, paired with auditory stimuli, could provide many new benefits. As virtual reality is on a digital platform, multiple people could be treated at the same time, possibly removing a barrier to accessibility. In addition to opening therapy to multiple people at a time, this approach could be much more affordable for communities that might not be able to afford traditional therapy, since virtual reality sets are a one-time purchase. Music therapy has shown incredible benefits for those who choose to partake in it, and the possibilities to provide more therapy options could be exponentially amplified with the development of virtual reality.

In this paper, the clinical applications of VR-enabled music therapy’s past and future implications will be discussed. These clinical applications include

pain medicine and palliative care, stroke rehabilitation, Parkinson’s disease, and other movement disorders. In addition to movement disorders, neurodegenerative diseases such as Alzheimer’s and other dementia disorders will be explored, as well as anti-anxiety therapy and other mental health interventions.

Development and Current Uses of Music Therapy

The earliest implications of music helping to heal the mind and body appear in Plato’s and Aristotle’s writings, and other cultural implications long before that (The American Music Therapy Association (AMTA)). More recently, music therapy was introduced on a bigger scale into the field of psychology after World War II, helping veterans through the trauma of war (Craig et al. 2019).

“Music Therapy uses music and its elements rhythm, melody and harmony to develop potential or restore functions of the individual so that it has a better quality of life through prevention, rehabilitation or treatment” (Correa et al 2017). Through music therapy, patients are offered various ways to enjoy music such as writing music, listening to music, playing musical instruments, and singing (Heidersheit et al 2016). Music therapy actually works by “improving respiration, lowering blood pressure, improved cardiac output, reduced heart rate and relaxed muscle tension. For mental health, this form of therapy is great for reducing stress’ common negative side effects, such as emotional and behavioral problems” (Hawgood et al 2016). Today, the versatility of music therapy is apparent in many fields of study. With its obvious benefits in helping with relaxation, memory retention, and motor functions, simply understanding music and its nuances is enough to provide noticeable differences (Koelsch et al. 2019). Listening to music affects the limbic and paralimbic systems in the brain, structures that affect emotional processing and regulation (Koelsch et al. 2019).

According to The American Music Therapy Association (AMTA), “Music therapy can be used for facilitating movement and overall physical rehabilitation and motivating clients to cope with treatment. It can provide emotional support for clients and their families, and provide an outlet for expression of feelings.” In addition, music therapy can lessen feelings of pain in hospitalized patients, reduce asthma in adults and children, and can lessen the effects of dementia. Music therapy can also be used to “help children with autism spectrum disorder to improve

their communication capabilities. Furthermore, it can help premature infants improve sleep patterns and increase their weight gain. Finally, music therapy can be used to help individuals with Parkinson's disease to improve motor function" (Craig et al. 2019). In relation to music therapy, listening to sad or happy music actually can determine one's outlook on the world (Blodgett et al. 2015). Simply listening to music has shown outstanding results in the field of clinical treatment, but the addition of a licensed music therapist creates a larger variety of opportunities to utilize music as an improved form of therapy.

Methods of music therapy include improvisation, recreation, composition, and listening to music (AMTA). Music therapy improvisation is the "free or guided extemporaneous use of music, undertaken by the therapist and/or client, using a range of tuned and untuned instruments and voice, to maintain or improve health" (Bruscia et al. 1987). Through this method, patients are able to explore self perception, improve focus, manage pain, and other benefits (Gracida et al. 2018). In recreational playing, patients play without the intention of mastering the instrument, but instead, play for the purpose of self-satisfaction. Patients compose their own music either with or without a certified music therapist in compositional music therapy, and this can be used to boost creativity, soothe pain, much like the other methods of music therapy, and other health benefits. Lastly, listening to music is a classical form of music therapy, as it is accessible to most and well-used in life. When one listens to music, blood actually flows better when there is music therapy. In addition, music boosts mood, decreases symptoms of anxiety and depression, stimulates memory, boosts workout endurance, and reduces stress, among other prevalent health benefits (NorthShore et al. 2020).

Today, music therapy is becoming increasingly popular in treating symptoms of depression and anxiety, helping with pain management, language and learning, dementia, Parkinson's, and other neurological rehabilitation processes.

A famous success story was that of Congresswoman Gabrielle Gifford after she had suffered a gunshot to her head in 2015. After this, she was unable to communicate verbally, but surprisingly, she was still able to sing some forms of verbal communication. After several years of working with music therapists, she was able to regain speech, as

the neuroplasticity "rewired" many parts of her left hemisphere to compensate for the damage that had been caused (Ashoori et al. 2015).

Another common clinical situation that fully utilizes music therapy and its diverse functions is the treatment of Parkinson's disease. Parkinson's disease is a "brain disorder that causes unintended or uncontrollable movements, such as shaking, stiffness, and difficulty with balance and coordination" (NIH National Institute on Aging (NIA) et al. 2022). These symptoms are also present in other Parkinsonian disorders. Recent studies show that rhythmic auditory stimulation (RAS) that plays rhythmic mark beats and dance therapy is an effective, accessible, and affordable route of therapy to combat Parkinsonian symptoms. In most studies, however, RAS works much more efficiently when it adapts to the movements of the patient (Ashoori et al. 2015). This is one example of how this technology can improve daily living and relaxation for patients experiencing a range of disabilities and disorders.

Virtual Reality

Virtual reality is a rather recent field of technology that is emerging as one of the most promising clinical developments in the past few decades. Defined as a way for people to "visualize, manipulate, and interact with computers and extremely complex data," virtual reality has promised a new form of clinical therapy for the field of psychology (Aukstakalnis & Blatner, 1992). From as early as the 1800s, humans saw the possible opportunity for creating a reality far different from what was known. The first prototype for "virtual reality" was created in 1838, using two mirrors to reflect a single image (Fi et al. 2019). Modern virtual reality prototypes consist of controllers and a set of goggles containing visual displays. Most notably, virtual reality uses highly detailed graphics to present a 360 degree, 3-dimensional model of a virtual environment that responds to the actions of the player. The player usually uses a handheld device to aid the goggles in tracking the player's position and movement. This allows us to understand the mechanics of virtual reality: "input devices, output devices, and the simulated scenario (i.e., the virtual environment)" (Parsons et al. 2017).

In the last 40 years, this technology has rapidly advanced to high-quality virtual experiences at a relatively low cost, raising questions about its

future possibilities. In addition, recent technology has allowed further advancement in this field. Researchers are exploring possible treatments for mental illness and mental disorders through virtual reality. This approach is hoped to foster a much more affordable and engaging approach to clinical care. Virtual reality also holds capabilities for future modes of education that do not require human intervention. From 4 decades ago to now, VR has made immense progress, and this technology's endless possibilities have yet to be fully developed.

Today, virtual reality has been used to aid rehabilitation journeys through post-traumatic stress disorder (PTSD) as well as attention deficit hyperactivity disorder (ADHD), anxiety disorders, pain management, eating and weight disorders, with long-term effects that take into action in real world situations (Riva et al. 2020). In addition, more recent research indicates that virtual reality has the potential to help treat and assess autism, psychosis, and addiction (Riva et al. 2020).

Some forms of VR are advancing to mimic the perceptions of the human brain. In this perspective, the brain sees the body as an “internal model (simulation)”, and models the surrounding world around it in order to make predictions about surrounding environments to minimize “prediction errors (or ‘surprise’)” (Riva et al. 2020). By planting the person inside this virtual world, “VR technology attempts to predict the sensory consequences of users’ actions by showing them the same outcome expected by our brains in the real world” (Riva et al. 2020). Then, this model would reflect the perceptions of the brain in order to make the individual feel more present in the VR metaverse—making the process of experiential learning much more effective (Riva et al. 2020). This model of technology is almost perfect for experiential learning: “One reason it is so difficult to get people to update their assumptions is that change often requires a prior step – recognizing the distinction between an assumption and a perception. Until revealed to be fallacious, assumptions constitute the world; they seem like perceptions, and as long as they do, they are resistant to change” (Glantz et al. 1997). In addition, VR works very efficiently in evoking emotional responses such as anxiety and phobia in its virtual situations, making it just as effective as exposure therapy (Powers and Emmelkamp, 2008; Opris et al., 2012).

VR therapy for PTSD is one of the leading

therapeutic applications under investigation in this emerging field. PTSD is a big issue amongst war veterans, as the “physical, emotional, cognitive, and psychological demands of a combat environment place enormous stress on even the best-prepared military personnel” (Rizzo and Shilling, 2017). The effects of virtual reality may prove to be effective on other populations that experience PTSD such as those who have experienced terrorist attacks, physical/sexual assault, motor vehicle accidents, and extreme weather events. These emerging studies hope to access, treat, and prevent PTSD in future scenarios.

As presented earlier, VR allows the new possibility of a hyper-realistic environment in a completely virtual space. Not only that, but VR allows complex interactions and testing within this virtual space, and opens doors for emotional therapy without taxing, real life situations. Instead, these participants will be accessed and treated all in a safe, virtual world. In this virtual world, VR scientists are able to recreate “virtual airplanes, skyscrapers, spiders, battlefields, social settings, beaches, fantasy worlds, and the mundane (but highly relevant) functional environments of the schoolroom, office, home, street, and supermarket. In essence, VR environments mimicking real or imagined worlds can be applied to engage users in simulations that support the aims and mechanics of a specific clinical assessment or therapeutic approach” (Rizzo and Shilling, 2017). One major method that has been shown to be extremely effective is prolonged exposure (PE) therapy (Bryant, 2005; IOM, 2008; 2012; Maples-Keller et al., 2017; Rothbaum, 2001). Virtual reality exposure therapy (VRET) is being explored as the method in use to administer VR as a viable treatment option. In order for this method to be successful, the elements that initially induced the fear and anxiety need to be reconditioned in a safe environment so that the patient can relearn responses to previously feared stimuli (Foa & Hearst-Ikeda, 1996). In this method, patients are re-exposed to the traumatic event in a therapeutic setting. Everything is monitored by the clinician, and the pace and relevancy of the administered material can be carefully controlled so that the trauma-relevant situations are shown in the most effective way possible. That way, the low-threat environment provides a safe space for patients to confront their trauma, process their emotions, and “de-condition the learning cycle of the disorder via an extinction learning process” (Rizzo and Shilling, 2017). VRET allows patients to skew away from their “natural avoidance tendency” by “directly delivering multi-sensory and context-relevant cues that

aid in the retrieval, confrontation, and processing of traumatic experiences” (Rizzo and Shilling, 2017).

Another prevalent use of virtual reality is in helping with anxiety disorders. The same exposure therapy can be applied to a plethora of other disciplines along this field. Although many people have anxiety disorders, only a few of them receive exposure therapy as treatment (Olatunji et al., 2010). Presenting VR as a possible option would allow many more people to receive this treatment at a much lower cost, and receive it with multiple other people simultaneously. Similarly to using VRET for PTSD, administering exposure therapy would be much more efficient, not to mention also much more affordable, available, and safe compared to alternatives such as vivo exposure (Riva et al. 2015).

Ongoing research sees the delivery of exposure therapy, cognitive behavioral therapy, or skill building through VR as the better option for numerous clinical scenarios such as ADHD, pain management, eating, and weight disorders—as mentioned previously. For pain management, clinicians are seeing virtual reality as a way to distract patients. Virtual reality draws the patient’s attention away from the area of discomfort and into that of a computer-generated space (Ahmadpour et al., 2019). In addition, VR works to induce positive emotions in order to combat the issue at hand, since negativity works to worsen the pain in the patient (Sharar et al., 2016). The issue of chronic pain is still an ongoing field of research; however, researchers have found that when patients are taught to task shift during their VR sessions, they are better at managing the pain. The downside of this method is that the effects of VR do not reach far out outside of the virtual reality session (Ahmadpour et al., 2019).

Other treatments for different disorders are similar to those that have already been developed in the field of VR. Virtual reality’s availability, effectiveness, accessibility, and convenience hold the keys to other disciplines that can be incorporated to further advance this field.

Music Therapy in Virtual Reality

People often underestimate music, thinking that it is a small factor of an overall bigger picture. When they hear the word music, they think of the day-to-day beats that are played, musical instrumentation, and other conventional scenes. They do not realize how important music is in enhancing other senses.

Sound is a crucial factor in appealing to the senses, possibly making the overall experience of VR that much more pleasing.

It will not feel completely “real” in a virtual world without sound, because the real world has sounds everywhere one goes. As explained previously, virtual reality creates a completely immersive atmosphere with 360-degree paneling and sensors to track the player’s movements. The player is completely immersed in the metaverse, complete with the full package to make the player perceive that the VR world seems so real, but is not. One feels their “presence” in the virtual world, as they are seeing through the lenses of their “fake” self. The addition of sound into this immersive environment introduces a new “dimension” to the authenticity and realness of the virtual world (Pagan et al. 2017). The player can hear sounds from their respective directions, and the environment mimics their nuanced movement. This creates an environment that is perfect for experiential learning and conditioning in a controlled environment. Alternatively, virtual reality provides a perfect visual aid for music. Having a visual and spatial guide makes music much more engaging, possibly providing a deeper effect of music on the listener. Just as music better immerses the player in virtual reality, a virtual reality experience in turn makes music more immersive.

Additionally, adding two accessible forms of therapy into the bracket provides many more effective options for those who might be unable to access in-person care, promoting the idea of virtual accessibility. Not only will people be able to engage in music therapy without an in-person visit, but multiple people could participate at the same time from different locations, while still feeling like they are receiving one on one care.

Clinicians and VR scientists are already testing the possibility of the combination of these two therapeutic modalities. Notably, music therapy in virtual reality is currently being tested in many fields: stroke rehabilitation, pain management and palliative care, movement disorders including Parkinson’s disease, and mental health interventions including anti-anxiety for adult and child burn patients, chemotherapy patients, and lumbar punctures.

One of the largest growing problems facing the aging population currently is Parkinson’s disease. Treatments for both have been scarce, and ongoing

research has yet to find a substantial cure for these neurodegenerative diseases. New research shows that music therapy in VR might provide an alternate method for those struggling with Parkinson's. Previously, rhythmic auditory stimulation (RAS) has been shown to improve the symptoms of Parkinson's disease. However, auditory stimuli paired with immersive virtual reality has been more recently used in "improving brain-body interaction and sensory-motor integration" (Ashoori et al. 2015). Utilizing these "multisensory cues" may prove to treat Parkinsonian freezes and other gait disorders. Similar to Congresswoman Gabrielle Gifford's success story, the same principle could apply to Parkinson's patients in helping the neuroplastic functions repair the brain's motor and cognitive function through, for example, learning a new instrument (Francois et al. 2015). In addition, beats, rhythms, and tunes make up a song, and through a process called rhythmic entrainment, humans naturally move to the beats of music (Ashoori et al. 2015). This innate timing is not only limited to auditory cues, however. Humans behave similarly when matching the timing of their steps to those around time, so visual cues are another sure way to follow rhythms (Ashoori et al. 2015). This is where the virtual reality aspect comes in. Virtual reality provides an immersive space for Parkinson patients, and the visual aids better implement the auditory cues. Paired together, the effects may be more powerful and effective compared to those of just one treatment.

Pain, anxiety, and mood management is another prevalent subject in both fields of study. Even with this seemingly common problem amongst people of all ages of all different circumstances, current remedies do not seem to address the problem in the most efficient way. According to WebMD, current solutions for pain include over-the-counter and prescribed medication, massages, other physical treatments, and alternative therapies. None of these options are one-time purchases, meaning over time, the costs of all purchases add up. Not only that, but many simply cannot afford the current therapies currently available. In a study done in 2020, breast cancer patients' anxiety and moods from chemotherapy were able to be alleviated through the means of music therapy in virtual reality (Chirico et al. 2020). Diagnosis of breast cancer can be very psychologically taxing for patients, and treating it can add more burden onto that stress. The effects of music therapy and virtual reality showed a statistically significant improvement over music therapy alone (Chirico et al. 2020). Again, like the treatment for Parkinson's,

the visual aid provided by virtual reality efficiently enhances the benefits of music therapy and vice versa.

CONCLUSION

With proposals of new forms of therapeutic remedies come concerns, as is with all forms of treatment. However, concerns regarding overstimulation, triggering unwanted memories, and potentially increasing anxiety can easily be overridden by the fact that music therapy is noninvasive and very easily regulated. According to Cancer Research UK, music therapy has no negative side effects that are of concern.

Regarding the negative reaction towards certain technologies in the medical field, some might experience "headaches, eye strain, dizziness and nausea after using the [virtual reality] headsets," but again, as a noninvasive and easily regulated treatment, these minor symptoms are easily avoidable with different intervals of usage, lighting, etc (Matthews et al. 2020). While presented with potential concerns for these forms of therapies, music therapy and virtuality's versatility and adaptivity easily override these concerns, being noninvasive and completely safe to use.

As presented, music therapy and virtual reality individually have their own advantages, and with close to no side effects, so together, they could prove to be so much more effective. Not only are these methods noninvasive, but they also provide an alternative option for those who cannot afford more traditional forms of therapy. This form of therapy can be somewhat "on the go," and multiple people are able to experience it, making this a much cheaper option as well. For the future, music therapy with virtual reality could possibly reach larger horizons such as Alzheimer's, and depression, amongst other things. This approach is a great option to consider for future studies and a new field of accessible therapy.

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Understanding the Double Reduction Policy Reform in China

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ABSTRACT

Education inequality is faced by all countries in the world, but it is particularly acute in China. The past two decades witnessed the flourishing of after-school tutoring of compulsory education in China, but this kind of development also deprived the right of low-income families to receive education. To address this problem, the Chinese government issued the Double Reduction Policy in 2021, banning after-school tutoring of compulsory education. Compulsory education should be provided by the government only. Excessive after-school tutoring does not improve the overall level of compulsory education. Instead, it intensifies the involution of education, further deprives the education opportunities of low-income families, and is also a waste of social resources. So far, the Double Reduction Policy has been implemented for one year and achieved effective results. Most after-school training institutions have been closed, releasing students' academic burden. Of course, it will take much longer before we know for sure whether the Double Reduction Policy has improved the inequality of education in China, that is, changed the phenomenon that "impoverished families can hardly nurture rich sons".

Keywords: Double Reduction Policy; Education Equity; After-school Tutoring; Compulsory Education; Basic Education; Gaokao; Involution; China

INTRODUCTION

With the annual average growth rate of 0.53 percent of the population in China, where the total population is already more than 1.44 billion in 2021 (Bulletin of the Seventh National Census, 2021), competition among students has become fierce. In response to this, parents sign their children up for many after-school courses to stand out in the future job market. In order to satisfy the increased demand, the after-school tutoring industry has taken off. Thirteen years ago, in 2009, China's primary and secondary school after-school tutoring market size was 189.7 billion Yuan. But by 2020, the market size has exceeded 800 billion with more than 100,000 after-school tutoring companies across the country (The Market Size of China's Primary and Secondary School Counseling Agencies Exceeded 800 billion Yuan in 2020, 2020). Moreover, the wealth difference between different families resulted in a widening gap in education resources for children. This is why children from high-income families usually have more opportunities to get after-school tutoring, while children from low-income families rarely can afford them. The former will be much more likely to get into good universities and finally receive advanced education. This relates to the Matthew effect in education, which is also a type of education inequality, leading to class solidification and affecting social progress. To fix all the problems above, the Chinese government came out with a policy called the Double Reduction Policy.

On July 24, 2021, the General Offices of the CPC Central Committee and the State Council issued the Opinions on Further Reducing the Burden of Homework and Off-campus Training for Students of Compulsory Education, the Double Reduction Policy (Opinions on Further Reducing the Burden of Homework and After-school Training of Students in Compulsory Education, 2021). This reform includes both in-school education and after-school tutoring. The provisions for the after-school tutoring includes (1) Local governments no longer approve new after-school tutoring institutions for students of compulsory education, and those existing institutions should be registered as non-profit institutions. (2) After-school tutoring institutions should not use national statutory holidays, rest days or summer holidays to do subject training. As the most important reform of China's education in recent years, one of the main provisions of the Double Reduction Policy is that no organization or individual is permitted to provide paid

extracurricular training to students of compulsory education.

Compulsory education is the main topic of this paper. Compulsory education refers to the fact that the government has an obligation to use public power to ensure that all citizens receive education, which has three basic principles: compulsory, universal and free. This kind of education should be compulsory for all school-age children, regardless of class or origin, and free of tuition (Chen, 2000). In most countries, compulsory education covers the basic education stage, including primary and junior high schools. In recent years, the rapid development of after-school tutoring in compulsory education in China has greatly affected the fairness of education. It is in this context that the Chinese government launched the Double Reduction Policy. This paper mainly discusses the background of the Double Reduction Policy reform, why the government should launch this reform, and how the Double Reduction Policy effectively solves the main problems in China's education.

Influence of Excessive After-school Tutoring

Educational inequity is faced by many countries around the world, but it is particularly acute in China. The university admission system in China is different from that in the United States. In United States, students always submit application materials to the admission office of universities, including not only the scores, but also some activity materials that can show their characteristic, while the admission system in China is just based on the scores of the college entrance examination, and there is only one unified national examination every year. Under this situation, receiving a good grade would be almost the only way for students to get into top universities.

Table 1 shows the admission rates of Gaokao (the standardized college entrance exam held annually in the Chinese mainland) of various kinds of universities in each of China's provinces, autonomous regions and municipalities in recent years (admission rate = number of local admitted candidates/number of local Gaokao examination candidates). It includes the admission rates of 985 select universities (the top 40 universities in China), 211 select universities (the top 100 universities in China), first-tier universities (the first-class universities in China) and Tsinghua University (THU) and Peking University (PKU), the top two universities in China.

**Table 1: Admission Rates of Gaokao of China's
Each Provinces, Autonomous Regions and Municipalities
(National College Entrance Examination Ranking, 2022)**

District	985 Select	District	211 Select	District	First-tier	District	THU & PKU
Tianjin	5.81%	Beijing	13.99%	Beijing	30.50%	Beijing	9.13%
Shanghai	5.33%	Shanghai	13.58%	Tianjin	24.10%	Shanghai	4.31%
Beijing	4.29%	Tibet	12.77%	Shanghai	21.80%	Tianjin	2.79%
Jilin	3.56%	Tianjin	12.68%	Ningxia	19.00%	Liaoning	1.22%
Qinghai	3.02%	Qinghai	11.66%	Fujian	18.70%	Zhejiang	1.20%
Ningxia	2.31%	Jilin	8.95%	Hainan	17.24%	Jilin	1.08%
Liaoning	2.30%	Ningxia	8.56%	Liaoning	16.10%	Qinghai	1.04%
Hubei	2.14%	Xinjiang	7.76%	Hubei	15.80%	Fujian	0.99%
Chongqing	2.13%	Heilongjiang	6.67%	Gansu	15.22%	Ningxia	0.94%
Fujian	2.01%	Jiangxi	6.46%	Qinghai	15.20%	Jiangsu	0.93%
Heilongjiang	2.01%	Inner Mongolia	6.03%	Shaanxi	14.60%	Tibet	0.88%
Shaanxi	1.88%	Liaoning	5.93%	Hebei	14.55%	Hainan	0.86%
Zhejiang	1.87%	Shaanxi	5.67%	Guizhou	14.50%	Hubei	0.85%
Hainan	1.765	Hainan	5.66%	Anhui	14.20%	Heilongjiang	0.84%
Tibet	1.73%	Chongqing	5.38%	Inner Mongolia	14.03%	Chongqing	0.83%
Hunan	1.71%	Fujian	5.37%	Zhejiang	14.00%	Hunan	0.81%
Xinjiang	1.67%	Jiangsu	5.19%	Heilongjiang	13.50%	Shanxi	0.76%
Jiangxi	1.55%	Guizhou	5.17%	Xinjiang	12.86%	Xinjiang	0.75%
Inner Mongolia	1.54%	Hubei	5.16%	Jilin	12.40%	Shanxi	0.68%
Hebei	1.48%	Shanxi	4.67%	Jiangsu	12.10%	Hebei	0.61%
Shandong	1.47%	Guangxi	4.61%	Chongqing	11.50%	Sichuan	0.56%
Sichuan	1.47%	Hunan	4.53%	Guangdong	11.20%	Inner Mongolia	0.56%
Gansu	1.47%	Yunnan	4.50%	Hunan	11.20%	Shandong	0.52%
Jiangsu	1.41%	Shandong	4.44%	Yunnan	10.85%	Jiangxi	0.50%
Yunnan	1.35%	Sichuan	4.44%	Shandong	10.60%	Anhui	0.47%
Guangxi	1.34%	Hebei	4.42%	Sichuan	10.60%	Gansu	0.47%
Guangdong	1.32%	Zhejiang	4.40%	Jiangxi	10.40%	Henan	0.46%
Shanxi	1.30%	Henan	4.14%	Shanxi	9.80%	Guangxi	0.43%
Guizhou	1.19%	Anhui	4.10%	Guangxi	8.44%	Guangdong	0.36%
Henan	1.14%	Gansu	3.50%	Henan	7.80%	Guizhou	0.35%
Anhui	1.10%	Guangdong	2.74%	Tibet	N/A	Yunnan	0.34%
National Average	1.63%	National Average	5.01%	National Average	12.43%	National Average	0.72%

As can be seen from the Table 1, the distribution of educational resources in various provinces of China is extremely unbalanced. Take the admission rate of 985 select universities for instance, the admission rates of the top three provinces are 5.81%, 5.33% and 4.29%, much higher than the 1.19%, 1.14% and 1.10% of the last three provinces, also much higher than the national average of 1.63%. This kind of phenomenon also occurs in the other three categories of admission rates. Moreover, there are also considerable differences in admission rates between cities within the same province.

The above situation is closely related to the level of local economic development. The top three cities in Table 1 are mainly Beijing, Shanghai and Tianjin. As is known to all, these three cities are the political centers, important economic centers and municipalities directly under the central government of China. These cities have higher local public revenues and thus have higher budgets on education. As a result, they have higher levels of education. Financial strength affects the level of education, both for districts and for families.

Since 2000, as competition for Gaokao has become more intense, China's extracurricular tutoring industry has taken off. A number of large training institutions have sprung up, such as Good Future, New Oriental and Suntech Education, many of which have gone public in the United States. Through offering preview courses and targeted tutoring, after-school tutoring institutions have helped many students achieve excellent grades. The purpose of extracurricular training has also changed from the original "keep up" to the current "be priority", accompanied by growingly high tuition fees. The Consumption Power Report of Tutoring Market in China shows that in 2019, the revenue of after-school tutoring reached 475.1 billion Yuan, and is expected to exceed 560 billion Yuan in 2021. Among the surveyed families, 31% spent on education 10%-20% of the total household expenditure, and 27% spent 20%-50% of the total household expenditure (K12 Extracurricular Counseling Market Will be 100 Billion and Parents' Anxiety Will Continue in 2020, 2020). This kind of situation would deprive the right of children from poor families to receive education. The children of economically advantaged families who can afford the extracurricular training are more likely to attend good universities and choose good majors, while the children of economically disadvantaged families are less likely to do so, the Matthew effect in education.

In a paper published in 2015, scholars from Tsinghua and Stanford University said students from China's poorest countryside were seven times less likely than their urban counterparts to get a university place and 14 times less likely to attend an elite one (Education in China is Becoming Increasingly Unfair to the Poor, 2021). Impoverished families can hardly nurture rich sons. This kind of phenomenon has blocked the way for lower or middle class to jump into the upper classes. If things go on like this, it may lead to solidification in social stratum, which is detrimental to the innovation and development of society.

Double Reduction Policy is the Optimal Choice

1. Compulsory education must be provided uniformly by the government.

Firstly, the purpose of the education industry is not to create profits, but to improve the knowledge level of citizens and promote social progress. The education level of residents is the guarantee of a society's civilization level and a country's international competitiveness. Thus, it is the obligation for the government to provide basic education. Secondly, basic education is provided to all the citizens, indicating a huge amount of expenditure. While individuals and enterprises are not able to afford, only the government has the financial ability to provide basic education freely. For example, Germany was the first country in the world to provide compulsory education by the government. At the end of the 16th century, some regions of Germany began to promulgate compulsory education. In 1763, the King of Prussia promulgated the Rules for Village Schools, and education was universal throughout the country. This is a leading position in Europe and the world. (The Origin and Development of Compulsory Education, 2019) Third, the private provision of basic education can lead to mobility constraints, depriving poor families of access to education. Due to limited financial strength, individuals or enterprises can only provide paid education. Thus, for poor families, they do not have enough funds to buy paid education. Even if they want to borrow from the bank, they cannot succeed due to the limited collateral. Finally, they have to give up the opportunity of education even if it is essential to them.

In the stage of compulsory education, excessive after-school tutoring only improves the competitiveness of some individuals, especially those from wealthy families. This undermines the fairness of education and goes against the purpose of the education.

2. After-school tutoring leads to involution, which does not bring Pareto improvement.

Involution is a widely discussed topic in China in recent years. The term involution originally comes from agricultural research (Geertz, 1969), which refers to the continuous decline of output caused by intensive farming in the declining process of small-scale peasant economy (Huang, 2000). Nowadays, involution refers to that individuals have to exert more effort to compete for limited resources in an overly competitive environment, resulting in a decline of revenue to effort ratio. Involution is a kind of irrational competition and meaningless internal friction, which represents the innovation dilemma and will lead to the state of growth without development. At present, there is a prominent phenomenon of involution in China's education field, and excess after-school tutoring will lead to more serious involution.

Imagine the following scene. At the beginning, some students engaged in after-school tutoring, and as a result, they got good grades in the examinations and better education opportunities. Then, other students began to follow this trend. Eventually, when the vast majority of students join after-school tutoring, the initial advantages disappear. Although the overall performance of all the students has improved, higher grades are needed to compete for higher education opportunities that could be obtained with lower grades before. In other words, the pie is the same one, but consumers have to pay a higher price for one piece now. What next? Thus, parents will pay much more for better tutoring to help their children get more improvement, setting off another round of competition.

There is a statistic shows that less than 50 percent of junior high school students in China have opportunities to enter senior high school (Nearly Half of Junior High School Students Cannot Go to High School, 2022). After-school tutoring does not increase the positions in senior high school, but only pushes students to do harder exercises within the established framework of knowledge and compete for the less than 50% opportunities with much higher scores. This process is a typical involution. Instead of improving

the level of compulsory education, it has increased the financial burden of families and created anxiety to the whole society.

3. Prohibition is more effective than subsidies from the government.

Government subsidies are financial help or support provided by the government to a business or individuals, aiming to promote an economic or social policy (Myers, 1998). Government subsidies can be carried out in many forms, including direct forms such as grants and interest-free loans and indirect forms such as tax cuts, low-interest loans and rent rebates (Haley and Haley, 2013). In theory, the Chinese government could solve the problem of after-school tutoring by offering subsidies, which means providing grants or interest-free loans to low-income families so that their children can receive extracurricular education. But there are significant problems with this approach.

First, providing subsidies for low-income families will be a huge expenditure for the government. As mentioned above, the cost of extracurricular training is quite high. According to the 2020 National Education Development Statistical Bulletin, the amount of students in compulsory education reached 156 million in 2020 (2020 National Education Development Statistics Bulletin, 2021). Even if only one tenth of those students need financial aid, there will be a tremendous expenditure and lead to a heavy financial burden for the government. Second, there is no need to provide after-school tutoring to all students of compulsory education. As discussed above, excess after-school tutoring only allows students to do more and more difficult practices, and eventually compete with higher and higher scores for admission opportunities. It does not improve the level of education and wastes social resources, so there is no need to use financial funds to support all students to receive after-school tutoring.

In addition, the government may regulate the tutoring industry through taxation. But tutoring institutions can pass the tax on to consumers by raising prices, which in turn further exacerbates inequality in basic education. Therefore, the current prohibition adopted by the Chinese government is the best solution to solve the problem of uneven distribution of educational resources caused by the overflow of extracurricular training. It not only avoids the waste of social resources, but also promotes the fairness of education.

CONCLUSION

To address the education inequality in compulsory education in China, the Chinese government launched the Double Reduction Policy in 2021. This paper mainly discusses the background of the Double Reduction Policy reform, the reason why the Chinese government should launch this reform, and how the Double Reduction Policy effectively solves the main problems in China's education. So far, the Double Reduction Policy has been implemented for one year and achieved effective results.

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How Can the Use of Mirror in the Painting “Las Meninas” be Analyzed through the Prism of Different Perspectives?

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Tianyi (Priscilla) Xie is currently a senior at Shanghai YK Pao School. She plans to major in art history at undergraduate level. She is particularly interested in early modern arts (i.e. Renaissance arts and Baroque arts). Her other research interests include comparative literature, theater, and cultural and gender studies. She loves traveling to different places around the world and communicating with people from various cultural and historical backgrounds. She is the founder and president of “Navigator”, a journal club devoted to finding connections between modern life and the arts and literature from the past. She also writes her personal blog to introduce the online community to a wide range of artworks, literature, films, and TV series that she enjoys.

ABSTRACT

Art critics nowadays sometimes attack artists from the past for lacking the revolutionary, creative minds of the modern-day artists. Nevertheless, the early modern arts from centuries ago are truly innovative. Under the royal patronage of Philip IV of Spain, the Baroque artist Diego Velázquez created unprecedented masterpieces with newly found ideologies and techniques. This essay will discuss how Velázquez displays artistic novelty in his famous work *Las Meninas*. Firstly, Velázquez deviates from the conventional religious themes and instead depicts the societal and historical backgrounds of the society at the time; secondly, he also evokes the audience to interact with the artwork in a more vivid, complex way than only adoring the religious figures in the painting as in the past. In its essence, it is his increasing curiosity about societal reality and his rising attention to audience mentality that later inspires modern arts centuries after, when artists eventually reset the common class, their city life, and their industrial productions as the primary subject matters. Therefore, the spirit of creativity, revolutions, and innovations has long lied in the vein of art creations, very since the early modern art masters, such as Velázquez.

Keywords: Baroque arts, Spanish arts, colonial arts, early modern arts, Spanish Golden Age, royal patronage, Diego Velázquez, Prado Palace



Fig. 1 Diego Velázquez, *Las Meninas*. Museo del Prado, Madrid

INTRODUCTION

Las Meninas (Fig. 1) is a royal portrait for King Philip IV of Spain of his family and servants, completed in 1656 by the artist Diego Velázquez (Kahr, 1975). King Philip IV of Spain was a significant art patron at the time. He appointed a large number of court painters, who could learn from his collection of Italian Renaissance arts at the Prado Palace while producing art for the royal family (Gerard, 1982). Among these artists was Velázquez, a lead painter at the court of King Philip IV. Notably, Velázquez was a pioneer in the Baroque arts, differentiating his own art from former pieces through various means. He fostered a closer relationship between artwork and reality, transforming paintings from a Heavenly art to an Earthly one. He also encouraged audience engagement in appreciating the arts, establishing artwork as a medium for communication with the public.

One of the most groundbreaking of his works, *Las Meninas*, illustrates the daily life of King Philip IV's royal family. This essay discusses two perspectives on how the use of mirror in *Las Meninas* differs the painting from traditional artworks before Velázquez: Firstly, *Las Meninas* is a commentary on both Spanish and global social relationships and hierarchy; secondly, Velázquez utilizes an illusion of realism in *Las Meninas* to communicate to his audience.

Part I: Social Relationships and Hierarchy in *Las Meninas*

In a revolutionary approach, Velázquez manifests his perception of Spanish people and society through the mirror in the painting *Las Meninas*. *Las Meninas* depicts characters in the Spanish court, commenting on the social relationships and hierarchy at the time. Velázquez not only pays attention to the local court, but also depicts the global situation by exploring exotic colonies' culture.

The subject-matter of this painting is the Spanish royal family and their servants in the Prado Palace. At the center is the infanta, flanked by her two *Meninas* (maids of honor). To the right of the infanta are two little men, who are entertainers for the infanta. To the left of the infanta, the artist himself stands in front of his canvas, holding his palette and pondering over his artwork. To the rear and at right stand a chaperone and a bodyguard, both of whom are in conversation with one another. The mirror in the center of the room reflects the infanta's parents, King Philip IV of Spain and his second wife Queen Mariana of Austria.

Velázquez depicts the King and Queen in the portrait to engage with his relationship to the leaders of social hierarchy in this era. There is a mirror in the center of the piece reflecting the King and Queen. At first glance, it seems that the audience of the painting stand in the same position as the King and Queen. The position of the mirror suggests the royal couple stand face-to-face with the characters in the entrance of the room, just as the audience does when looking into the painting.

In this way, while the audience gazes at the characters in the painting, the King and Queen also gaze at their own subjects in the painting. The painting depicts the tension within the social structure by placing all characters (including the painter Velázquez himself) in deference to the gaze of the King and Queen, who are at the top of the social hierarchy. The etiquette of receiving the gaze and standing upright demonstrates the respect of the subjects towards the King and Queen. Moreover, only a few of the subjects dare to look directly into the gaze of the King and Queen, including their daughter, a close maid, a little woman, and the artist himself. The eye-contact with the high royalty is a limited honor for the subjects, and thus may indicate that some subjects have a higher status than others. Thus, Velázquez explores the

relationships between the royalties and their subjects, while also highlighting the complex hierarchy amongst the royalties' subjects themselves.

Additionally, the hierarchy is demonstrated by the mirror in the painting. Velázquez uses the mirror in the portrait to show a reflection of the King and Queen. In a portrait session a mirror such as this would allow the subjects to see their own reflections and "thereby correct any Disagreeableness in their Look to have as good an Air as they desire" (Bauer, 2000). Thus, the sitter cooperates with the artists and gains a partial control over the portrait painting process. If this reflection were of the King and Queen viewing themselves, the audience may assume that the relationship between Velázquez and the King and Queen is no different from the conventional artist-patron relationship at the time.

However, on closer inspection, it becomes clear that the reflection of the King and Queen are from the artist's canvas in the painting, rather than a direct reflection of the King and Queen themselves. This is because the King and Queen (the same as the audience) must stand directly in front of the mirror to see their reflection in the mirror. However, the audience of the painting is positioned to the right of the mirror. Thus, according to the law of reflection, from the audience's position, the King and Queen cannot see themselves in the mirror. The reflection the audience sees, when standing at the right of the mirror, is from Velázquez's canvas, which is to the left of the mirror symmetrically. Velázquez has used a similar reflective illusion previously in his painting *Venus of Rokeby*. In this painting, at first glance, Venus seems to be watching herself in the mirror. Yet, in reality, from the angle of the mirror, Venus would not be able to see herself in the mirror if the audience can.

Velázquez's use of the mirror to reflect his canvas, in fact, enables the sitter to "see the reflection of the portrait being painted and oblige the artist to alter or correct the painting according to the sitter's own judgements and preferences" (Bauer, 2000). Thus, the artist concedes to the sitter and surrenders his authority over his artwork to the sitter. Therefore, even though King Philip IV is renowned as a great patron that shows compassion and appreciation towards the artists, the artists still concede to the King and strive to please him. Different from the experience of artists during the Italian Renaissance, in which Leonardo da Vinci claimed painters as "lord and god" who may even rebel against their patrons (Gombrich, 2000), this

painting establishes that artists in the Spanish Golden Age, including Velázquez himself, submit entirely to their patrons and are rather perfect courtiers at the service of their patron and King.

Velázquez's approach to demonstrate the societal structures through the mirror in the painting implies his concern and attention to the societal issues involving gaps in social classes at the time. He is curious about how people in different social status may interact among one another. His painting is therefore a rather objective, nuanced record of the minorities and their social reality in the Spanish Golden Age. This depiction may have paved the way for paintings in the later eighteenth century. During this time, subject-matter shifted from only aristocrats to people of multiple classes, along with the popularization of the media of art.

The portrayal of social structure extends beyond the borders of Spain and to the budding new world order under colonial rule. In *Las Meninas*, an object exported from the Spanish colonies into Spain are depicted: the Cochineal Dye of the red curtain reflected on the mirror (Hamann, 2010). The products from the New World are superior to the local products at the time. Compared to the local products, the cochineal pigment from South America is more potent and stable (Hamann, 2010). Therefore, the Spanish well-to-do homes favor the products from the New World over the local products. They collect these luxuries in households to demonstrate their wealth and power (Hamann, 2010). In these collections, as shown by the depiction of Velázquez, the foreign products are mixed with the domestic products without any distinctive boundaries. This indicates the open, embracing attitude of the Spanish society towards various cultures of heterogenized origin: the society form an integrated vision of cross-space cultures around the world, and even value some of the foreign artifacts over local handicrafts.

The composition of the dye in the painting suggests the significance of the exotic luxuries in the context of the painting, Velázquez's personal life, and colonial relationships. Interestingly, in *Las Meninas*, the exotic product of dye is at the center of the painting. There are three ways this emphasis could be interpreted: as a mockery of the decline of the Empire, a heightening of the artist's personal honor, and a reflection on the indigenous artifacts as they relate to Velázquez's own art.

Firstly, by drawing attention to the luxuries at the court, Velázquez could have mocked the economic difficulties in society. Even though the royal family insisted on displaying these exotic products to boast their wealth, they faced a major financial crisis: they could not purchase enough food and firewood for their basic living needs and were unable to offer salary payments to laborers for years. Velázquez himself had not been appropriately paid and may have been discontent (Hamann, 2010). This economic crisis stemmed from the empire's trades with the colonies. The gold and silver from the colonies transported to Spanish ports were eventually distributed among other European countries rather than Spain, causing the Spanish economy to shrink and the royal family to go bankrupt (Hamann, 2010). Therefore, by juxtaposing the luxurious affluence in the painting with the deteriorating economic stagnation in reality, Velázquez satirizes the superficiality of the affluence and glory, while implying concerns for the menacing financial shortage that undermines the strength and influence of the empire at the time. Admittedly, as the audience for the painting is the court, Velázquez might not risk destroying his reputation by alluding to the faults of the King in managing the Empire, especially when he was striving for honor to become a Knight at the time the painting was completed (Pereda, 2010). However, a very implicit, nuanced form of subtle satire may help him to escape inspection of the court, while allowing him to vent to his critical thoughts over the decline of the Empire. As a very experienced, sophisticated courtier, Velázquez may have simultaneously to flatter his patron and spoken some truths at the same time.

In his craving for higher honor, Velázquez may have highlighted the importance of the exotic artifacts in the painting to enhance his personal dignity. The exotic artifacts imported into Spain and Europe passed through the southern port of Seville, where Velázquez's ancestors lived (Hamann, 2010). By emphasizing the central position of these imported goods from Seville in the royal households, Velázquez implicitly underscores the supremacy of his Sevillian past and his genealogical background. The emphasis of his honorable background could have been especially crucial for him at the time, as he was seeking membership as a knight in the Order of Santiago, a group that generally despises painters who paint for a living (Hamann, 2010). Velázquez therefore must stress his dignified social status in other terms to win the respect of the Order and be accepted as a member. To sum up, the central position of the exotic products from the New World, if proved to be a deliberate

composition devised by Velázquez, could have implied Velázquez's anticipation for his personal glory at the same time.

Moreover, there are similarities between indigenous craftsmen and the royal painter Velázquez himself. First off, their careers were both inside the artistic and cultural sphere: they processed raw materials obtained from the earth to create sophisticated artwork through ingenuity and effort. Furthermore, these indigenous artworks were renowned luxuries collected by the royal family. Velázquez himself was a talented artist appointed by the royal family, thus enjoying the same level of fame and appreciation as the exotic luxuries in the Spanish empire. Yet, despite the resonance between the art of Velázquez and the indigenous artifacts, there are still gaps between court painters and the indigenous craftsmen according to the Eurocentric views in Spanish society at the time. Therefore, Velázquez shows the dominance of his medium by incorporating and visualizing them in the background of the painting. The art of painting includes different textiles and forms of art as the most powerful media of art. Velázquez takes advantage of this claim to justify his dignity as an artist and his superiority over traditional craftsmen (Mignolo, 2010), which may simultaneously boost his social status and make him an honorable member of the Order. In conclusion, the comparisons by Velázquez in this piece to new world art shows his exploration and self-comparison to indigenous arts.

To conclude, in the painting *Las Meninas*, through the use of mirror, Velázquez depicts his perception of both the Spanish and the global society. He constructs the local social structure based on the diversified characters and the interactions and hierarchies among them. Moreover, he illustrates the colonial states and the international world that are in contact with the Spanish Empire as well, but through the lens of the imported artifacts this time. Therefore, using the mirror, Velázquez demonstrates his perception of the complex social stratification in *Las Meninas*, which is one innovative aspect of the painting.

Part II: Illusion of Realism in *Las Meninas*

Another innovative aspect of *Las Meninas* is in the construction of the illusion of realism to engage the audience who appreciate the painting. This revolutionary step was specifically taken by Velázquez in the Baroque era, which was an age of crisis in

art. Before the Baroque era, arts were only created for religious reasons. The Pope and the Cardinals commissioned artworks on the theme of the Biblical scenes and stories, which were painted inside of the churches for the pilgrims to pray to. At that time, artists communicated with the pilgrims through a pre-established system of symbolic languages. Each symbol created by the artist had one fixed meaning according to the Bible, and there was no possibility for any other explanation to discuss among the audience. The artist had a dictated explanation for his own work, while the audience, who are only allowed to worship the painted religious figures, found no freedom in personally interpreting the meanings of the paintings.

However, at the start of the Baroque era was the Reformation of Martin Luther. Religion lost its supreme authority among the public. There were less demands of public worship in Churches. However, the formerly rigid, inflexible communication between artists and audiences only applied to public worship. Thus, it was gradually eliminated at the time. Artists in the new era needed to find a novel form of communication between themselves and their audience. Their solution was to offer the audience greater freedom in the interpretation of the artworks. There were less absolute truths or definite references in their paintings. Instead, there was a new sense of ambiguity. The artists left space for the audience to fill in with their own thoughts, so that the audience could also become part of the art creation. Velázquez, with his curious nature, enjoyed inviting the audience to engage in his painting and experimenting with this unprecedented form of communication in art.

Velázquez uses the mirror to engage the audiences in *Las Meninas*, manipulating their disillusions.

To play with the deceptiveness of vision and the imagination of minds, Velázquez takes advantage of the mirror reflections in *Las Meninas*, as mentioned in Part I. In *Las Meninas*, the mirror causes a split interpretation amongst the audience, who stare at the crowd in the same position as the King and Queen. At first glance, some viewers imagine that the reflections belong to the King and Queen who have just entered the room and stand straight in front of the mirror. However, a closer analysis of the King and Queen's position suggests that the reflection on the mirror is from the image of the King and Queen on Velázquez's canvas. Therefore, by playfully tricking and challenging the audiences' vision utilizing

mirrors, Velázquez implies that people's subjective imaginations may be inconsistent with the objective phenomena, raising a sense of doubt and aspiring critical thinking.

Moreover, the two interpretations of the figures reflected could be seen as a sign of Velázquez's playfulness. During the Renaissance, art has been redefined as a category of science. Renaissance artists are obsessed with applying scientific rules to their paintings, boasting their high intellect and their nuanced understandings of the natural laws. One of their major interests is perspectives (Ackerman, 1989). During the Renaissance, Mantegna excitedly experimented with the most unorthodox and difficult perspective to paint Christ (Clark, 1958); Uccello overly exercised perspectives and foreshortening to exaggeratedly deepen the space that the war-horses dwell in (Pudelko, 1934). Similarly, Velázquez complicates his own art with the mirror and messes with the audience for fun and thrills. Velázquez's experiment with the mirror inside the painting is an extension to the Renaissance artists' experiment with perspectives, as it adds an extra dimension of space and thus the law of reflection into the painting. Velázquez inherits the Renaissance spirit of exploration and develops the Renaissance resolution of challenging oneself in unknown fields.

To conclude, in a revolutionary approach, Velázquez interacts with the audiences through the painting *Las Meninas*. He misled the audience's visions with the use of mirror. Velázquez proves himself as a creative, daring master who abandons the communicational means of the traditional painting and establishes more freedom and choices among his audience in the new era.

CONCLUSION

Diego Velázquez proves his blooming artistic creativity in his painting *Las Meninas*. He manifests two specific intentions in the painting: Firstly, he constructs a social commentary on both Spanish and global social relationships and hierarchy. Secondly, he creates an illusion of realism to communicate with his audience. These messages were unprecedented, distinguishing the artist and their artwork from predecessors and ushering in a new age in the world of arts.

With this contribution, a new world of arts opened. Numerous artists built on Velázquez's devotion to social phenomena and his curiosity to realism and illusions. Impressionists (Saunders, 2008) and realists (Kiaer, 2014) are prompted by populations, social relationships, and modern revolutions. These artists are enlightened by the curiosity to examine different social classes, devoted to paint the daily life of the common class in plain settings rather than solely focusing on the aristocrats. Cubists (Leighten, 1988) and Surrealists (Hobbs, 1985) clung to Velázquez's obsessions with various deceptiveness of vision, perspectives, and other splendid visual effects. They strive to shock and engage the audience with surprising representations of ordinary objects. Overall, inspiring generations of artists after him, the great Baroque art master Velázquez potentially brought his novel perceptions and pursuits into the art world throughout the following centuries.

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The Effects of Cultural Values on the Subjective Well-being of Asian American College Students

By Siqi Li

AUTHOR BIO

Currently a high school senior at Gulliver Prep in Florida, Siqi Li was born in Qingdao, China. Their primary academic interests are social sciences, including psychology, sociology, and anthropology. At school, Siqi is club co-president for their school's queer-straight alliance, PRISM, and communication officer for the National Art Honor Society (Gulliver Prep chapter). Besides academics, they are passionate about visual art, having earned multiple honorable mentions and one Gold Key in the regional Scholastic Art and Writing Awards.

ABSTRACT

This literature review studies culture's impact on subjective well-being, specifically Asian American cultural values on Asian American college students. Culture, as multifaceted as it is, would have nuanced implications regarding well-being. As empirical research has shown, one's culture has a persistent impact on an individual regardless of immigrant status or geographical location. A cross-cultural survey previously conducted in this field also reveals that cultural differences directly impact the understanding of subjective well-being and related concepts. One of the fastest growing immigrant groups, "Asian American" is an umbrella term for many different ethnicities, however, there are some values commonly associated with them in general. Collectivism and the prioritization of success are two values this literature review focuses on. Contrary to individualism, which is more common in western cultures and societies, collectivism prioritizes the greater community rather than the individual. The prioritization of success is also more present within Asian American communities. The review concludes that both values have their own benefits and drawbacks to Asian American college students' subjective well-being.

Keywords: Asian American, subjective well-being, culture, college students, cultural values, mental health, psychology, research review

INTRODUCTION

Asian Americans are one of the fastest-growing ethnic groups in the US. The wave of immigration in the past half-century has dramatically increased the Asian population, with people tracing back to many different countries and ethnicities (Pew Research Center, 2012). Though the Asian diaspora in the US has many different ethnicities and cultural identities, with sizable differences, Asian Americans are distinct as an entirety compared to other racial groups in the country. Asian Americans share common cultural values that are less prevalent or present in other communities.

Cultural backgrounds greatly influence one's perception of happiness. Different cultural backgrounds and languages lead to varying interpretations of the same concepts, including but not limited to subjective well-being (SWB), optimism, and life satisfaction (Biede, et al., 2017). Another study aimed to find the durability of one's culture on subjective well-being (SWB). Its findings suggest that the power of culture over feelings of well-being can persist for generations and travel along with the people (Rice & Steele, 2004). One's cultural values can be a significant factor in determining subjective well-being (SWB), regardless of the individual's status as an immigrant.

To determine the cultural values that should be examined in this research review, both Asian American shared values, as well as Asian cultural values, are researched. Some values more commonly shared by Asian Americans than others include career/material success and expectations of marriage and parenthood. In a survey conducted in 2012, "Asian Americans place the highest priority on being a good parent. About two-thirds (67%) say this is "one of the most important things" in their lives, and an additional 27% say this is "very important but not one of the most important things." Only 5% say being a good parent is "somewhat important" or "not important" to them personally. A similarly worded question was asked of the general public in a 2010 Pew Research survey. The public also ranked being a good parent the top priority. However, a smaller share (50%) said this was one of the most important things in their lives. An additional 44% of American adults said being a good parent was very important to them but not the most important thing"; the same survey reveals "...27% of U.S. Asians say being successful in a high-paying career is one of the most important things in their lives. Four-in-ten

(39%) say this is very important but not one of the most important things. Some 27% say career success is somewhat important to them, and 6% say it is not important ... [a]mong all U.S. adults, only 9% say being successful in a high-paying career or profession is one of the most important things in their lives (Pew Research Center, 2012). Similarly, some frequently cited Asian values include educational achievement, being family-oriented, and filial piety (Carteret, 2010; Henders, 2017).

This research review will focus on collectivism (being family-oriented, expectation of marriage and parenthood, et cetera) and personal success (material, financial, and educational success/achievements). The role of parental expectations will be discussed. It is important to mention that the approach to defining cultural values will be more broad and more general here. There are many different ethnicities and cultures under the Asian American umbrella identity, with each individual community differing socio-culturally, being more general with concepts and values allows this research review to not falsely generalize all Asian Americans.

This research review primarily focuses on college students for a few reasons. First, it is unrealistic to review the data of the entire Asian American population, as the first Asian immigrating to America dates to the mid-1800s, making the population too big and making reviewing the effects of acculturation and assimilation difficult (History.com Editors). Secondly, reviewing data from the college student demographic can still cover a significant portion of the Asian American population, as most Asian Americans have been living in America for two or fewer generations (Kim, Ng, & Ahn, 2005). Thirdly, it is assumed that Asian American college students, the majority of whom grew up in Asian households, will be raised with Asian cultural values. Thus, will ensure the subjects are still influenced by Asian cultural values. Lastly, focusing on this demographic allows the research review to consider parental expectations. Collectivism and the emphasis on success are multi-faceted cultural values, and the Asian American college minority experience may add to that nuanced implications, making it important to consider both the positive and negative impacts on well-being.

Collectivism

As opposed to the common western individualism, collectivism teaches people to prioritize groups and communities before the individual. The first research is done by Tom W. Rice and Brent J. Steele. Their 2004 research aimed to find the durability of cultural influence on subjective well-being. Their research compares the “subjective well-being of citizens in 20 nations with the subjective well-being of Americans who claim to have ancestors from these countries” (Rice & Steele, 2004). This study’s result suggests that culture has a tenacious effect on the well-being of generations of individuals. To quote directly, “[They] find that the relative rankings of subjective well-being among citizens in 20 contemporary nations and among Americans with ancestors from those nations are very similar, a result implying that the aspects of culture that influence well-being have been transmitted from people who lived in these nations centuries ago to their contemporary descendants in the homeland and in America” (Rice & Steele, 2004).

The second research referenced is by Julia K. Boehm, Sonja Lyubomirsky, and Kennon M. Sheldon. Published in 2015, the paper aims to compare the effectiveness of happiness-enhancing strategies in Anglo Americans and Asian Americans. The happiness-enhancing strategies are directly derived from collectivist vs. individualistic cultures, one dominant in Asian cultures and the other dominant in Western cultures. Their results show that individualistic culture’s emphasis on pursuing personal happiness, self-improvement, and personal agency, would encourage its members to enhance their well-being. In comparison, members of collectivist cultures are less likely to do that, as their culture does not prioritize personal happiness and individual goals as much. Their findings also suggest that “cultural background [...] impacted participants’ “will” to exert effort into enhancing well-being”, and people need both a “will” and a “way” to pursue happiness successfully.

Many aspects differentiate collectivist cultures and individualistic cultures. For example, the expected relationship dynamic between individuals. In collectivist societies, harmony and cooperation matter in day-to-day interactions, and it is expected for individuals to build stable relationships and form families. This speaks to creating your individual family unit, while still maintaining a close connection to relatives and of course, your parents, all while

keeping these relationships stable and harmonious. Thus, the satisfaction of family and friends is considered a priority in collectivist cultures. This also leads to what type of personalities are more valued in each culture. An individualistic culture that focuses more on the individual may value more individual uniqueness and other agentic aspects of personality; a collectivist culture, prioritizing harmony in communities, may value personalities like agreeability, being accommodating, cooperative, and trusting (Proctor, 2020), and perhaps even selflessness. This can contribute to happiness in different ways. In one way, adherence to this idea can foster positive relationships, assuming that adherence to this would lead to an individual wanting to put in more effort in building supporting and stable relationships. The creation of positive relationships can consequently lead to creating social support for the individual, improving their SWB by creating a coping mechanism to potential stress. However, being over-compensating and perfectionist in relationships can create additional pressure in everyday interactions, leading to perhaps unnecessary self-consciousness and additional stress. The lack of adherence to this concept can be positive and negative as well. On one hand, this may lead the individual to cherish their uniqueness which is more celebrated in individualist cultures, possibly increasing self-esteem; on the other hand, pursuing a more individualistic lifestyle can receive backlash from family, who expected said individual to adhere to collectivism. Again, referencing Boehm, et. al (2011), “in accordance with [their] hypotheses, Asian Americans seemed to benefit marginally more from conveying gratitude to people in their lives rather than expressing optimism about their personal futures”, meaning that caring about their community/family by expressing gratitude can lead to positive mental health effects (Boehm, Lyubomirsky, & Sheldon, 2011).

Aside from different levels of expectations of connectedness between individuals and the different aspects of personalities being valued, individualist and collectivist cultures also prioritize happiness differently. Because of their individualist culture, European Americans may seek out personal happiness more, as well as be more comfortable with personal happiness; however, because of collectivist teaching, Asian Americans may feel personal happiness as something selfish, especially if it doesn’t extend to their community/family (Proctor, 2020). This presumed guilt may be emboldened if the individual is straying away from this idea, but their family/friends/ close social circle is not.

Pursuit of success

Another common theme regarding cultural values is the importance of success. According to Hannah R. Proctor's 2020 paper, "Asian Americans have the highest level of education and income compared to other ethnic groups in America, yet they tend to have lower levels of well-being." In this section, the idea of individuals needing a "will" to pursue personal happiness is still relevant. As mentioned in the introduction, Asian Americans prioritize career success more than others. Furthermore, according to research published in 2009, "more Asians (41%) than whites (9%) prioritized prestige over happiness, while more white students (67%) than Asian American students (28%) deemed happiness as paramount in selecting a college" (Dundes, Cho & Kwak, 2009). The emphasis on academic achievement could be a strategy to overcome racial discrimination and a way to be socially mobile. In a study conducted by Furr, Westefeld, McConnell, and Jenkins in 2001, university students often cite academic stress as a leading cause of depression, anxiety, and suicidal ideation.

As most sources cite that Asian Americans prioritize academic and subsequent career success, it may be a valid conclusion that there would be significant pressure from parents. This pressure can be the driving force for academic excellence, as most Asian Americans tend to have higher levels of education and income than other minorities; however, they also tend to have lower levels of SWB. So even though success academically can be a way to social mobility, it can cause stress and poor mental health for college students. To add, there is a stigma in seeking mental health support and mental illness in general, as it is not only considered an individual struggle, but rather something that shines a negative light on their direct family (Han & Pong, 2015). Hence, the combination of high stress with low mental health support can produce low SWB in Asian American college students.

To conclude, the two factors being discussed each have their own benefits and drawbacks to mental health. Collectivism may encourage individuals to create positive and supportive relationships, but the culture itself does not quite prioritize personal happiness. Subsequently, an individual may not want to pursue personal happiness. The emphasis on career/academic success is a double-edged sword as well, it can be a tool to survive in America as a racial minority,

but it is important to note that excessive pressure to succeed from parents can cause poor mental health and low SWB.

It is also important to note that many other factors may contribute to SWB for Asian Americans. For example, acculturation discrepancy and a general conflict of values/worldview are experienced by immigrants and can negatively affect mental health but is out of the scope of this paper. Another factor to consider is racial prejudice in America and its pressure on individuals. Moreover, something unique for Asian Americans and not present for Asians is the model minority myth, which would also be significant in the study of SWB for this demographic.

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Lake Turkana's Forsaken Fishery: The Recurring Failures of Foreign Aid

By Fenya Lyn Walter

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ABSTRACT

In the face of continuing development challenges in the world's poorest countries, there have been new calls to increase the volume of development aid. Yet equal attention is needed to reform the aid business itself, that is, the practices and processes, procedures, and politics of aid. This paper sets out the shortcomings of the foreign aid industry and addresses the widespread conceptual and empirical literature that suggests that foreign assistance is ineffective. It outlines the four most commonly quoted reasons for project failure, including collusion and coordination failures resulting from wrongful incentives on donor and local governments; unknowledgeable recipient nations; and the failure to evaluate the projects' long-term results. This paper then uses NORAD's attempt to establish a frozen fish industry around Lake Turkana, Kenya, as a case study to find clarity on why its shortcomings came to be and eventually suggests a possible practical fix to the system.

Keywords: Development aid, Lake Turkana, information, incentives, project, NORAD

INTRODUCTION

“If you give a man a fish, he will be hungry tomorrow. If you teach a man to fish, he will be richer forever.” (Chinese proverb)

That was the motto of the Norwegian government when they landed in Kenya, intending to provide a solution to the cycles of drought that had been exhausting the northern region for centuries. Yet, 50 years later, all that is still visible of the 23 million USD regional development project are the ruins of a processing and freezing facility once called the Kalokol Fish Factory. Now coined the “desert cathedral,” it stands forlorn and vandalized along Lake Turkana’s bank.

In 1971, the Norwegian Agency for Development (Norad) arrived in Karakol, a town nestled on the western shore of Lake Turkana, the largest permanent desert lake in the world. Well-meaning, big-spending foreign donors had come to act as saviors to a pastoral tribe of some 200,000 tall, graceful people. The tribe had been living in the arid and harsh environment on the verge of famine and starvation—a problem rendered more acute by advances in medical and health care which increased longevity and expanded the Turkana population beyond the area’s agricultural and livestock carrying capacity. The plan was to build a foreign-funded frozen-fish plant and irrigation scheme that would ship out fish produce to nearby cities and was supposed to catapult Turkana out of a drought-stricken wasteland and into a commercially viable venture.

Fishery development on the Lake had previously been funded by the Kenya Government Fisheries Department, which started in 1961 as part of the famine relief and rehabilitation measures. It was a means of assisting drought-stricken and destitute Turkana to a new and less vulnerable way of life, while at the same time helping to relieve some of the excessive pressure on traditional grazing grounds. In 1967, NORAD’s joined in on the effort, and in 1971 the Lake Turkana fishermen’s co-operative society (TFCS) was established.

For almost 20 years, NORAD provided more than 1.6 million USD of aid to establishing the Kalokol ice-making, freezing, and cold storage plant, including the complex of buildings, offices, and workshops. The transformation from subsistence fishing to the production of fish for an external market

required changes in technology and the internal organization of production. Spears, hooks, and plunge baskets, usually operated individually, gave way to nets, lines, and boats that required a more collective organization. In addition to the supply of modern equipment, which enabled producers to specialize in fishing as a permanent occupation, an external market system offered channels for distribution was established. To ensure a minimum price to producers and help the co-operative to obtain the necessary volume of fish to cover operation costs, the TFCS was even granted a marketing monopoly in 1973 for all fish landed on the western shore – a legal act which was later reinforced in 1977. However, despite this level of assistance, the processing plant was closed within days of production.

Trends of botched foreign aid missions—where “savior” Western nations in an attempt to “better the lives” of the locals in almost every rural community, have only further trapped regions in a cycle of corruption, poverty, and slower economic growth—have left Sub-Saharan Africa a graveyard of numerous development projects.

This paper will explore potential explanations as to why specific foreign aid projects continuously fail to meet their intended purposes, shedding light on how past projects aimed at economic development failed. These observations can then be extended to explain why we should not expect foreign aid to achieve economic development in the present unless adequately reformed. The analysis within this paper will take a twofold approach: My framework includes arguments that rely on evaluating the incompetence of donors and disparities in incentives as the primary attributes to the abysmal failure that is the foreign aid situation on the continent. As foreign aid policies are heavily influenced by public choice theory, they, in turn, alter the incentives for both governments and citizens within these countries. I thus explore in-depth how such neglectful incentives in donor countries, aid agencies, and recipient countries shape the outcome of foreign aid, yet ultimately are not held accountable as evaluation, and proper checks and balances are scarce. Secondly, the paper focuses on a specific example of an instance of the Lake Turkana Fish Processing Plants and how the lack of information and knowledge about the situation led to its unfortunate demise.

Incentives: public choice theory

When discussing motives behind foreign aid, in many cases, it is presumed that individuals act out of altruism and in the best interests of the developing nations they are helping. One of the world's leading experts on sustainable development and vocal advocate for foreign aid, Jeffrey Sachs (2005), famously relies on an underlying principle called the public interest theory. This concept is commonly used in debates in favor of foreign policy and is built on the assumption that actors prioritize maximizing beneficiary nations' wellbeings. Implying that agencies involved with dispersing foreign aid will always take the most effective means in achieving the stated ends. However, this line of reasoning takes for granted the fact that donor countries and aid agencies are unbiased in their initial decision to donate to a specific country and aggrandizes the presumption that recipient governments accomplish their required tasks and effectively allocate foreign aid. Public choice insights call these assumptions into question, by taking the same principles that economists use to analyze people's actions in the marketplace and applying them to people's actions in collective decision-making. Customarily, economists conclude that although most people base some of their actions on their concern for others, the dominant motive in people's actions is a concern for themselves (Shaw, 2013).

This prioritization of personal interests becomes particularly problematic when considering that the decision-making process surrounding aid disbursement is burdened with countless different stakeholders, special interests, and profit-seeking activities. Claudia Williamson is an Associate Professor of Economics and the University of Mississippi, and in her 2009 paper "Exploring the failure of foreign aid: The role of incentives and information," she concludes that even in regards to supposedly selfless projects, politicians within donor governments are to a large extent, restrained by domestic special interests. Public choice means that all donor governments, holding an obligation to serve their people, prioritize their own political, military, and commercial interests influenced by their citizens. In "Foreign Aid and Foreign Policy: An Implementation Process," Sukhwant S Bindra argues that countries primarily use aid for "politico-strategic reasons." They give the example of the United States purposely providing aid to particular eastern developing countries during the cold war. What this tendency entails, is recipient nations being

selected primarily to be able to eventually benefit donor nations either financially or politically. China, for example, with the world's second-largest economy, can engage in substantial development assistance programs and government investment in any emerging market countries. Yet the nation selectively chooses to support the expansion of port facilities in East Africa to meet its growing demand for fossil fuels and ferrous and nonferrous metals or uniquely supports Taiwan's past allies in an attempt to have the upper hand in the never-ending chase to claim the island. Point is, that those nations will attempt to support precisely the countries willing to participate in a mutually beneficial "financial friendship", leaving more precedence to perform an act of foreign aid for the sake of showing diplomatic ally-ship, rather than producing tangible long-term benefits for the local people.

Precarious motives are especially harmful in this case because they give little incentive for donor countries to fully commit to carrying out and guaranteeing the success of their financial aid projects. Financial aid given by the donors does not go directly to the individual or families who are struggling for their existence, but instead have to be placed into the hands of authority figures in these developing nations, who are expected to do their role in distributing the aid. Unfortunately, recipient nations often tend to have high levels of corruption within the government bureaucracy, whose members, now given large sums of money, have no actual obligation or incentive to spend it on the intended purpose. Moreover, individual voters not only lack proper access to become further informed about specifics in foreign aid policy and remain rationally ignorant but also are often partaking in illegitimate democracies where their votes hold little leverage over their leaders. Meaning little to no form of checks and balances are present to hold these governments truly accountable beyond the performative facade of having done a good deed. Instead, this aid is placed in the hands of government officials who—being in countries with comparatively less established democratic election systems—have less pressure to appease the population. Instead, they may have priorities, such as satisfying personal and group interests: from giant industrial projects of questionable efficiency to accumulating private fortunes or buying many luxurious assets. The inclination to prioritize personal gain means politicians in both countries primarily seek to pursue their agenda in the disbursement and allocation of foreign aid rather than the most utilitarian. Or, like in Ethiopia's 2010 elections, when Prime Minister Meles Zenawi

reportedly “withheld the distribution of foreign aid, including agricultural supplies and food, from families that failed to vote for his party” (Zablonski, 2014, p.2).

The public choice model applied to foreign aid shows that those involved in the process of foreign aid, both giving and receiving, often fail to facilitate the coordination and cooperation necessary to achieve effective development. The credibility of future aid depends on the ability of the aid system to demonstrate that it can address corruption proactively and comprehensively.

Uninformed Donors

A key factor to the effective implementation of foreign aid is the requirement of adequate local knowledge of the situation. For funds to be properly utilized, donors must recognize that aid is needed, figure out exactly what is needed, who needs it, and evaluate whether or not what they are doing is working. This involves some form of evaluation and feedback to identify problems, then somehow, through the extensive bureaucratic process to try and solve these knowledge problems.

One of the larger obstacles in tapping into this necessary information is the governments and other bureaucratic agencies managing donor organizations. Certain government agencies are created to oversee foreign aid disbursement, which answer to other aid agencies, such as the World Bank, which also with its internal bureaucracies. Hence, we see layers upon layers of individual groups with specific duties, with no entity holding a truly holistic outlook on the situation and evaluating whether the right decisions are being made. These layers upon layers of bureaucracy are a necessary and inevitable outcome of government-controlled activities to maintain a clear flow of authority, however, these conditions are unfavorable in foreign aid.

Unlike private firms, which only have to tell managers to maximize profits, the system of profits and losses is more ambiguous in the context of foreign aid, as no longer is there a numerical amount that can act as a benchmark as to how well a manager is contributing to the firm’s goal. Government agencies are not created to seek or make profits, nor do they use a system of profits and losses to guide activities. With the absence of a single goal for managers to live by, it is therefore difficult to ensure that managers in government contribute to the overall goal of the

agency. Hence, some other guide must be employed. This political mechanism is bureaucracy. Detailed procedures and protocols replace the profit objective to guide and check managers’ behaviors, delaying genuine progress and initiatives and are more susceptible to human error. Foreign aid is approved by voters of rich country A, whose aid bureaucracy gives money to the government of poor country B, who are then expected to give the money to the poor people in country B. However, the poor people in country B have little voice in their own government, and the rich country A has little incentive to listen to the poor people from country B who do not vote or form a pressure group in country A. Not to mention, bureaucracies face their own set of incentives, fueling a perverse environment in which aid agencies operate, further hindering their abilities to succeed. These perverse incentives result in negligible feedback from beneficiaries, hard-to-observe outcomes, and the low probability that bureaucratic efforts translate into favorable outcomes. To respond to these incentives, aid bureaucracies organized themselves on what William Easterly called “a cartel of good intentions,” suppressing critical feedback and learning from the past, suppressing competitive pressure to deliver results, and suppressing identification of the best channel of resources for different objectives” (Easterly 2003, p. 34).

The reason behind many failed development interventions is the tendency for implementors to prescribe solutions to pastoralists’ problems without involving the recipients they intend to serve. Minimal effort is made to survey and brainstorm with their target groups, within their traditional setting. For instance, fingers were pointed at the Turkana for refusing to bring fresh fish to the fish freezing plant complex at Kalokol fisheries. However, the inhabitants around lake Turkana were pastoral people who traditionally survived by raising cattle, goats, and camels. Turkana locals who fished commercially are perceived as poor, for they usually only do so out of necessity from either having lost their livestock in drought or being unable to afford cattle. Therefore, fishing was considered sort of a derogatory vocation. The underlying cause of pastoralists’ isolation from the development projects is that development agents never bothered to talk to the intended beneficiaries about the interventions they were introducing. After the plant was built, it was discovered that freezing fish in the daily 100-degree temperatures would take more electricity than was available in the entire Turkana district. Turkana’s remoteness, cut off from

the rest of Kenya by poor roads, few telephones, and little electricity, made it a difficult place to sustain a fishing business. This lack of discussion is the greatest weakness among development agents, who do not accept the need to change their approach, but continue to hurl abuse against “these backward pastoralists who are unwilling to welcome change.”

Unknowledgeable Recipients

Once that funds make it past the barriers of entry and into the hands of a regional government willing to spend it on its people, for aid to be effective and properly utilized, donors must have gathered critical information on the regions and its people so that changes are lasting and permanent. Recipients must also possess adequate knowledge about how to achieve these specific goals outlined by foreign aid. Yet, between 1967 and 1981, three out of five World Bank live-stock projects used no anthropological research during the life of the projects (Gerhart and Harden, 1991).

Even if, in the best case, there is benevolence on part of recipient governments, one must recognize that they may not possess the necessary information to achieve tangible results. Recipient governments, like donors, cannot tap into the knowledge critical for success. Individual citizens within these countries hold local knowledge and are more likely to know what is needed, yet are often unaware that aid is available, how to get it, or even how to adapt to new forms of industry the donor nations are trying to build. With foreign aid in hand, these poor, mismanaged governments of developing nations have the burden of figuring out who is in need, what is needed, and how the money can be appropriately allocated to help them. Easterly explains the problem with this system in a simple analogy: “Consider the process that a poor person in Tanzania must go through to get a road repaired. The Tanzanian informs a civil society representative, who informs government officials in Tanzania. These officials ask for help from aid donors by asking for a loan. To get a loan, the government must satisfactorily complete the necessary paperwork. Next, the donor agency handles the paperwork internally, which involves several detailed steps that ultimately end with officials developing a plan that may or may not finance the road repair. Suppose the donor agency approves aid for the road. In that case, the money must pass through the Tanzanian national government, provincial governments, and district governments at which the district government decides

whether or not to repair the road “(Easterly, 2002, p.2). Even when individuals know what they need, relaying the essential information to aid agencies involves many costly steps that may not guarantee that the information gets delivered. This lack of essential knowledge can significantly hinder the success of foreign aid. To effectively initiate positive change, not only do donor agencies need to figure out what is truly needed by the local people, but recipient governments need to be held accountable for taking responsible actions towards using the aid to meet those needs.

Evaluation

Because of how especially ineffective central planning is, in the rare circumstance a project is set in place, evaluation and monitoring are even more important to guarantee it stays and fulfills its purpose. Presently, evaluation has been reduced to merely taking a snapshot of outcomes at the end of a development project or program to prove to aid donors whether it succeeded or failed. However, the evaluation ought to be seen as a long-term management process and tool for enhancing the effectiveness of projects through continuous learning and decision-making based on sound knowledge of past and present similar projects. A periodic evaluation process can produce timely information from an intervention project to determine whether the project is running smoothly as planned, and the extent to which it achieves the intended objectives and anticipated results. In most projects and programs funded through official development assistance in Sub-Saharan Africa, like in many other regions, there is a lack of enough baseline information making it difficult to attribute program success or failure to the programs that influence their effectiveness (Birdsall, 2008). It is difficult enough for a foreign aid agency to observe another nation’s well-being from across the ocean continuously. But even more for aid bureaucracies to get constructive feedback from past mistakes, as any admission of past failure may threaten to get new aid resources to dispense in the future.

Nancy Birdsall argues that some official and private agencies that develop and manage development assistance programs hesitate to publicize the limits of their craft. These agencies are worried about being subjected to political criticism and limiting new resources for aid programs that transparent evaluation might trigger. Another challenge is the immensely expensive nature of such an evaluation process, which further discourages donors from funding it. Some

aid-funded projects are huge and complex, carrying out a comprehensive and participatory evaluation process that will attract a huge amount of aid money. Combined with the potential of concluding the aid efforts were unsuccessful in bringing positive change, which may question the legitimacy of the organizations, risking the loss of donor support, operators commonly choose not to entertain the idea. The high costs involved, mean donors rather stay in denial and prioritize short-term achievements rather than urging long-term, permeant changes. Hence, though the donors have financed billions of Dollars worth of projects, few have built into them the ingredients for actual systematic evaluation. As a result, this has drastically reduced the effectiveness of aid money on the living standards of poor people in developing countries. The lack of emphasis on good evaluation has created a toxic cycle of oblivion. As a result of the absence of a timely, credible, and independent evaluation, many aid Dollars have only been continuously misdirected, repeating the same mistakes. Many factors have caused foreign aid failures, but there is a consensus among experts that poor decision-making when choosing an intervention program is a significant contributor to aid money ineffectiveness. Donors lack good information that can help them identify programs that are working as intended, those that are no longer needed, and those that are not accomplishing the desired objectives.

Negligent planning and care mean ridiculously minuscule and obvious mistakes that can lead to the project's downfall. When NORAD set out to teach the poverty-stricken Turkana people how to fish and exploit the lake's fish stocks to bring in hard cash, the project's principal objectives were to develop the fisheries to improve the living conditions and raise the incomes and welfare of the Turkana fishing communities. All while securing a balanced utilization and conservation of the Lake's fish resources. Previously, there was little fishing in the lake. The few fishers in the lake mainly used artisanal craft, which was unsuitable for navigating the sections of the lake's open water which suffered from strong diurnal wind patterns. Even then, the fish harvested suffered high post-harvest losses due to a lack of hygiene and sanitation facilities for its handling. The bulk of what remained was dried under dusty conditions, resulting in a five-fold loss in market value. This only further exacerbated poverty among Lake Turkana fishers and further diminished their status within the pastoral community. The Turkana people, unlike other Nilotic peoples in the horn of Africa, are semi-nomadic

pastoralists who live off their herds and do not fish. Fishing is a sign of being poor, done most likely out of necessity due to a herd dying from drought rather than it being the most commercially rewarding. This cultural clash was especially challenging when outsiders with fishing expertise needed to be brought into the region. Inviting experienced fishermen from other regions sparked much hostility, as nomadic tribes within the volatile region often clashed on territory and resources. NOMAD could not bring in the Luo tribe from Western Kenya, even though it was more commercially beneficial, as it would have likely caused conflict and an already skeptical Turkana people to stop cooperating. Failure to understand these cultural habits was the first mistake made by foreign donors.

The decision not to directly consult with the Turkana people was detrimental. There was hardly any research or management activities around the lake in the first place, mainly because the few Government staff around the fishery lacked the necessary capacity (resources, equipment, personnel) to undertake their duties which led to many odd inconsistencies in implementation. For example, the mission endorsed earlier recommendations that the technology levels employed should be to avoid capital-intensive developments in favor of labor-intensive approaches, in areas like non-mechanized fishing boats and simple fishing methods. However, an exception was made for the ice-making, freezing, and cold storage complex. Norwegian consultants and others repeatedly stressed the need to avoid capital-intensive development of the Lake Turkana fishery, in favor of more labor-intensive approaches to maximize employment and spread the project benefits as widely as possible. This was proven to be the correct approach. In most cases, the levels of technology employed, in the form of unmechanized boats and simple fishing techniques, were appropriate for both project objectives and the peoples' needs. The high import content and cost of fiberglass boats and problems with their repair and maintenance led to a decision to test cheaper wooden alternatives for durability and suitability to local conditions. Equivalent considerations should have been made in establishing the processing plant. This exact exception, closed down the entire project after just a few days because it could not continue functioning beyond that point. The factory ran on generators, as Turkana's remoteness, and the absence of an electricity grid, telephone lines, and functioning roads made it an unfit place to sustain such a large, demanding factory. The costs of keeping the freezers functioning overnight

became more than the revenue from actually selling the fish, and as a result, the entire project had to be dropped.

CONCLUSION

An evaluation of the long list of failed foreign aid projects in the past decades yields the repetitive trends of incompetence and the inability of the central planning-like style of foreign aid to overcome the incentives and information problems of donors and recipients. The performative nature of the system makes certain foreign aid simply incapable of achieving its intended benefits, leaving well-meaning projects like that of Lake Turkana deserted and hopeless. A clear paradigm shift needs to be drawn for the scope of foreign aid in developing countries to truly bring fruitful results. If foreign aid has been seen as ineffective in reducing poverty, there should be alternative methods to overcome barriers of ineptitude in governments. In many African countries, there has been an influx of non-state-controlled development entities and agencies which complement the efforts of the government to supply goods and services to the people. The majority are non-profit organizations operating as independent bodies involved in social services delivery, with institutionalized and well-organized bodies staffed with professional administrative personnel working across nations. These organizations, beyond simply offering financial assistance, actively empower the less advantaged portion of the population by promoting good governance when they advocate for human rights, environmental protection, and sustainability, fight against abuses against vulnerable people and encourage the population's participation in the development processes of nations. And unlike bilateral donors injecting funds into corrupt governments, Nongovernmental organizations have specialized research departments and policy units and respond to known problems. They resolve concrete problems with or without the government's intervention. Like "Friends of Lake Turkana", whose been in the region over the last decade, working with local communities to hold the government and investors to account with respect to environmental conservancy and community rights in industrial and infrastructure projects. Aid projects unaffiliated with governments and their politics can even be a source of change as they play advocacy roles and act, at times, as part of the civil society to exercise external pressure on governments and foreign donors to commit themselves to vital

issues without being hindered by personal economic incentives. Despite existing arguments for and against the impact of foreign aid in most countries, it is undeniable that it is a crucial source of financial resources and holds the potential to play an essential role in the promotion of the rule of law, democratic governance, and turn economic development. Foreign aid driven with clear development agendas has a high potential to improve the rule of law, create solid democratic institutions, strengthen policies and assist governments with low revenues committed to development. In addition, the rule of law initiatives sustained by foreign aid can put an end to violent conflicts, alleviate the woes of post-conflict societies, advance economic development, and most importantly, promote and protect human rights. A great goal that current foreign aid bureaucracies are striving toward, but would need substantial improvements to achieve.

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How e-learning during the COVID–19 Pandemic could influence Adolescents’ Development and Well-being in China

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ABSTRACT

The COVID-19 pandemic has created huge challenges for schooling. Online study became the only solution for students during the pandemic and became a new trend for future education. This paper sheds light on the potentially negative effects for students of online study. These negative effects include but are not limited to the financial burden of acquiring the hardware, increased unnecessary pressure when facing technological malfunctions, increased difficulty discussing the course content with teachers and classmates, etc. All these add together make adolescence easy to be mentally stressed, even mentally depressed. Depression is one of the most common mental disorders among adolescents. One of the strong triggers for it is excessive pressure. This paper focuses on the online study during the lockdown effect and its potential causation of depression. Online study could become the trend of the future, hence we need to know the pros and cons of it, particularly its connection with mental health for adolescents.

Keywords: Depression; psychology; adolescents; online study; e-learning; lockdown; China; High school students; SARS-CoV-2; academic performance; brain

INTRODUCTION

From 2019 to 2022, the COVID-19 pandemic has impacted the world greatly. The global pandemic dramatically changed the pattern of usual, such as education. In China, the Chinese government insists on the zero-COVID policy. The zero-COVID policy is a “control and maximum suppression” strategy. It involves using public health measures such as contact tracing, mass testing, border quarantine, lockdowns, and mitigation software to stop community transmission of COVID-19 as soon as it is detected. Therefore, students must stay at home when their cities detect a positive case of COVID-19. Studying online at home starts to be the new norm in China.

Online study at home limits their daily interaction with their classmates and teachers (Maatuk et al., 2022), reduces physical activity and increases screen time significantly. The lockdown’s effect on Chinese students is harmful since low physical activity and high screen time are significantly positively correlated with anxiety, depression, psychopathological symptoms, and poor sleep quality (Wu et al., 2015). Moreover, to achieve the best results from the online study, students need to have appropriate levels of stress and the school needs to provide sufficient technical support. Too little or too much stress and anxiety would only deter learning (Wong, 2020). Online courses also tend to be reading and writing intensive. Therefore, maintaining a proper status is the key to online study. Online study is unfavorable for students who lack self-regulation and have low reading abilities since maintaining motivation in online courses is a challenge for online learners (Gilbert, n.d.).

Chinese students from 12 to 18 years of age are currently in one of the most important periods of their life, which is GAOKAO. KAOKAO refer to the senior high school entrance examination and National College Entrance Examination, respectively. The lockdown may negatively affect students’ success with KAOKAO because online study requires sufficient technical support. The thing is that not every school can provide students with sufficient technical support and not every student has a good study environment after leaving school. Therefore, struggling to perform at the expected level may produce increased stress and depression among adolescents (João Pires, 2019). The report describes the true high school students experiencing GAOKAO under the pandemic. For most children, studying is not something happy, it requires

a good environment and someone to supervise. Except for a very few students who have strong self-control and are free from outside interference, most children do not have that strong self-control, and even for adults, sitting in front of a computer all day is boring, not to mention that home is not an environment for studying either. (“Don’t Blame Them for Not Doing Well on the Exams, This Epidemic Has Been Too Hard on the High School Seniors!,” n.d.) High school students have been greatly affected by the epidemic in terms of their physical and mental health and academic performance.

Structural changes in the adolescent brain

The plasticity of adolescents’ brains refers to the possible significant neuronal changes. Plasticity allows adolescents to learn and adapt to acquire independence. Plasticity includes the process of neuronal proliferation, rewiring, dendritic pruning, and environmental exposure (Sharma et al., 2013). However, the process of plasticity exhibited the brain is undergoing would post exhibited by the brain during this pubertal period may make individuals more vulnerable to perturbations, such as stress (Romeo & Mcewen, 2006).

Effects on adolescents due to lockdown policy

The lockdown policy from the Chinese government posed detrimental effects on Chinese students’ mental health. First, the lockdown decreases the chance of students having face-to-face connections between students and their instructors and friends (Maatuk et al., 2022). Second, the lockdown can lead students to have tremendous stress. During the lockdown, students are not only facing the pressure from their academic performance but the pressure of staying healthy (Lee, n.d.). For children and adolescents with mental health needs, such lockdown means a lack of access to the resources they usually have through schools.

Moreover, school routines are important coping mechanisms for young people with mental health issues. When schools are closed, they lose an anchor in life and their symptoms could relapse. For some children with depression, there will be considerable difficulties adjusting back to normal life when school resumes. Furthermore, students still need to study online, and e-learning can worsen students’ mental conditions. Online study does promote education, but it still has some serious disadvantages.

Online study requires a stable connection, sufficient technical support, enough computer literacy, and a proper environment. It's hard to achieve all of them at the same time. The poor e-learning experience increased the sense of panic from peer pressure.

Moreover, missing school for a prolonged period will likely have a major impact on student achievement. When students returned to school, some students would fall with greater variability in academic skills. (Kuhfeld et al. 2020) Students would panic and be stressed out if the gaps between each other's academic performance keep getting bigger. Therefore, the lockdown harms students' mental health.

The effects of e-learning on adolescents

To begin with, the adaptation to the technology needed for online school can trigger negative feelings (Dumford & Miller, 2018). Technology is a double-edged sword: although it makes online education possible, it also could introduce new problems.

First, students and teachers could face technical issues during classes. Increased technical issues may interfere with students' engagement in the course material or their ability to learn from it (Dumford & Miller, 2018). Many faculties yet lack the relevant software and accompanying equipment, as well as adequately trained staff, who would use them in their work with students. (Radović-Marković, 2010) Students and teachers may struggle with their electronic devices and websites since they are not IT experts. Students' satisfaction with their online classes was considerably higher when students felt they had received adequate training to use the necessary technology (Kim & Frick, 2011). This requires the school to have extra financial support (Maatuk et al., 2022, p.), which increases the burden. According to the research by Nguyen et al. (2021), students from Van Lang University in Ho Chi Minh City, Vietnam claimed that unstable network connections interrupted interaction between students and faculty leading some students to suggest extending the time to study online to keep up. These results correspondent to Bui et al. (2021) who found that students often faced technical problems as they took online classes. Meanwhile, teachers also are experiencing similar issues. There are difficulties from teachers' internal and external factors, such as low ability to use technology for online learning, the absence of a distance learning culture, teachers' boredom and social life loss, and increasing

costs of the internet. (Yohannes, 2021)

Second, it's difficult to arrange and interact with students for online study. It can be difficult for instructors to adapt certain activities (such as performance assessments, continuous assessments, and proctored tests) to the online format without losing content knowledge or interaction between classmates and/or instructors. According to research by Nguyen et al. (2021), there are 30% of teachers supported that unstable network connections can interrupt the interaction between students and faculty. The poor interaction between teachers and students can largely interfere with students' motivation for their classes. Students' motivation toward e-learning would change since organizational support was a critical factor for students to engage and sustain in e-learning. A study conducted found that four factors caused difficulties for teachers in implementing online learning. Those were obstacles from teachers, students, curriculum, and school, which student factor was the biggest obstacle in implementing online learning. In conclusion, interactions between students and teachers are crucial during online classes. (Yohannes, 2021)

Third, there are accessibility issues. Not everyone has the proper laptop and printer at home and especially in China. In effect, low-income students with fewer resources have less access to the proper learning materials and supported environments. In certain areas, the internet quality is poor and not stable. Some students and teachers in undeveloped areas face insufficient knowledge about the use of information and communication technology. The provision of content such as video and advanced applications is still a new thing for many educators (Maatuk et al., 2022). According to the research by Nguyen et al. (2021), up to 70 students find it inconvenient to study online using smartphones. They pointed out that the smartphone has a small display and little configuration. That made studying even more inconvenient than with tablets.

Moreover, even though some families are using laptops or tablets, they might still run into trouble since they don't receive enough online education and support services. (Chen et al., 2010) Similarly, math teachers face similar problems. According to (Yohannes, 2021), in high school, mathematics, which contains abstract topics, requires an excellent presentation strategy so that online mathematics learning becomes effective and meaningful. As prominent in online learning,

mathematics teachers prominent in online learning, mathematics teachers need to compile and present exciting and intelligible online mathematics learning. However, high school mathematics teachers still experienced various difficulties in conducting this online learning in the implementation.

In addition to the problems above, students would encounter social pressure associated with Gaokao. Gaokao is a national 2-day exam that takes place at the end of grade 12. The performance of Gaokao is the only criterion for university admission in China. To a lot of students, families, and even society, going to university is considered the only future path for the students and means a lot to their families (João Pires, 2019). A lot of families even take Gaokao as a life-changing event. Hence, Chinese parents would pay too much attention to their kids, and that may backfire, and trigger some negative resistant feelings.

More importantly, cultural factors make it habitual for individuals to be judged or compared with others in form daily life in the personnel-recruitment market, while an impressive degree is exactly a symbol of distinction. Under such heavy pressure from family, society, and students/herself, they are facing tremendous burdens and are very vulnerable to having mental illnesses. There're numerous studies showed a high risk of suicidal mentality as well as attempts among Chinese adolescents, especially during the Gaokao period (João Pires, 2019b). It is easy to imagine when this system meets the pandemic lockdown, students would form a negative loop under these circumstances. They would face more pressure and negativities than before. That can cause students to have mental illnesses.

In addition, research showed that social media became a primary stream of communication among adolescents during the lockdown (Dumford & Miller, 2018). Compared with data before the lockdown, there's more time-spending on social media by teenagers. One concern is that increased social media among students would put them at risk of developing depression (Hudimova, 2021). For example, research from Hudimova (2021) found that involvement in the virtual world increases excessively, which leads to adolescents' insomnia and depression. Moreover, social media usage often leads to anxiety, and feeling isolated from the outside world. . Similarly, another study found that research shows that heavier Social network sites (SNS) use were associated with low self-

esteem, sleep disorders, and psychological well-being especially for younger adolescents (Tsitsika, A. K., 2014). Students would receive cyber violence from social media. Therefore, the heavy use of social media during lockdown would not prompt study but distract students. All these factors cause students to have a negative online study experience, triggering negative thoughts and feelings.

DISCUSSION

In the midst of a situation that makes students anxious, and depressed, the lockdown policy is still being put into action. Schools may shut down at any time, and students have been through online study for 2 years. Students are facing an increased risk of getting depressed, anxious, and having sleep disorders as long as they are studying online. When they are studying online, they face the problem of connection problems, mismanagement of time and course schedule, expensive accessories, poor website/app design, social media abuse, and academic pressure. The pandemic is still developing and shows no sign of ceasing. School closure and lockdown would be part of our life until we overcome Cov-19. Therefore, students need to be ready for online classes. As we mentioned above, all the factors are based on the background of the pandemic lockdown, and all these factors contribute to the result that Chinese high school students suffered from studying online. They are not only experiencing poor education, lost chance of social interaction, developing mental and physical illnesses, and facing an unknown future. We need to provide students with a good online study experience during the lockdown. The government and scholars must take the move to find a perfect way for students to study online during the pandemic lockdown. Online study has its advantages, but it also has some problems. We should find a suitable way for students to study online. We must focus on the long-term, not just the temporary offline school replacement during the pandemic lockdown, and work to implement this change now.

CONCLUSION

It can be stated that Chinese students have been traumatized by the epidemic. Due to the Chinese government's policy, the lockdown would remain. If the city has a pandemic, students must study online to follow the lockdown policy. Online study has significant differences from school, and students can't be as good as at school. For high school students,

it's hard for them to have strong self-control and concentrate all day sitting in front of a computer. A student's performance during online study can be determined by the Internet connection, study environment, interactions, technical problems, social pressure, and future pressure. All of these can lead students to a poor mental health conditions, such as depression. We must persistently address the impact of online learning in high school. It might be helpful to do a study with a little rethinking of a solution: provide students, parents, and teachers with a guidebook and support that explains everything. However, online study can never fully replace offline study at school. The development of a high school student is not only about their academic performance, but also their social skills, their interests, physical, and mental development. Online education can only try to match the academic capabilities of offline education, but it cannot replace the role of offline education.

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The Texas Tower Shooter: An Analysis of Charles Whitman

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ABSTRACT

This application paper will examine common attributes of serial killers, such as biological impairments in their brains and other aggravating factors: experiencing child abuse, having violent fantasies, and fitting into the categorization of organized/disorganized killing. These factors will be analyzed to determine how accurately they apply to serial killer Charles Whitman and to what extent they influenced his decision to commit a mass shooting. Information from empirical studies on serial killers, review articles on neurological defects concerning violence, and book chapters were assessed to establish what aspects relate to Charles Whitman. The results indicate that Charles Whitman had common traits of a serial killer, such as undergoing an abusive childhood, being classified as an organized killer, and having violent thoughts. The research supports the fact that Whitman had a neurological defect, a tumor on his amygdala that could have contributed to his actions. The overall findings suggest that further neurological research on how biological elements impact violent actions can contribute to a better understanding of preventive measures regarding violence in serial killers.

Keywords: Charles Whitman, serial killer, neuroscience, brain tumor, amygdala, biological, school shooting, murderer

The study of the most dangerous and feared criminals: serial killers, is a prevalent topic of interest today. Whether it is by criminologists or the general public, most people want to know the why behind a serial killer's actions; what causes a human being—like them—to be able to commit such atrocious and unimaginable acts to others without any evident empathy? Research on serial killers is necessary to society as it can provide more information on understanding them and offer insight into the question of how their actions can be prevented. Unfortunately, understanding the motives behind a serial killer's actions is not a straightforward process due to the complexity of their behavior. However, many different theories exist to attempt to explain their behavior. Investigating a serial killer's childhood, mindset, environmental influences, and/or biological processes of their brain are different approaches that can help further analyze the actions of a serial killer.

There are specific factors in all of these theories which are proven that certain serial killers exhibit. Crime and the brain are linked because there is evidence that certain parts of the brain can be linked to aggression and violence, like the amygdala and prefrontal cortex. Along with neurological influences, research has shown that the environment a serial killer grew up in could affect their future actions. Suffering from child abuse and witnessing domestic violence are examples of harmful childhood experiences that could increase the likelihood of violence in the future. While identifying risk factors is essential, acknowledging existing traits in a serial killer's personality is also necessary. A distinguishable factor of serial killers' is their type of killing being labeled as organized or disorganized. Another feature attributed to serial killers is fantasizing about violent thoughts. This paper will discuss how these factors are present in serial murderer Charles Whitman and how they can be applied to his actions. Moreover, various research findings on these topics will be utilized to comprehensively explain specific characteristics of serial killers and how advancing neuroscience knowledge can contribute to a better understanding of biological impacts.

Charles J. Whitman would be described as a mass murderer, someone who has killed four or more victims at one location on a single occasion. He committed a mass school shooting at the University of Texas in 1966 by shooting and killing 14 people while wounding 32 others. Earlier on the day of the shooting, Charles Whitman murdered his mother and wife as well.

Charles Whitman's childhood consisted of being raised in a middle-class home in Florida by his mother and father, Margaret and C.A. Whitman. He was described as a healthy young boy who regularly attended Mass with his mother and two brothers and did well in school. He joined the Boy Scouts of America and enjoyed playing piano and hunting. However, his father was abusive to him, his brothers, and his mother. He suffered from harsh expectations his father set for him to succeed in all aspects of life, like his extracurriculars and school. Additionally, he continually witnessed and experienced the violence his father inflicted on the family. (Lavergne, 1997).

Two weeks after he turned eighteen, Charles Whitman left his home, joined the Marines, and eventually went to college at the University of Texas where he met his future wife, Kathy Leissner. As the years progressed, he began complaining about headaches and stress. He was referred to a psychiatrist, and had a session with him in which he discussed his frustrations with how his father treated him in his childhood, his attempts to treat Kathy well, and his fantasy of going up the clock tower at the university and shooting people (Lavergne, 1997).

The day before the murders, he wrote a note and again admitted to having violent fantasies by stating that he was a "victim of many unusual and irrational thoughts," even though he was "supposed to be an average reasonable and intelligent young man." He wrote about his plan to kill Kathy and his mother and discussed how he was prepared to die. Whitman explained that he could not pinpoint "any specific reasons" for his actions. He then requested an autopsy after his death to reveal if there was anything physically wrong with him due to the severe headaches he had been having. Whitman briefly mentioned seeing the doctor for what he called his "overwhelming violent impulses" but believed it didn't help as he stated he was left to fight his "mental turmoil alone" (Lavergne, 1997).

Around midnight on August 1, 1966, Charles Whitman went to his mother's apartment and murdered her. Right after her death, he wrote a note stating that he had taken his mother's life and believed he had relieved her of her suffering on Earth. He mentioned his hatred of his father and how his mother had suffered because of his father for far too long. Then around 2:30 AM, he returned to his apartment where his wife Kathy was asleep. He stabbed her five times in her sleep. In his previous note, he mentioned

that he planned to kill Kathy as “painlessly as possible” and he loved her a lot. Then he wrote a note requesting that if his life insurance policy was valid, to pay off his debts and “donate the rest anonymously to a mental health foundation,” proposing that “maybe research could help prevent tragedies of this type.” (Lavergne, 1997)

After the murder of his wife and mother, Whitman carefully planned the shooting that would take place that very same day. It was clear the shooting was organized and thought out. Charles Whitman had the intent to murder as many people as possible. He entered the clock tower at the University of Texas by posing as a janitor and brought along several different guns, ammunition, and other supplies. Once he reached the top, he shot at victims near the observation deck and barricaded himself inside, beginning the mass shooting. His experience in the marines undoubtedly assisted with his ability to shoot individuals from the tower that rose over 300 ft above the campus. He shot at anyone in his view, including students, a pregnant woman, and young teenagers. He ultimately killed an unborn child and thirteen people that day, the fourteenth victim dying a week later from the injuries. Charles Whitman had injured 32 other people in the shooting as well. Eventually, he was shot and killed in the tower by the officers of the Austin Police Department. Upon his request, an autopsy of his death was performed, and a tumor was found in his brain. This tumor caused speculation about what impact it could have had on his actions (Lavergne, 1997).

The murders Charles Whitman committed were surprising to his friends and family. His father believed he had lost his mind and other close relatives attributed his actions solely to the tumor. He was said to have a good relationship with his mother and wife. He was also described as an ordinary young man by people who knew him. There is a lot of speculation about what ultimately motivated his actions. Approaching the study of Whitman’s actions from a biological approach can help to scientifically analyze what he was experiencing. Several parts of the brain, such as the prefrontal cortex and amygdala, have been proven to be associated with violence upon damage.

In Charles Whitman’s case, he had a tumor called a glioblastoma which was in a region of his brain beneath the thalamus, on the hypothalamus, and in a position that caused it to compress and over-stimulate the amygdala (Eagleman, 2011).

The amygdala is a small almond shaped part of the brain that is associated with emotion regulation. It is activated in humans, especially in situations regarding fear and aggression (Eagleman, 2011). A University of Baltimore Law Review Article examined the role of Functional Magnetic Resonance Imaging and how it can be used in a court of law. Functional Magnetic Resonance Imaging, or fMRI, is a process researchers use to monitor a human brain and identify impairments. The research done on fMRI does not fully support it being utilized for lie detection; however, the article proposes that fMRI should be considered to be eventually taken into account in court hearings by the jury and judge because it can provide evidence displaying how specific impairments of the brain are linked to violence and aggression. The article analyzes fMRI studies and presents the findings that support the claim that the amygdala functions in the brain directly increase or enhance anger and aggression. Several fMRI studies examined the role of fMRI with the prefrontal cortex and amygdala, regions of the brain that can affect how well an individual can fully understand the culpability of their actions. The article claims that since these neurological impairments can be identified from fMRI, they should be considered when assessing a criminal’s actions in court. Based on the article, present evidence from fMRI can demonstrate that in Charles Whitman’s case, his seemingly unexplainable actions could be due to the overstimulation of his amygdala that he was experiencing. Findings show that over-stimulation of the amygdala would result in “uncontrollable violent behavior” and an inability to comprehend this criminal behavior.

The information presented in the Law Review Article simply recognizes the link between Charles Whitman’s brain tumor on his amygdala and how that could have led to increased violence and aggression. However, neuroscience research and how accurately it can be used to explain criminals’ actions is still advancing. Whitman’s tumor could provide a potential explanation for the motives behind the murders. Still, there is evident uncertainty in this research about the extent to which he was personally responsible for his actions. The tumor affecting his amygdala did not necessarily indicate he had no control over his actions. Additionally, other aggravating factors would need to be considered as it would not be realistic to identify one sole cause. Charles Whitman had risk factors and experiences that have also been identified in other serial killers, such as experiencing child abuse.

A systematic review was conducted by Allely et al. (2014) in which mass and serial killers were studied to analyze the number of serial murderers with neurodevelopmental disorders like autism spectrum disorder (ASD) or a head injury. The study investigated psychosocial risk factors in relation to these disorders as well. The research was conducted by searching for studies and books on internet-based biological databases related to associations between mass/serial killers and brain injury or ASD. 239 serial killers were finalized to use for the study. The analysis displayed that 21.34% (N = 51) had had a definite or suspected head injury, and 28.03% (N = 67) had definite, highly probable, or possible ASD. Out of the 106 killers with ASD and/or head injury, 55% (N = 58) had experienced psychosocial stressors such as physical, psychological, or sexual childhood abuse. Additionally, a definite head injury was defined as a situation where a brain scan revealed damage to the brain or head trauma (Allely et al., 2014).

These findings suggest that there could be a relation to head injury and psychosocial stressors in serial killers, which applies to Whitman. The autopsy suggests there was damage to the amygdala in his brain because of his tumor. Moreover, during the time he spent in the marines, there was also an incident in which he and his friend fought with other marines, and he was kicked in the head, leading him to be treated for headaches and dizziness. The systematic review indicates that over 55% of eligible killers in the study had experienced psychosocial stressors. Charles Whitman experienced the psychosocial stressor of child abuse. He was physically abused by his father growing up, who had admitted to spanking his kids, using a belt, his fists, or a paddle to instill his sense of discipline. When Whitman was almost 18 years old, he arrived home intoxicated. In anger, his father threw him into the swimming pool, causing Whitman to almost drown. Whitman's father physically abused Whitman's mother frequently. His family was very broken, and Whitman witnessed his mother's abuse while growing up. He also had a lot of pressure placed on him by his father; his good grades, activities, and sports throughout his childhood were generally a result of force from his father, who he lived in fear from. Whitman suffered from both psychological and physical abuse from his father. The review acknowledges that in several studies and reports, psychological and/or physical abuse was a pervasive characteristic of serial killers' childhoods (Allely et al., 2014). Overall, the child abuse Whitman suffered related to the findings indicating that a high

percentage of mass/serial killers with a head injury had psychosocial stressors like child abuse.

The child abuse that Whitman suffered manifested itself in some of Whitman's own explanations for the murders. In a note he wrote after killing his mother, he discussed that she experienced his father's abuse for too long, and by killing her, he was "relieving her suffering" (Lavergne, 1999). Similarly, he claimed that since he was ready to die, he killed Kathy because he did not want her to suffer alone (Lavergne, 1997). While his words do not explain the mass shooting, it displays how witnessing abuse growing up led him to offer it as a reason behind one of his many murders.

Whitman's actions can be analyzed and studied to learn what type of killer he was. Organized and disorganized are two common characteristics employed to describe murderers based on their behavior before, during, and after the crime. A study from the National University of Public Service, Hungary, analyzes several cases of serial killers to identify and cluster the most common traits of serial killers. The study looked at their general attributes, psychological risk factors, biological effects, and common ways serial killers can be clustered. It identified several specific characteristics that applied to organized serial killers, such as having a rough family history involving abuse and being of above-average intelligence. The description of being methodological, socially adequate, and a white male was also included. Other characteristics were employment struggles and several suicide attempts (Simon, 2015).

In contrast, the study explained that the disorganized serial killer would have a low IQ and murder impulsively and without a plan. They would generally lack friends or significant others, live alone, and be described as having odd personalities. These killers were also typically sexually perverted and would deform the corpses of their victims. While these categories have several other factors, those listed summarize the general idea of what an organized or disorganized serial killer would be (Simon, 2015). Based on the study, many factors regarding the "organized killer" section would apply to Whitman, whereas many of the characteristics related to the "disorganized killer" do not apply to Whitman. Whitman reportedly had an IQ of 138, suggesting that he had above-average intelligence, similar to organized killers. The shooting he committed could be described as methodological and premeditated. He

had planned how to get into the tower by pretending he was a janitor. He also created a way to hide the several guns and ammunition he carried with him by using a trolley. It was well thought out and not an impulsive decision—which would have been a trait of a disorganized killer. Whitman was also socially adequate because he had a wife and many friends. He experienced abuse and had an unstable family history, both experiences that were described as typical characteristics of organized killers. Additionally, there was no evidence that he was sexually perverted or that he deformed the corpses of his mother or wife, indicating that the disorganized characteristics did not apply to him.

While Whitman did not have every single trait listed under the organized category, his actions identified mainly with being an organized killer compared to a disorganized one. Whitman was intelligent and had a detailed plan to conduct the shooting. He was socially adequate because he was known as friendly and had built relationships with people in his life. Of the two most common ways of identifying a killer, Whitman was an organized killer.

Along with experiencing child abuse and being classified as an organized or disorganized killer, another general characteristic of a serial killer is experiencing violent fantasies. A study analyzing a typical serial killer's thought process, from having a fantasy of murder to committing murder, explains how experiencing violent thoughts is a component that leads to the ultimate murder of the serial killer's victims. While it is unclear how the data was collected, the article compiles information from several articles related to serial killing. Eventually, it identifies serial homicide behavior as being characterized by socio-environmental, relational, and individual factors. An essential aspect of an individual factor of a serial killer is listed as "Imaginative Life (fantasies)," which indicates that one of the factors involved in serial homicide is having fantasies of murder, such as wanting "destruction of other people" for "personal gratification" (Malizia, 2017). The article explains that typically before the killing, the serial killer will fantasize about it in his imagination and eventually feel obliged to satisfy the fantasy by actually murdering the victims. The article reviews all aspects of the killer's mindset and attributes childhood, biological predispositions, and personality as factors that strengthen the role fantasy plays in the murders (Malizia, 2017).

Whitman discussed his own frustration with violent fantasies he experienced in the notes he wrote before his death. He explained that he did not understand himself and experienced uncontrollable violent urges and unusual thoughts. He also spoke of the shooting fantasy beforehand. During his first and only session with the psychiatrist, he sometimes thought about "going up on the Tower with a deer rifle and shooting people" (Lavergne, 1997, 71). Whitman's own college dorm residents recalled him mentioning how he would like to go on top of the University of Texas clock tower and shoot people (Lavergne, 1997). The psychiatrist and residents never suspected that Whitman could be serious about such an idea. Like the serial killers discussed in the article, Whitman experienced violent thoughts and eventually acted on them by turning them into reality and becoming a serial killer.

Charles Whitman—the Texas Tower Shooter—committed one of the first school shootings in American history on August 1st, 1966, at the University of Texas. He took the lives of fourteen people that day, including his own mother and wife. He wounded 32 more and was finally shot to death by police. Whitman's impact on the University of Texas and the United States understanding of school shootings was dire. Rarely had the American public been exposed to such a violent crime inflicted by an individual in a mass murder spree. The victims' families suffered greatly, and the injured civilians, students, and staff at the university were horrified by the event they had gone through.

Perhaps the most perplexing part of Whitman's killings was his motivation behind them. Many people could not understand why a former university student and an intelligent, seemingly happy man would want to go on a murder spree. Despite being the most favored theory, the uncertainty regarding the impact of Whitman's tumor reveals the necessity of modern neurological research; it could help researchers understand current cases similar to Whitman's. A review of research on biological connections to violence by Ling et al. (2019) examined the brain mechanisms discovered in serial killers and psychopaths in comparison to the rest of the population. It was determined that the amygdala in serial killers generally had stimulated hyper or hypoactivity. A maldevelopment involving the amygdala defers it from its typical role of detecting distress or threat cues; and it no longer discourages criminal behavior. With continuing analysis of the

brains of serial killers, several differences are being identified in the limbic system of the brain, prefrontal cortex, and striatum region. (Ling et al., 2019). Existing studies involving fMRI, PET scans, and analysis of brain autopsies help to inform society about a definite understanding on neurological aspects in violence. A clearer understanding of the perpetrators self control may be revealed, thus assisting with the application of legal policy in murder cases. Additionally, with more attention on analysis through a biological lens, the proper treatments and prevention methods may eventually be discovered and implemented correctly.

The purpose of this paper was to analyze several aspects of serial killers and demonstrate how they could be applied to Charles Whitman. Studying his case has proved the significance in focusing on advancing studies, research, and biological findings that will allow the public to better comprehend the mindset of serial killers. With an increase in the knowledge of the neurological influences behind murder, there will be highly probable prevention of violence, pain, and fear of victims that serial killers cause worldwide.

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Othello: The Interplay Between Bondage and the Nature of the Self

By Alice Liu

AUTHOR BIO

Alice Liu is a rising senior at Westminster School in Simsbury, Connecticut. She is the recipient of the Yale Book Award, the co-editor-in-chief of the school newspaper, co-head of the Multicultural Student Union Club, and a founder and co-head of Life on the Hill Club producing videos on life at Westminster. Her interests include history and writing. Her work has been published in The European Journal of Humanities and Social Sciences, the Scholastic Art & Writing, National History Day, and Teen Ink Magazine. She aspires to spotlight marginalized or obscured voices in history and give them equal attention as prominent ones.

ABSTRACT

Narrating the downfall of Othello from his prestige as the Venetian army general, Shakespeare's tragedy Othello is a prism that probes the nature of the self, of society, of the possibility of a dichotomy between the exterior and the inner self, and of the fusion of the two sides of the dichotomy. The play examines the fluidity of identity in both individuals and societies. While most paper analyzes character evolution along plot lines, this paper attempts to understand characters through repetition of the words denoting "bondage" across Shakespeare's Othello. Such words include "bound," "bind," "bond," and "bondage." Through analyzing Othello and Emilia's relationship with their bondages under the context of the play, this paper argues that the idea of the true self in Othello emerges upon freedom from bondage. In this way, the nature of the self becomes a fluid entity, capable of evolving as the relationships between individuals and their societies shifts.

Keywords: Othello, Emilia, Shakespeare, bound, bondage, identity, fluidity, appearance

INTRODUCTION

Number of times words related to bondage appear, arranged by frequency of appearance:

“bound:” 9
 “bind:” 2
 “bond:” 1
 “bondage:” 1

In *Othello*, Shakespeare examines the influence that bondage levies upon one’s position in society and utilizes the diverse portrayals of that influence to discuss the nature of the self. Articulated through his use of the words “bind,” “bound,” “bond,” and “bondage,” but primarily through his use of “bound,” bondage denotes commitment to one’s role in society. Through the convergent interactions that two seemingly disparate characters – Emilia and Othello, two opposing sides of the master-slave relationship – display with their bondages, Shakespeare questions what it means to be “thou art” given the context of one’s role in one’s surroundings.

Throughout the play, the word “bound” is employed nine times. Desdemona is bound to her father “for life and education” (Act 1, Scene 3), Cassio is bound to Emilia for obtaining Desdemona’s handkerchief (Act 3, Scene 2), and Iago states that he is “bound to every act of duty” (Act 3, Scene 3). The impact of bondage is particularly significant in the characters Othello and Emilia. When they are freed from bondage, both actualize their true selves.

Emilia: Merging the Exterior and the Interior Self

Across the nine instances where the word “bound” is used, only Emilia is “bound to speak.” Perhaps she is meant to be presented as the only character whose outward presentation and inward beliefs unite in defining herself. Emilia’s embodiment of the union of the inner and outward self is underscored when contrasted with the dichotomy that Iago establishes between the two.

IAGO: 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. (Act 1, Scene 1)

EMILIA: Moore, she was chaste. She loved thee, cruel Moore. So come my soul to bliss, as I speak true.

So speaking as I think, alas, I die. (Act 5, Scene 2)

If Iago’s appearance is distinct from his thoughts, then Emilia is her thoughts. Departing from Iago’s inverted “I am not what I am,” Emilia states “so thinking as I think, alas, I die.” By speaking her thoughts, Emilia marks the union of the two opposing sides of the dichotomy that Iago works to distinguish. However, Emilia’s articulation of her thoughts is qualified by “as I die.” This marks a condition upon which she speaks the truth. The meaning of this condition is further revealed in the following lines.

EMILIA: Thou hast not half that power to do me harm
 As I have to be hurt. O gull! O dolt,
 As ignorant as dirt! Thou hast done a deed –
 I care not for thy sword. (Act 5, Scene 2)

EMILIA: I will not charm my tongue; I am bound to speak. (Act 5, Scene 2)

EMILIA: ‘Twill out, ‘twill out. I peace?
 No, I will speak as liberal as the north.
 Let heaven, and men, and devils, let them all,
 All, all cry shame against me, yet I’ll speak. (Act 5, Scene 2, 260-263)

The context in which Emilia chooses to speak indicates that her commitment to speaking the truth is contingent upon the death of her bondage as Desdemona’s maid. In this role, Emilia is located within an intricate hierarchy where multiple parties hold leverage over her: Iago, her husband; Othello, her “lord”; and Desdemona, to whom she has a strong emotional attachment. Yet, upon Desdemona’s death, Iago’s credibility collapses, and Emilia’s matrimonial attachment to him evaporates. At the same time, Othello, no longer Emilia’s “lord,” falls to his “naked self” (Act 5, Scene 2). To Emilia, Othello’s loss of power means that he “hast not half that power to do me harm.” Freed from her bondage to other people, Emilia is now “bound to speak” (Act 5, Scene 2). While Iago refuses to present his true self because he needs to play the role of “honest Iago” to achieve revenge against Othello, Emilia can speak the truth because she no longer processes any pursuits.

Nor does Emilia retreat to silence under Iago’s command. Retorting that she “will not charm my tongue,” she is determined to “speak as liberal as the north,” without regard for the repercussions of her speech: “all cry shame against me, yet I’ll speak.” Emilia’s true thoughts surface when she exclaims

that “the Moor” is “as ignorant as dirt.” Her reference to Othello’s skin marks a shift from her previous reference to him as “my lord.” Unbonded, Emilia’s inner racial view surfaces. Her indictment of Othello as “ignorant as dirt” who “hath killed my mistress” manifest her previously unseen thoughts, which contrast with her former appearance. Through Emilia’s expression of her formerly hidden perspective, Shakespeare argues that the true self, divergent from appearance, perhaps only emerges when one is no longer attached to his or her role in society.

Othello: Breaking Free from Bondage

Paralleling Emilia’s realization of her identity, Othello realizes his own when he is freed from his attachment to Iago. Admittedly, Othello and Emilia appear very different; in the master-slave relationship, Othello assumes the dominant role, while Emilia occupies the subordinate position. However, Shakespeare explores the impact of bondage and its influence on the definition of the self through the two characters’ parallel actualizations of their identities upon their freedom from their bondages.

OTHELLO: I am bound to thee forever. (Act 3, Scene 3)

OTHELLO: Speak of me as I am. Nothing extenuate,
Nor set down aught in malice. Then must you speak

Of one that loved not wisely, but too well;
Of one not easily jealous, but being wrought Perplexed
in the extreme [...]
Where a malignant and turbaned Turk
Beat a Venetian and traduced the state
I took by th’ throat the circumcised dog
and smote him, thus. He stabs himself (Act 5, Scene 2)

While bound to Iago, Othello only reveals his inner emotional turmoil through soliloquies. His perception of himself in his soliloquies oscillates between the disparate definitions that Venetian society levies upon him; he is “a general in the Venetian Army,” but he is also “the Moor,” or as Emilia notes, “the blacker devil” (Act 5, Scene 2, 162). He seems to absorb Venetian society’s image of the Black man when he questions whether Desdemona regrets marrying against her better judgment. Ultimately, as Othello breaks from his commitment to Iago, he realizes that his true self cannot be defined singularly.

Othello’s final speech before his death displays a parallel structure that resonates and reinforces its content. The parallelism embedded within Othello’s speech echoes the structure in Iago’s opening soliloquy, in which the latter indicates that “I follow him to serve my turn upon him,” “we cannot all be masters, nor all masters cannot be truly followed,” and “I am not who I am” (Act 1, Scene 1). But if Iago’s inverted sentences erase his identity, Othello’s parallel sentences actualize his true self. In “loved not wisely, but too well” and “not easily jealous, but being wrought,” the portions before and after the transitional conjunction “but” mark two distinct aspects of Othello’s character. He is not “easily jealous”, yet he appears to be because he is “wrought.” He appears to have “loved not wisely,” but this belies the truth because he only seems so because he loved “too well.” The conjunction of two different aspects of Othello in turn reveal the complexity of his identity.

Perhaps no other example better highlights Othello’s complexity than his description of himself as “a malignant and turbaned Turk/ Beat a Venetian and traduced the state/ I took by th’ throat the circumcised dog.” Here, Othello denotes himself an “insider” Christian who defeats the “outsider” Muslim. However, as he recounts killing the “outsider” Turk, he also stabs himself. This reveals that Othello perceives himself to be at once both the insider and the outsider. He realizes that his true self is complex and contradictory. He is at once included and excluded from the Venetian society; he is both the Venetian general and the devil Moor. Through Othello’s discovery of his identity upon release from his bondage, Shakespeare displays the complex nature of the definition of the self. Instead of being definitive, the actual self is drenched in contradictions.

CONCLUSION

Through Emilia and Othello, Shakespeare explores the nature of the self. Othello’s plea to Desdemona to reveal “what art thou” conjures the central question that the play seeks to examine: what defines the true self (Act 4, Scene 2). The answers the two characters achieve diverge. Emilia’s character presents the self as the union of the seen and unseen factors, while Othello sees it as a dynamic, fluid entity. Yet, the journeys of the two characters unite and present a cohesive exploration of what defines the self. Both attain the actualization of their true identities upon their release from bondage. In this way,

Shakespeare presents a compelling argument that truth regarding the self springs from release from societal constraints.

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The Intersection of Music Listening and Stress

By Claire Li

AUTHOR BIO

Claire Li is a senior at Arcadia High School in Arcadia, California. She is particularly fascinated by the intersection of STEM and the arts, as the subjects typically are regarded as separate. Currently, she is the Student Managing Intern for Arcadia Unified School District's Digital Communications Internship, and has been playing piano for many years, invited to play at Carnegie Hall and Zipper Hall. She was also a top 20 finisher in the Southern California Section of the Chemistry Olympiad. In the future, Claire hopes to study an interdisciplinary field that combines arts and science to find new ways to solve traditional problems.

ABSTRACT

The COVID-19 pandemic accentuated a growing concern towards mental health and stress, with reports of stress increasing since the onset of the pandemic. Long term exposure to stress may not only yield health risks but may also add costly financial burdens for society. In more recent years, music listening—especially relaxing or pleasurable music—has been shown to positively affect stress management and relaxation. In specific, classical music was found to have a great effect, and music chosen based on songs popular during a patient's adolescence or early adulthood may help identify music regarded as pleasurable. Though music listening and stress modulate common brain regions such as the amygdala and hypothalamus, they induce different responses. Stress activates the sympathetic nervous system, the body's "fight or flight" response which increases cortisol levels, while music can trigger the "rest or digest" parasympathetic nervous system which dampens the HPA axis and lowers cortisol. Music's ability to regulate the HPA axis, lowering stress biomarkers such as cortisol levels, heart rate, and blood pressure is crucial to its use as a therapy for stress. Traditional stress management or prevention measures are often rather expensive and inaccessible; however, music listening provides a cheaper, non-invasive, and accessible alternative.

Keywords: Stress, music, music therapy, music listening, mental health, limbic system, HPA axis, emotion, paralimbic nervous system, amygdala, classical music

INTRODUCTION

The onset of the COVID-19 pandemic has brought mental health and stress to the forefront of discussion. American Psychological Association chief executive officer Arthur C. Evans Jr., PhD, commented that Americans are now “reaching unprecedented levels of stress that will challenge [their] ability to cope.”

Stress can be defined as a response to a bodily or environmental demand that disrupts the body’s homeostasis (Kumar et al., 2013; Jackson, 2013). Such demands may require physical, mental, or emotional adjustment (Kumar et al., 2013) and may be perceived as either threatening or benign based on whether coping resources are available to an individual (McEwen and Gianaros, 2010). Though not all stress is unhealthy and a degree of stress in everyday life is natural, excessive stress may have an adverse effect on health, behavior, and relationships (Jackson, 2013). Further, the repeated activation of stress responses (chronic stress) has long term effects on the body which may contribute to mental health problems such as anxiety, depression, or and/or addiction as well as physical health risks such as chronic pain and cardiovascular disease (Witte et al., 2019). Because prolonged exposure to stress may lead to substantial financial expenditures for society and traditional stress management measures are rather expensive, cost effective preventative and stress management measures have been sought after (Thoma et al., 2013). Music therapy, an economic, non-invasive, and accessible tool, has recently received great interest in regards to managing stress.

Both music and stress have the ability to modulate the autonomic nervous system, which can be divided into the sympathetic and parasympathetic nervous system. The sympathetic nervous system is responsible for the body’s “fight or flight” response, a state of elevated activity and attention. Blood pressure and heart rate increase as a result, and nearly all living tissue is innervated (Waxenbaum et al., 2021). Contrastly, the parasympathetic nervous system, which promotes “rest and digest,” lowers heart rate and blood pressure, and innervates only the certain parts of the body such as the head (Waxenbaum et al., 2021).

This paper explores the viability of passive music therapy, music listening that eliminates rhythmic movement involved in active music therapy (McPherson et al., 2019), as a means of reducing stress in the post-COVID world. First, the mechanics of

music listening and emotional processing are explored; second, the mechanisms of stress are identified; third, the intersection of the brain regions affected by stress and music is analyzed. Subsequently, I propose how music can be used as a therapeutic tool for stress.

Methodology

This paper is a literature review compiled using search engines such as Google Scholar and Pubmed. There was no restriction on the end date of the articles chosen. However, the initial date was restricted to January 1, 2000. Keywords used to locate sources include music, limbic system, neural basis of music perception, music and emotion, mesolimbic system, amygdala, neural basis of stress, and the parasympathetic nervous system. Findings from the articles were then categorized into five main sections: Neural Basis of Music Perception, Emotional Processing of Music, Stress, Music as a Therapy for Stress, and Choosing Music for Stress Relief Music Therapy. This study will focus on the emotional processing of music as it most pertains to the brain’s response to stress.

Neural Basis of Music Perception

The sensory system for hearing is arranged in a hierarchical manner, beginning from the neural processing stations in the ear and ascending to stages with growing complexity or abstract features (Warren, 2008). Acoustic information is first translated into neural information within the cochlea (inner ear) (Kolesch and Siebel, 2005), where complex sounds are converted into electric impulse or signals (Särkämö et al., 2013). The information is then transmitted from the auditory nerve to the auditory brainstem (Särkämö et al., 2013), allowing features such as periodicity or intensity of the sound to be processed. From the brainstem, auditory information travels to the thalamus, and is projected primarily to the primary auditory cortex (PAC) and adjacent secondary auditory fields in the temporal lobe, and also to the amygdala and medial orbitofrontal cortex (Kolesch and Siebel, 2005; Särkämö et al., 2013). Within the auditory cortex (AC), more specific information such as pitch chroma, timbre, and intensity are extracted (Kolesch and Siebel, 2005). In subsequent stages, the cerebral cortex is involved (Warren, 2008).

Following the initial encoding, music triggers cognitive, motor, and emotion processes controlled by both cortical and subcortical areas. For instance,

listening to familiar music may activate processing in the hippocampus, medial temporal, and parietal areas—regions involved in episodic memory—while music perceived as emotion may engage limbic and paralimbic areas (Särkämö et al., 2013).

Emotional Processing of Music

Analysis of functional neuroimaging studies (e.g. fMRI and PET) have shown music to modulate activity in brain structures such as the amygdala and nucleus accumbens (NAc) which are crucial to processing emotion (Schaefer, 2017). The structures documented are involved in both the limbic system, a complex network central to emotional processing (Koelsch, 2010).

Limbic System

Virtually all limbic structures are shown through functional neuroimaging and lesion studies to be affected by music-evoked emotions (Koelsch, 2010). Though there is no universal consensus on the total list of structures in the limbic system, key brain regions involved are: the limbic cortex, hippocampal formation, amygdala, septal area, and hypothalamus (RajMohan and Mohandas, 2007). Limbic brain regions communicate back and forth with other regions including the thalamus and midbrain. The limbic system induces emotional responses like fear as well as autonomic and endocrine responses (Rajmohan and Mohandas, 2007). Pleasant music is found to activate both limbic and paralimbic structures such as the posterior hippocampus, nucleus accumbens, and anterior insula (Koelsch et al., 2006). Unpleasant stimuli, based on blood-oxygen-level-dependent (BOLD) responses comparing unpleasant and pleasant stimuli, were shown to inhibit emotional activity in limbic regions. Pleasant music can therefore be favored to alter limbic activity.

The amygdala, a highly differentiated region located near the temporal pole of the cerebral hemisphere (Swanson and Petrovicha, 1998), plays a crucial role in regulating and modulating the emotion network (Schaefer, 2017). After the amygdala receives and processes information from the central auditory system and sensory systems, signals are sent to pathways to the hypothalamus, an area integral to maintaining homeostasis and overcoming stressors (allostasis) (Saper and Lowell, 2014; Schaefer, 2017; Akimoto et al., 2018). When music is processed, projections to the hypothalamic-

brainstem structures from the amygdala and hippocampus induce autonomic and endocrine responses (Li, Cheng, and Tsai, 2019). One hormone produced by the hypothalamus is oxytocin. Oxytocin responses occur during music listening after the music stimuli is transferred to the amygdaloid body and the hypothalamus receives information from the amygdaloid body circuit (Akimoto et al., 2018). Some studies suggest that pleasant stimuli increase oxytocin production (Akimoto et al., 2018); oxytocin is said to regulate the hypothalamic-pituitary-adrenal (HPA) axis (Akimoto et al., 2018; Neumann et al., 2000) by reducing the amount of cortisol (C21H30O5) released by the HPA axis (Schaefer, 2017), indicating the hypothalamus can affect the parasympathetic nervous system (Schaefer, 2017).

One pathway related to the limbic system is the mesolimbic system, a dopaminergic reward pathway originating in the ventral tegmental area (VTA) of the brain that projects to the amygdala, NAc, and hippocampus (Cox and Lee, 2016). Functional magnetic resonance imaging (fMRI) conducted by Menon and Levitin (2005), aimed to examine the role of the mesolimbic pathway involving the NAc and VTA, found important dynamic interactions mediated by the VTA to the hypothalamus, insula, and orbitofrontal cortex (OFC) (Menon and Levitin, 2005). The pathway is functionally connected to the AC; for instance, connectivity between the AC and NAc can dictate whether an individual will purchase a song (Schaefer, 2017).

The mesolimbic pathway starts first in the VTA, an area in the brainstem. Mesolimbic dopamine neuron cell bodies are found in the VTA, and are projected to the NAc, a structure involved in pleasure, reward, and addiction located in the ventral striatum (Schott et al., 2008), via the mesolimbic pathway (Menon and Levitin, 2005). VTA and NAc activations were found to be significantly correlated, indicating a link between hedonic music and dopamine release; greater feelings of reward during music listening is attributed to increased dopamine levels in the VTA and NAc (Menon and Levitin, 2005). The release of dopamine affects pleasure (“chills” are one indication) as well as motivational drives of musical reward (desire to spend money) (Ferreri et al., 2019). Even in the absence of chills, activity changes in the amygdala, ventral striatum, and hippocampal can occur as indicated by a 2006 fMRI study (Schaefer, 2017). This emotional arousal is correlated with increased sympathetic nervous system as measured by a study

that examined sympathetic nervous system markers such as heart rate and body temperature following pleasurable music listening (Zatorre and Salimpoor, 2013).

As highlighted by recent studies, key limbic regions affected by music include the amygdala, hippocampus, and hypothalamus. In addition, music is proven to modulate both the sympathetic and parasympathetic nervous systems, with the regulation of the HPA axis correlating with parasympathetic activity and the increase of dopamine associated with sympathetic activity. This indicates that different music may yield different responses, hinting that the specific genre or type of music may be important to examine to achieve the best stress mitigating effects.

Stress

The brain is the primary target for various stressors due to its sensibility to stress-induced situations (McEwen and Gianaros, 2010; Kumar et al., 2013) and is also the location where the stress response begins, as the brain can discern whether a stimulus is threatening (McEwen and Gianaros, 2010). First in the stress response is the perception of a threatening stimulus (Godoy et al., 2018). Stimuli can be generally categorized into either physical (e.g. infection or hemorrhage) or psychological stressors (e.g. failure to satisfy internal drives) (Godoy et al., 2018; Doewes et al., 2021). Different stressors—physiological or psychological—are processed in different brain circuitries, though there may be some overlap (Godoy et al., 2018; Doewes et al., 2021).

The brainstem and hypothalamic regions of the brain are the main structures involved in the processing of physical stressors (Godoy et al., 2018; Doewes et al., 2021). Short-lasting responses such as alertness occur as a result of the sympathetic adrenomedullary system (SAM), the first phase stress processing (Godoy et al., 2018). Activation of the HPA axis occurs as the second phase, resulting in amplified and prolonged secretory reactions (long-lasting responses) (Godoy et al., 2018; Doewes et al., 2021). Apart from the brainstem and hypothalamic regions, limbic regions such as the amygdala, hippocampus, and prefrontal cortex (PFC) have been shown to participate in the stress response for physical stressors by influencing the autonomic response to stress and stimulating the HPA axis (Godoy et al., 2018; Doewes et al., 2021).

Psychological stressors tend to induce physical and cognitive stress responses. Fundamental in the regulation of the stress response for psychological stimuli are the prosencephalic nuclei and limbic regions like the PFC, amygdala, hippocampus, PVN, VTA, and NAc. PFC's significance in the stress reaction is complicated; however, one known role of the PFC is sending major projections to the amygdala, which was initially proven to stimulate corticosteroid synthesis and secretion (Godoy et al., 2018; Doewes et al., 2021).

The HPA axis is activated by both physiological and psychological stressors, signifying that it plays an important role in stress response. Moreover, there is an anatomical overlap between brain regions affected by physiological and psychological stressors and music. For both stress and music, limbic regions were documented as critically involved. Activity within these areas, such as the amygdala and hippocampus, suggest that music has the potential to affect brain areas implicated in stress, and consequently, alter the body's response to stress.

The stress response system is also interconnected with many hormones and neurotransmitters. The HPA axis is critically involved in hormone release, while neurotransmitters involved include serotonin and dopamine (Kumar et al., 2013).

HPA Axis

Activation of the HPA axis is among the most distinguished features of the physiological stress response (Stanwood, 2019). After a stimulus is received in the hypothalamus, the HPA axis is initiated. Corticotropin releasing factor (CRF) is released, which then initiates the release of adrenocorticotropic hormone (ACTH) and beta-endorphin from the pituitary. Released ACTH triggers the liberation of adrenal steroids such as cortisol and testosterone (Schaefer, 2017; Kumar et al., 2013). High cortisol levels are associated with greater stress, regardless of psychological or physiological stressors (Schaefer, 2017). Once the threat subsides, cortisol levels decrease, and the parasympathetic nervous system lowers the stress response (Weissman and Mendes, 2021).

Understanding the role of the HPA axis in stress and music listening responses is crucial towards understanding the effect of music therapy on stress. Significantly, music and stress alter the HPA axis in

opposite ways: stress activates the axis while music can regulate it, inducing the parasympathetic nervous system which lowers the stress response.

Serotonin

Long-standing stress has been evidenced by previous studies to reduce serotonin levels (Kumar et al., 2013). Within the endocrine system, serotonin has a complex effect on the stress pathway as it helps to regulate the HPA axis at many levels (Berger et al., 2009). It was found that oxytocin triggers serotonin release (Lefevre et al., 2017).

Because oxytocin and the serotonin produced regulates the HPA axis, it likely may be an important chemical in the stress coping response. Thus, higher levels of serotonin or oxytocin may be associated with lower levels of stress and may be an indicator towards whether music therapy is beneficial or not.

Dopamine

Preclinical studies have suggested varying dopamine responses to different stimuli. More acute, controllable, or escapable physical stressors were found to increase dopamine release in the ventral striatum, while chronic, inescapable stressors reduced dopamine levels (Kumar et al., 2013). Further, dopamine facilitates the stress response by coregulating chemical transmitters (Stanwood, 2019).

Interestingly, both stress and music can induce the dopaminergic system. Though dopamine contributes to the stress response, it may also affect the stress coping response (Stanwood, 2019). For instance, midbrain dopamine neurons were found to be capable of regulating the HPA axis as dopamine decreases reduced stress-induced corticosterone secretion (Stanwood, 2019), suggesting music's ability to increase dopamine levels may not necessarily signal an increase in stress, but rather, may help reduce stress.

Music as a Therapy for Stress

In general, music that is considered pleasurable or relaxing is correlated with decreasing stress. The ventral striatum, part of the mesolimbic "reward" pathway, is activated during pleasurable music listening; for instance, music that is found pleasurable because of its familiarity (Chanda and Levitin, 2013). "Relaxing music" (generally including slow tempo, consonant, low pitch, and no lyrics)

was demonstrated to decrease stress and anxiety in healthy subjects, pediatric patients undergoing medical procedures, patients undergoing invasive medical procedures (e.g. surgery, dental procedures), and those with coronary heart disease (Koelsch et al., 2006; Chanda and Levitin, 2013). Secretory immunoglobulin A (sIgA) is an antibody involved in immune exclusion, the process of limiting access of microorganisms, bacterial, or antigens (Schaefer, 2017; Corthésy, 2013); high levels of sIgA are associated with positive effects, while low levels may relate to chronic stress (Schaefer, 2017). Relaxing music or musak were observed to significantly increase sIgA concentrations (Schaefer, 2017; Kreutz et al., 2004). A 2004 study found no significant changes in sIgA, but did note a decrease in cortisol levels (Kreutz et al., 2004). Though many studies reaffirmed the benefit of music therapy towards stress, not all studies found a significant change likely because music is very subjective. Taken together, the findings generally indicate that relaxing music can reduce stress. Since the 2004 study did not find significant changes but also did not discover adverse effects of relaxing music, it signals that relaxing music for music therapy may be a good strategy to potentially help patients suffering from stress without the risk of inducing much harm.

Various characteristics of the music presented often impacts the effects of music therapy. Classical choral, meditative, and folk music have been found to greatly lower cortisol levels, while techno music has been correlated with increased cortisol levels (Schaefer, 2017; Chanda and Levitin, 2013). The increase in cortisol level triggered by techno music highlights how certain types of music may actually increase stress levels as opposed to decreasing levels, thus underscoring the importance of choosing the right music for stress therapy. Unlike the more relaxing music types such as classical, choral, or meditative, techno music is characterized by its heavy bass drum on each beat, snare of clap on the second and fourth beats, and hi-hat on the sixteenth beat. Likely, this strong drumming pattern impairs the relaxing qualities of music. Slow-tempo music has also been shown to increase salivary oxytocin compared with fast-tempo music (Akimoto et al., 2018). Because brainstem neurons generally fire synchronously with tempo, slow music and musical pauses often correlate with lower heart rate, respiration, and blood pressure, whereas faster music increases such parameters (Chanda and Levitin, 2013). Another study compared three pieces of music selected due to their different rhythmic properties: a Strauss waltz (regular rhythm),

a modern piece by H.W. Henze (irregular rhythm), and a meditative piece by Ravi Shankar (non-rhythmic). Though the meditative piece was shown to significantly reduce plasma levels of cortisol and norepinephrine, no effect was concluded for the other two pieces (Chanda and Levitin, 2013). Results from this study indicate non-rhythmic music may be best used as a stress therapy. Additional study explored the effects of 528 Hz music, which has more recently been regarded as “healing” music, and 440 Hz music, music based on the reference tone of tuning. Exposure to 528 Hz soothing piano music significantly reduced mean cortisol levels and increased mean oxytocin levels after 30 minutes, while exposure to 440 Hz music showed slightly decreased mean cortisol levels after 30 minutes. No stress mitigation effect could be confirmed from the 440 Hz condition because there were no significant differences in the mean oxytocin levels or mean levels of cortisol (Akimoto et al., 2018). Taken together, results from these experiments suggest that music is beneficial to treating stress and may share characteristics such as an absence of a strong bass (i.e. classical choral, meditative, and folk music), slow tempo, and pitch based on the 528 Hz tone.

When using music as a therapy for stress, regard for individual music preferences and context factors appear to be significant in mediating the effects of music (Kreutz et al., 2004). Further, some researchers noted that music preferences may vary depending on the listener’s mental state (Akimoto et al., 2018). These two factors underscore how music therapy not only varies from person to person, but may even differ in an individual from time to time. Because of this, there may be some disparities in the studies presented, as the music chosen may now have been the most pleasurable or relaxing to all participants. In addition, it highlights the need to carefully examine the individual to find his/her preferences when selecting music used to alleviate stress.

Based on the studies outlined above, I propose that certain types of music, the most optimal generalized as music that people find pleasant and relaxing, which may typically feature characteristics such as familiarity, slow tempo, absence of strong drumming, and non-rhythmic patterns, can be used to activate the parasympathetic nervous system to reduce cortisol and relieve stress. This is especially useful in the post-COVID world where stress has increased and music streaming platforms have made music more accessible than ever. For the best results,

individual preference and mood should be taken into consideration as music is very subjective.

Choosing Music for Stress Relief Music Therapy

Preferential relaxing music best suited for stress relief music therapy often possesses characteristics such as familiarity, slow tempo, and non-rhythmic patterns. Though people’s music preferences are shaped by factors such as ethnicity, personality, and/or social class, the most determining factor has been identified as age and nostalgia (Davies et al., 2022). This indicates that finding music released during a person’s late adolescence or early adulthood may help when selecting music for music therapy. For instance, for the Baby Boomer generation, one might choose more music under the rock and roll genre, while pop or hip hop might be used more for Generation Z. While familiar, self-selected songs have shown to reduce stress (Labbé et al., 2007), other studies revealed that classical music has a greater benefit (Chennafi et al., 2018). Likely, both the popular, familiar music and classical music can induce oxytocin stimulation, associated with positive, happy feelings; however, the genres most popular amongst generations tend to have a faster, upbeat tempo which is involved more in emotional excitation (Ooishi et al., 2017), contrasting with the physiological relaxation associated with slower tempo music.

In regards to classical music, I propose that music from the Impressionist Period may be best suited for passive music therapy when treating stress. Pieces from this period are known for evoking more surreal impressions or feelings, less confined to a traditional harmony or structure. Further, the music often lacks a steady, defined rhythm, unlike music from other periods. Choosing slower tempo Impressionist music can thus fulfill characteristics of relaxing music such as a slow tempo and non-rhythmic pattern known to activate the parasympathetic nervous system.

CONCLUSION

Of the total respondents in the United States 2022 Pandemic Anniversary Survey conducted online by The Harris Poll on behalf of the American Psychological Association, 56% noted that they could have used more emotional support than received since the onset of the pandemic. Music, which can lower stress and stimulate pleasure, may be an effective

tool to help address such needs. Stress activates the sympathetic nervous system, stimulating the HPA axis and producing cortisol, while music listening triggers the parasympathetic nervous system which regulates the HPA axis and lowers cortisol production. Before using music as a therapy for stress, though, individual preferences regarding relaxing and pleasant music must be considered to ensure music will alleviate, not magnify stress. Music selections can be made by taking in factors such as the person's age to choose music popular during their adolescence. Classical music was also shown to be amongst the most effective genres to use, and music specifically from the Impressionist Period may be a good selection, fitting characteristics of stress relieving music such as a non-rhythmic pattern. Future studies may analyze music preferences amongst certain age groups or cultural groups to identify genres or songs that are viewed as most pleasurable or relaxing to each category. More research can also be conducted to assess the impact of music therapy in conjunction with other tasks such as exercise as a means of reducing stress.

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Why Women Serial Killers Kill: An Analysis of Elizabeth Bathory

By Lingshi Chen

AUTHOR BIO

Lingshi is a secondary school student studying in Auckland, New Zealand. She is passionate about the biological sciences as well as philosophy and ethics. As an ethics olympiad gold medalist, she strives to unravel the mysteries of the past and apply modern theories as to why history is shaped the way it is in the present. Acknowledged mentor: Dr. Esther Hanes.

ABSTRACT

Over the past century, serial killers have become an inseparable part of pop culture as we see references to killers such as Jack the Ripper and Ted Bundy. They are defined as killers who kill continuously over a certain time period, usually with three or more victims (Hanes, 2022). The current media overdramatize these killers and sometimes present them very differently from what they were like. Movies, TV shows and books twist and change their stories in order to capture more audiences and clicks and alter their personalities completely to catch eyeballs. However, one female stands out among the male killers as the most sensationalized and twisted in history: Countess Elizabeth Bathory. More commonly known as the blood countess or Countess Dracula, Elizabeth Bathory was a serial killer active in the 1500s who also fell victim to the media. Modern culture shows her as a blood-sucking vampire, a monster who bathes in the blood of young women and an inhuman creature like they do with most supposed evil women (Stang and Trammel, 2020). A common misconception is that Elizabeth's crimes were caused by satanic rituals and connections to witchcraft instead of actual scientific explanations. This paper aims to explain that Elizabeth Bathory's crimes are more likely caused by either childhood trauma or neurological damage as a child than influences of satanism and witchcraft as believed at the time.

Keywords: Serial killers, Elizabeth Bathory, criminology, criminal psychology, murderers, female killers, mass murders, serial killings, true crime, murder theories

Countess Elizabeth Bathory de Ecsed was born Bathori Erzsebet on 7th August 1560 into a wealthy family in Hungary. Her father was a Baron, making her mother a Baroness (Wikipedia, year). Her childhood is a widely disputed topic, with some sources stating that she was abused and some stating that she was introduced to witchcraft. There were even rumours amongst the peasants that she gave birth to a child at the age of thirteen who was given away to a local woman. Due to the fact that these events occurred too long ago, it is difficult to find solid proof of what happened during her childhood as it is largely undocumented. However, if they are to be believed, some of these events do provide an explanation for her actions later on in her life. She was first married in 1573 to Count Ferenc Nadasky and gifted the Castle of Csejte, where it was alleged she later kept girls in captivity and tortured them. She was later imprisoned in that same castle after her crimes were exposed.

Her husband was sent to war in 1578 and left Elizabeth in charge of the house. During this time, she had to intervene and defend women from the Ottomans as the Ottoman empire was trying to keep Hungary under its control. This led to her hearing of and witnessing some horrifically violent events these women went through. Her husband later returned from war and they were together for another 26 years before Ferenc passed away. He made the choice of entrusting his widow and heirs to a man named Gyorzy Thurzo, who later ended up investigating Elizabeth, leading to her imprisonment.

Her husband's death marked the start of Elizabeth's violent ways. According to many sources, she has shown violent behaviour towards servants in the past and has been accused of killing some of them before her husband passed away. However, it is after he died that she started directly killing girls and actively seeking out new victims. Between 1604 and 1610, rumours of Elizabeth's killings reached the court of Vienna and the King assigned Thurzo to collect evidence against Elizabeth. He allegedly collected over 300 witness statements at the end of 1611, which eventually led to Elizabeth being kept under house arrest in December 1610 in her castle, which is where she stayed until she died.

One leading theory of how Elizabeth turned out this way is that her family abused her or influenced her to be a cold-blooded killer (Source). Childhood trauma is a common characteristic among serial killers as it is one of the most impactful environmental

factors (Hanes, 2022). The fact that she was born in a high-class family also plays a role in this since researchers have predicted that the criminality curve has two modes: one at the lower class and one at the higher class. There are many claims that she witnessed many executions and punishments carried out by her family's officers. She also had multiple seizures and epilepsies during her childhood and common treatments for those illnesses at the time were rubbing blood on the epileptic's lips or feeding them a mixture of a non-epileptic person's blood and skull. These treatments could have been linked to the fact that she was obsessed with the blood of her victims later on. According to a study conducted by Shwab-stone et al. (1999) on a community of adolescents, exposure to violence at a young age had a very strong correlation with external behaviors such as antisocial behaviors and willingness to use aggression and violence. It also had a correlation with internal behaviors such as anxiety and depression. Survey questions were given to students in a school in an area of high crime rate asking them to rate the severity of crimes they've witnessed and whether they experienced any symptoms listed. There were 2748 final surveys completed. It was noted that males had a higher percentage chance of exhibiting external behaviors while females were more likely to exhibit internal behaviours. In Elizabeth's case, she exhibited a lot of antisocial tendencies and aggression as she was known to abuse and later kill her servants physically. There were also records of her lashing out aggressively at servants which shows usage of aggression. There is no solid information in terms of internalized behaviour as mental illness and well-being weren't well researched and understood during the time period.

Another source explaining the correlation between childhood abuse and violent crimes in adulthood is a retrospective cohort study by Mitchell and Aadmott (2005). This study consists of information compiled on 50 serial killers and self surveys three of the killers in the cohort. This study showed that abuse, both physical and mental, has a close connection to becoming a serial killer later on in life. Abuse is much more prevalent among serial killers than among the average population. There were rumours surrounding Elizabeth when she was young about how her aunt abused her and that she had an unexpected pregnancy as a teenager. Although these rumours can't necessarily be proven, it is still possible to see that there is most likely a correlation between her childhood experiences and her actions later on in life.

Another theory is that epilepsy and seizures Elizabeth had when she was young were a sign of some severe mental / physical issue which also happened to cause violent tendencies. Epilepsy has been connected to mental illnesses such as psychosis and schizophrenia which are both conditions that can cause one's mental state to be altered (Stratton et al, 2016). This could've explained Elizabeth going supposedly "crazy" and killing girls while being obsessed with their blood. A percentage between 3% to 7% of the epileptic population was diagnosed with schizophrenia later on and Elizabeth could've been one of those people. Her abusing her servants and lashing out at them at times can be explained by a psychotic episode and would also explain the fact that her actions increased in violence drastically after her husband's death as severe emotions such as sadness caused by losing a loved one can trigger & worsen both schizophrenia and psychosis.

In a study by Kanemoto et al.(2012), dozens of studies were compiled into tables and analyzed. Through the information, it is possible to see that there was a significantly higher percentage of patients suffering from schizophrenia in the epileptic child population. The median percentage of patients suffering from schizophrenia among the general population was 0.22% while the percentage of patients with schizophreniform psychosis in patients with epilepsy was 0.75% (Lindsay et al, 1979).

In an editorial published by Toone (2000), Toone explains that schizophrenia-like symptoms occur in epileptic patients more commonly than chance predicts and that seizures almost always precede the development of psychotic symptoms by a few years. This shows that the likelihood of Elizabeth developing psychotic or schizophrenic symptoms was very high even though they weren't recorded. However, it is unknown today whether Elizabeth did end up developing these symptoms or not. If she did, these conditions would have explained her later actions.

In another retrospective cohort study, Stratton et al (2016) conducted neurological testings on 25 men and women individuals that killed another person. All 25 of them were diagnosed with schizophrenia. The results found that the impaired cognition and decision-making caused by schizophrenia may have an important role in leading the patients up to homicide. This could've applied to Elizabeth if she were to have suffered from schizophrenia or any conditions that would've caused her cognitive functions to be impaired.

One theory was that the Countess was under the influence of witchcraft, which she allegedly studied when she was young. This is why the current media often portrays Elizabeth as a witch using the blood of young girls to stay young. There have been rumours about how she had family members involved in satanism and witchcraft. All of her accomplices and servants involved in the killings were killed or burned under the name of witchcraft after her imprisonment, leading people to believe that she was involved in witchcraft. However, there is no solid proof of these activities and all of the witchcraft claims can easily be explained by the fact that people nowadays and back then tend to portray evil women as inanimate or monstrous witches. There were often witchhunts in the 1600 and 1500 century and many women uninvolved in witchcraft were accused and killed. There are cults and serial killers in the modern era who killed under the influences of religion and witchcraft such as the "vampire murders" in 1996 Florida. However, it was easy to see that these killings were related to Pagan culture as they would refer to themselves as a cult and use very religious words, symbols and markings such as referring to their meeting spots as "hell" (Barker, 2003). Elizabeth displayed none of those traits and the only connection she had to witchcraft and satanism was a supposed family member and the fact that she was interested in blood, which could be explained by other theories.

Overall, society has a tendency to demonize women and portray them as hysterical monsters. However, there are logical explanations as to why Elizabeth Bathory committed her crimes as stated previously in the paper. There is little to no solid proof of witchcraft or satanism and given the time period of the event, it's very likely that she and her servants were sentenced as witches due to the stigma. Looking from a modern perspective, it is possible to see several undiagnosed mental and physical illnesses within her character which could've logically explained her actions.

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Differences between Asian and Western views on Sexual Minorities & Challenges faced by Global Sexual Minorities, especially for Adolescents

By Qiaru Tan

AUTHOR BIO

Qiaru Tan is a grade 11 student in Shanghai, China. I am interested in the psychology and sociology fields, and would like to work on them in the future. I have completed programs related to neuroscience and development psychology. Throughout my contact with psychology, I have been curious about how factors aside from genetics can influence sexual orientation, as I've seen this minority group growing in population, especially among my peers. Outside of academic interest, I love art, including ballet, contemporary dance, appreciating artworks, and painting, all of which enable me to enjoy the beauty of human body, nature, or creation. Through publishing this article, I hope to express ideas about sexual minorities from an adolescent's perspective and hear the voices from comprehensive perspectives in regard to sexual minorities. I sincerely appreciate that you view my work and would love to get your comments.

ABSTRACT

With the rising global population of sexual minorities, especially in younger generations, the difference between Asian and Western countries' views and actions on sexual minorities manifests. On one hand, sexual minorities receive more acceptance due to the improvement in education and ethical awareness. On the other hand, discrimination and prejudice toward sexual minorities, especially in Asian countries compared to Western countries are still brewing. The origin of Asian and Western different views and actions on sexual minorities can be traced back to history and dominant cultures. The contrast between Confucianism, a dominant Asian culture, and ancient Roman culture best buttresses this point. Besides, the societal outlook, collectivism or individualism, forms Asian-Western differences in sexual minorities as well. However, despite cultural differences' impacts on sexual minorities, prejudice and discrimination against sexual minorities are still the primary challenges around the globe. Considering the fact that sexual minorities are more susceptible to mental disorders when compared to the ordinary, they need a great amount of attention and support to gain the courage to disclose their identity and make the world hear their voice. Besides, the proportion of sexual minorities that conceal identity is still high while sexual orientation concealment is associated with a series of mental disorders. Therefore, in terms of these issues, clinical psychology and psychology counseling should provide customized services to ensure sexual minorities' mental health. Sexual orientation education and sexual minority protection should be initiated and popularized in primary schools as well.

Keywords: Sexual minorities, sexual minority adolescents, sexual orientation, sexual identity, Asian-Western culture difference, mental health, sexual orientation concealment, closet, identity disclosure.

INTRODUCTION

The sexual minority refers to those whose sexual orientation or gender identity is different from what the majority in society has. Sexual orientation is the sexual attraction towards the opposite sex, the same sex, both sexes, or neither sex [1]. Gender identity is the sex an individual perceives himself as. This can be a male, a female, a combination of both, or neither.

The sexual minority includes lesbian, gay, bisexual, transgender, queer, intersex, and asexual, among which the first three are the most common sexual minority groups. A study [2] summarized data from 2011 to 2016 in Australia showed that 3.6% of males and 3.4% of females belong to the sexual minority. Interestingly, the younger age groups have larger numbers and higher sexual minority percentages than the older age group [2] (Table 1). When extrapolating the data, it is predictive that adolescents will have an even higher percentage in the sexual minority.

Table 1[2]: Percentage of Australia's population identifying as a sexual minority by age group between 2011 to 2016.

Age Group	Percentage of the sexual minority
18-24	5.39
25-34	4.96
35-44	3.42
45-54	2.69
55-64	2.63
65+	2.16

*Note: Table is adapted from the Table in the reference

Another study reported the sexual minority data in the US among adolescents in 2020. The data [3] clearly showed that the population of sexual minorities, especially adolescents, increased. The proportion of adolescents reporting minority sexual orientation identity nearly doubled, from 7.3% in 2009 to 14.3% in 2017 [3].

When talking about factors contributing to minority sexual orientation, genetic factors is the one supported scientifically. According to a monozygotic twins study [4], genes are a definite factor in sexual orientation. Thirty-eight pairs of monozygotic twins and twenty-three pairs of dizygotic twins were the

subjects of this study. Researchers got the result that 65.8% of monozygotic twins tend to develop homosexual orientation together, while only 30.4% of dizygotic twins tend to do so [4].

Since genetic factor only matters by chance, there are also social factors rising the population of the sexual minority. Over the last decades, research in human development has been paying more attention to the sexual minority, most of which is on youth, adolescence, and vulnerabilities [5]. This growing attention causes more liberal societal attitudes toward sexual orientation diversity, increasing the acceptance of the sexual minority. Moreover, with increasing education level, the majority realizes the ethics related to accepting the sexual minority, since it is closely related to the uncontrollable factor - genetics. As a result of the changing societal attitudes toward the sexual minority, potential subjects to the sexual minority may realize their authentic sexual orientation. There is also an increasing number of the sexual minority that feel less anxious about their identity and are willing to disclose it. Specifically, the sexual minority begins to disclose their non-heterosexual orientation at an earlier age, averagely [6]. All these factors lead to a rise in the sexual minority population, as more people define their sexual orientation correctly and willing to disclose them.

However, opinions on the sexual minority differ according to country. Generally speaking, Asian countries hold more conservative opinions and a lower likelihood of acceptance toward the sexual minority, compared with Western countries' more liberal views on the diversity of sexual orientations. A study [7] investigating the effect of Asian values on sexual minorities suggested that the adherence to Asian values is positively related to internalized heterosexism, or internalized homophobia, and is negatively related to sexual orientation disclosure to others. By contrast, the legalization of homosexual marriage and acceptance of sexual minorities are more common in Western countries.

Discussion

1. Culture & History

When identifying factors contributing to the differences between Asian and Western countries regarding sexual minorities, cultural contexts plays a critical role, as the dominant culture in one area largely determines people's behavior and thinking there.

Confucianism is a dominant culture influencing Asian countries such as China, Korea, Japan, and Vietnam. A study [8] done in three Asian cities - Hanoi in Vietnam, Shanghai in mainland of China, and Taipei in Taiwan - suggested that the percentage of adolescents and young people who hold a positive view of homosexuality is relatively low in Asian countries influenced by Confucianism. With 13.5% of males and 15% of females in Hanoi, 19.5% of males and 28.1% of females in Shanghai, and 33.8% of males and 58.6% of females in Taipei think homosexuality is normal. The overall percentage increased from Hanoi to Shanghai to Taipei. This study [8] found that respondents with higher economic and educational status are likely to have a more positive perception of homosexuality. Also, more contact with Western movies or videos may increase the possibility of a positive view of homosexuality [8]. Therefore, as Taipei is a Chinese city more influenced by Western culture than Shanghai, and as Shanghai and Taipei are overall more developed than Hanoi, the difference between these three cities' data corresponds with the finding.

Social virtues under Confucianism restrict sexual minorities' expression and their possibility of being accepted. One of the main Confucian virtue is the filial piety [9], meaning the complete obedience to one's parents and good care of them. For example, Chinese parents put great pressure on sexual minorities who reach the age of marriage to get heterosexual marriage [9], probably because their children have not "come out" or parents do not support non-heterosexuality. With the Confucian virtue of filial piety, parents' imperative expectation for marriage and pregnancy forces some sexual minorities to conceal their identity and obey.

By contrast, western history predetermined the higher possibility of acceptance of sexual minorities. Ancient Rome was not specifically free in homosexuality but was free in sexuality as a whole. As ancient Romans legalized prostitution [10], and valued "Pornographic" paintings [11], ancient Roman culture exposed western countries to extremely liberal sexuality through literature, art, and remains. Even though the current western culture is not influenced by ancient Roman culture in this aspect, the interaction between these two cultures still expands the view western countries have on sexuality, making sexual minorities more acceptable when compared to legalized prostitution and "Pornographic" paintings. Apart from that, ancient Rome set examples for

what is known as homosexuality today. Within that patriarchal society, males could take advantage of homosexual behavior to express their masculinity and status, if they are in the "dominant, or penetrative" role. Ancient Roman culture contains quite a few artworks such as paintings or sculptures representing homosexual behaviors. As western countries do appreciate Roman art, they somehow intake Roman values and ideologies. For instance, British Museum states that its prints and drawings department holds many works on paper connecting with LGBTQ.

2. Collectivism & Individualism

Collectivism versus Individualism has always been a topic that separates Asian and Western culture. While collectivism prioritizes the goal of a group over individual interests, individualism emphasizes the right and interests of an individual [12]. It is reasonable to contend that societal outlook of whether collectivism or individualism affects people's attitudes and behaviors towards sexual minorities.

Most Asian countries are collectivist. This leads the majority to adopt the rules that standardize the group, and try to conceal their voices that are divergent from the crowd. Specifically, people under collectivist society attach importance to interpersonal connections, and tend to alter individual response to others' thoughts or feelings. Sometimes, even not expressing the true feeling [13]. Similar things happen to sexual minorities who worry to "come out" to family and friends, mainly because of their misgiving about others' reaction and the lack of support from the societal norm. Asian sexual minorities tend to conceal their identity, which in turn diminish their own right and interests. This is because the contradiction between following collectivism and expressing self-identity may lead to serious mental disorders, as the minority stress theory claims that sexual minorities are prone to develop mental and physical problems through the exposure to prejudice and stigma [14].

On the other hand, western countries uphold individualism, which forms people's pursuit of high independence and diversity within society, and makes them feel free and comfortable to critically comment on public events if they oppose. As this is the case for western sexual minorities, they feel less stressful about coming out when compared to the ones from Asian. This is particularly because they take much less notice of others' subjective views if prejudice appears. They also get supports from the population

who favors sexual minorities, as they are comfortable speak up for sexual orientation's and gender identity's diversity. Sexual minorities living a publicly known nonheterosexual life and getting recognition and approval from other people is their basic right to recognition [15]. As individualist values individual right, the legalization of same-sex marriage are more common in western countries.

4. Culture difference examples

The effects of both history and social outlook on sexual minorities not only include a country's policy on sexual minorities marriage and the population's general standpoint regarding sexuality, but also trivial or daily affairs. I will provide two examples from China and the U.S to explain.

Within Chinese film industry, most producers of films with sexual minorities topic or clips of non-heterosexual behaviors face difficulty to obtain film release license and official publication opportunities from China Film Administration. Despite the hurdles producers experiencing of getting the permission to shoot a sexual minorities film, their productions still have high risk of being cut by China Film Administration. Apart from that, films from abroad would also be limited if there are sexual minorities scenes. Clips cutting and publication prohibition occur frequently to those foreign productions in Chinese film market. Limited access to foreign films related to sexual minorities can only be found on nonconfirming website which are quite unstable for audience to watch films.

On the contrary, most United States universities and high schools have LGBT organization, a specific community created for sexual minorities. Through hundreds of universities' official website, we can always find a webpage for sexual minorities organization, LGBT+ support club. Some Universities also offers degree programs on sexual minorities. Sexual minorities is not a topic people avoid to discuss in the public, Instead it is a community that is well protected, and an academic subject that is taught and continues to be explored.

5. Potential challenges & Suggestions

No matter Asian sexual minorities or Western sexual minorities, mental health is a common problem among them. A study [6] traced the origins of sexual minority adults' elevated mental disorders

including depression and mood disorders, anxiety disorder, posttraumatic stress disorder, alcohol use and abuse, suicide attempts or ideations, and psychiatric comorbidity. The result shows that distress and behaviors related to these disorders appeared in those adults' youth, meaning sexual minority adolescents are more likely to develop mental disorders than their heterosexual counterparts. Clearly, the awareness of distinct identity from others has been affecting sexual minorities greatly since their adolescence, during which the public's discrimination and prejudice, especially peers', interrupt their role determination process and lead to introverted personality or weak interpersonal skill. However, sexual minorities' mental health problem is not only associated with their awareness of their identity, but is also associated with their response to this awareness, specifically the concealment of sexual orientations. There is a positive correlation between sexual orientation concealment and internalizing mental problems, including depression, anxiety, distress, and problematic eating [16]. Moreover, according to a representative study from the United States [17], DSM-5 eating disorders, including anorexia nervosa, bulimia nervosa, and binge-eating disorder, are more commonly diagnosed among sexual minorities. The prevalence rate for anorexia nervosa, bulimia nervosa, and binge-eating disorder are 1.7%, 1.3%, and 2.2% respectively, which are higher in sexual minorities adults compared to their heterosexual counterparts [17].

As mentioned above that sexual orientation concealment, or known as "closet", is likely to contribute to internalizing mental problems, the large number of sexual minorities conceal their sexual orientations is another challenge. The result from a recent survey [18] done on 85,582 sexual minorities from 28 European Union member countries suggests that 83% of the global sexual minority population conceal their sexual orientations from all or most people. Apart from mental health problem, the large size of global "closet" also diminishes the societal structural reform that benefits sexual minority [18]. Specifically, if most of the sexual minority population's identity is invisible in public, they are less likely to get public acceptance and support. However, it is because of an alteration in public opinions and behaviors that the social structure can reform to vacate a space for sexual minorities [18].

Sexual minorities are likely to avoid facing their mental health problem directly, mainly because they are unwilling to acknowledge their identity

may be a factor in mental problems. It is strongly recommended that psychology counseling and clinical psychology industries create a special channel for sexual minorities, as most of this population still feel stressful to disclose their sexual orientations or discuss their identity with others, and is also more prone to develop mental disorders than heterosexual counterparts. Therefore, psychology counseling and clinical psychology institutions should consider cultivating professional practitioners who specialize in sexual minorities as their subjects, clients, or patients, so that an approach to protect mental health is available for those unwilling to disclose sexual orientation to family, friends, and medical or psychology staff.

Besides, the protection of sexual minorities should start at an earlier age. As mentioned above that the origins of sexual minority adults' mental disorders can be traced back to their youth, sexual minority education and protection should be strictly implemented throughout primary school to high school. For example, there could be public lectures, student organizations, clubs, extracurriculars, and demonstrations that all aim to stress that each kind of sexual orientation or gender identification is a normal variable among humans.

CONCLUSION

Culture, history, and societal outlook contribute to Asian and Western countries' different views and actions on sexual minorities, which can be seen in some Western countries' legalization of homosexual marriage and a higher proportion of sexual minority acceptance than that of Asian countries. Unfortunately, discrimination and prejudice toward sexual minorities still exist in every corner of the globe. Although the proportion of positive views on sexual minorities on a global scale rose significantly when compared to the past, mental health problems and sexual orientation concealment are still great challenges for sexual minorities, especially their effects that can be traced back to adolescence period. As mental disorders become highly associated with sexual orientation concealment and the proportion of sexual minorities unwilling to disclose identity keeps high, the public's acceptance and support are imperative for the mental health of sexual minorities and the survival of sexual orientation diversity. Therefore, psychology counseling and clinical psychology should provide specialized, more

customized services for sexual minorities to ensure they would resort to professionals without worrying about identity disclosure. Sexual orientation education and sexual minority protection should be popularized at an earlier age as well.

Looking at the big picture, cultural diffusion would benefit sexual minorities, as if Western culture diffuses, relatively more open opinions on sexual minorities would spread on a large scale in Asian countries. In spite of whether the discrepancy between Asian and Western views and actions on sexual minorities would reduce or not, the elimination of discrimination and prejudice against minority groups should always be prioritized to maintain the good health of society.

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The Impact of Music Education on the Linguistic Ability of Children under Seven

By Talia Dauer

AUTHOR BIO

Talia Dauer is currently a senior at Greenhill School in Dallas, Texas. Talia is an avid flute player, founder of her school Tri-M chapter, highly involved in school musical ensembles, private instruction, international, national and state competitions, and selective summer music programs. In addition, Talia founded a national organization to provide volunteer music performances to hospitals and retirement centers and teaches music to children on a pro bono basis. Through her research for this literature review, Talia became particularly interested in the intersection of music and the brain in the adolescent population, specifically under the age of seven. This past summer, she had the opportunity to investigate the neurobiology of vocal learning in zebra finches as a research assistant in a neuroscience laboratory. In college, Talia intends to continue her research in the field of music cognition.

ABSTRACT

Research in the area of music cognition demonstrates a clear positive correlation between music education and linguistic development in the adolescent (specifically under seven) population. This relationship is modeled most commonly by an electroencephalogram (EEG), which records brain activity – the firing of electrons – throughout the auditory pathway. The auditory pathway processes music and language; the maturation and plasticity (i.e., ability to learn) of this pathway is a major focus of music cognition and adolescent brain development research. By recording the EEG responses of musicians and non-musicians to evoked potentials, it is observed that musicians' brains demonstrate less latency. This finding indicates that musicians' brains are better equipped for other realms of linguistics, such as vocabulary. Although the intersection of socioeconomic status with music education was not an initial focus of my research, it became clear early on that socioeconomic status impacts the availability of a quality music education as well as adolescents' linguistic development. This review lends insight into the importance of recognizing and working to implement accessible music education.

Keywords: Music cognition, music education, music education and the brain, socioeconomic status and music education, linguistics and music, adolescent linguistic development, language acquisition.

INTRODUCTION

This literature review focuses on studies that explore the effect of before age 7 music exposure on later linguistic ability. I focus on two elements: neurolinguistics - the technical aspects of storing language in the brain, and socioeconomic status - the impact of class on access to effective music education. Studying socioeconomic status was not an initial aim, but it became clear through this work that it is an important aspect of music education, impacting both the accessibility of a quality music education and linguistic development.

I begin by summarizing the methodology used to write this review, including dates of studies reviewed, keywords, and search engines used to find sources. Following a discussion of the neurophysiological measures that are used to assess the ability of the brain to process music, I then focus on scientific studies. Particular attention is given to two studies, both of which are longitudinal and followed multiple cohorts of children under age seven. Both focus on the impact of music education on the linguistic development of two or more cohorts and follow the maturation of auditory processing using electroencephalograms (EEGs). Different measures of EEG activity are used to measure maturation of the auditory pathway, the different parts of the brain that process music and language. Such measures of auditory maturation and plasticity (i.e., ability to learn) are a major focus of music cognition and adolescent brain development.

Both studies find that early music education increases the neuroplasticity of the auditory pathway, supporting enhanced linguistic ability. These linguistic skills include abilities such as vocabulary size and auditory discrimination – the ability to distinguish similar sounds.

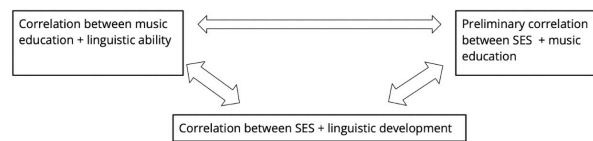
The final section of this review includes original preliminary research I performed focusing on the relationship between socioeconomic status (SES) and music educational opportunities. By analyzing the opportunities for music education at two schools in the same broad Detroit Metropolitan area, I report a stark correlation between SES of students and access to effective music education (e.g., specialized music rooms, specialized teachers, small class sizes, etc.).

Methodology

This literature review includes papers from a variety of sources – Nature, Science Direct, and Developmental Cognitive Neuroscience. I began my research by searching keywords – music cognition, music education and the brain, socioeconomic status and music education, etcetera – on google scholar. To choose the sources to use, I considered the inclusion and exclusion criteria described above. I reviewed studies published from 2010 to present. Because this review focuses on the effect of music education on typically developing children, I chose studies that excluded individuals with pre-existing neurological abnormalities.

Analysis

Overall Strategy and Summary



This three-way diagram is the cornerstone of my research. As indicated in the top right square, my original aim was to study the correlation between music education and linguistic ability. Completing this research led me to the conclusion that there was a correlation. I then explored the correlation between socioeconomic status and music education; this research also supported a link between these factors. These two findings suggested a new correlation: one between socioeconomic status and linguistic ability. Students of a lower socioeconomic status are less likely to receive effective music education, suggesting one reason that they are less likely to develop higher-level linguistic skills by age 7.

Neurophysiology

The term neurophysiology broadly refers to mechanisms the brain utilizes to accomplish any task. Researchers have devised various tests to measure different neurophysiological measures. The main focus of music neurophysiology studies is the auditory pathway, which is altered by music education. Researchers use EEG recordings to map electrical activity as signals are passed from one part of the auditory pathway to another. Specific measures are described further below. In general however, the more mature the auditory pathway, the more rapidly

these signals are detected. These changes are crucial to understand because they are the mechanism by which music alters the brain and enhances its processing ability.

Music Education, and Auditory and Language Skills

‘Music Training for the Development of Auditory Skills’ by Kraus, et al, 2010 establishes a baseline of knowledge about the correlation between auditory skills and music education. This work demonstrates that the skills acquired through music training, such as the ability to discriminate (i.e., hear the difference between) distinct sounds, positively impacts other domains, including vocabulary and reading ability. This effect is believed to occur because music and language have many similarities, such as the need to discriminate pitch and timing. This paper also explores the relationship between sound perception and language comprehension. For example, a musician highly skilled at hearing deviations in pitch through experience with a musical instrument is better equipped to hear ‘pitch contours’ (changes in pitch), and therefore more accurate at labeling a spoken sentence with a characteristic pitch signature as a question. This study also found that early involvement in music training, such as participating in an orchestra, supports the ability to more easily identify and differentiate distinct notes. This cognitive ability has been shown to positively impact hearing pitches in speech – a skill known as ‘sound discrimination.’ ‘Biological impact of preschool music classes on processing speech in noise’ by Strait, et al, 2013, describes an additional benefit of sound discrimination – the ability for one’s brain to isolate an individual’s voice within a noisy crowd. The study notes that even one or two years of music training “protects musician’s neural responses from the degrading effects of background noise,” such as the noise heard in a crowd. These two studies are representative of a number of behavioral experiments demonstrating the ability of early music training to enhance different aspects of auditory discrimination, which benefits language development.

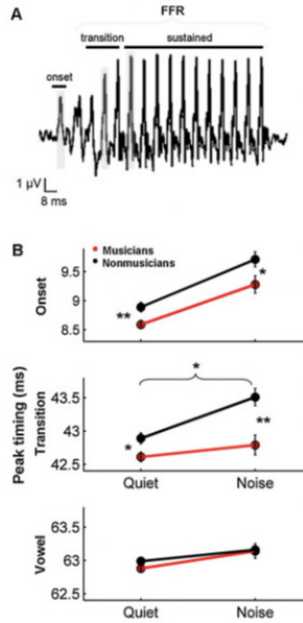
‘Music Training for the Development of Auditory Skills’ (Kraus, et al, 2010) attributes this to enhanced neuroplasticity, the brain’s ability to learn. Music education has been shown to increase neuroplasticity, the underlying cause for increased

sounds discrimination that enhances both musical ability and language comprehension. Enhanced neuroplasticity from an early age may have long term advantages, helping to support the acquisition of new skills to be developed into adulthood. Indeed, adults who took childhood music lessons have been shown to have an easier time learning a foreign language. Learning a new language requires hearing many new and distinct sounds, and the skill of sound discrimination is enhanced by early music education.

Additional support for a link between early auditory exposure and subsequent language development comes from studies that link sound discrimination to socioeconomic status. Sound discrimination is also widely correlated with socioeconomic status. Children of a lower socioeconomic status (SES) are often exposed to more noise. These children tend, statistically, to have more siblings, inhabit busier neighborhoods, and have more classmates due to lack of school funding. They are also less likely to receive musical education. Together with other factors, the combination of these factors is believed to limit the language abilities of children from low SES backgrounds.

Brain Mechanisms and Music Education

In a study by Strait, et al, 2013, entitled ‘Biological Impact of Preschool Music Classes on Processing Speech in Noise,’ researchers from Northwestern University conducted a study with thirty two three-to-five year old children. Two cohorts of children participated in this study. The first cohort consisted of 18 child musicians. The criteria for a child being a ‘musician’ was for the child to have partaken in private or group music lessons weekly for at least a year prior. The other cohort was the 14 remaining children who had not received a formal music education. This longitudinal study compared the two cohorts of children after following them for one year. An electrophysiological measure was used to compare the groups. These researchers measured a brainstem evoked potential known as the frequency-following response (FFR). The FFR is measured from an EEG response following a sound and reflects the brain response to sound. The FFR response was measured at study entry and one year later. Graphs of the level of sound versus FFR onset, peak timing, and sustained FFR response (noted on the graph as ‘vowel’) were recorded.



The musician cohort (in red) had a shorter delay (i.e., more rapid) in neural responses to musical stimuli compared to the non-musician cohort (in black). This is inferred by seeing that the red line had consistently lower values on the Y-axis, meaning that the musician’s brains exhibited the FFR more rapidly. The study was done in both ‘quiet’ and ‘noise’ environments to factor in sound discrimination ability.

Because the musician cohort had consistently lower FFR values in both environments, these investigators concluded that the musicians studied were better able to differentiate sounds.

“Neural correlates of accelerated auditory processing in children engaged in music training,” by Habibi, et al, 2016, used a different electro physiological measure to examine a related question. These neuroscientists from USC used EEG to analyze the brain activity of a group of 37 children aged six to seven. There were three cohorts: 13 children who were provided with formal music training (formal orchestra program), 11 children who received soccer lessons, and 13 who received neither activity. Although not explicitly stated within the paper, including a third cohort of another activity (soccer) is a control for another type of structured learning activity. Auditory pathway maturation was recorded by EEG, measuring the P1 amplitude and latency. A shorter P1 latency indicates that the sound is being processed more

quickly, implying that the auditory pathway is more mature. The researchers found that children in the music cohort consistently demonstrated lower values than either of the two other groups.

P1	Music	Sports	No-training
Baseline Peak Latency (ms)	119	116.6	112
Year 2 Peak Latency (ms)	84	92	87.6
N1	Music	Sports	No-training
Baseline Peak Latency (ms)	NA	NA	NA
Year 2 Peak Latency (ms)	120.7	122.6	128.8
P2	Music	Sports	No-training
Baseline Peak Latency (ms)	202	201.2	197.4
Year 2 Peak Latency (ms)	180.2	179.8	181

This table demonstrates the peak latencies of each of the three groups at baseline (without training of any types), and after two years of training. For P1, the music group had the only notable change (-34ms). The other two groups did not have nearly as notable a change (-24.6ms soccer; -24.4 control). For N1, the baseline was not recorded because the “N1 potential was not yet present at [the age of the participants at the onset of the study].” In year two, the music group demonstrated a lower value than both the control and sports cohorts. It is also important to note that the sport cohort showed some improvement compared to the control (other extracurriculars are shown to have a subtle impact on cognition), but not as significant as the change in the music cohort. For P2, the music cohort also had the most significant change from baseline-year 2 (music = -21.8ms; sports = -21.4ms; no-training = -16.4ms).

The researchers concluded that the cohort receiving music lessons exhibited increased maturity of their auditory pathways.

In accordance with studies by Kraus, et al, 2010, and Strait, et al, 2013, this research demonstrates that formal music education programs (e.g., band, orchestra) have a positive impact on brain mechanisms responsible for processing music. This improvement in brain maturation likely supports other cognitive domains that utilize the auditory pathway, including linguistic ability.

Socioeconomic Status

When studying the impact of music education, a commonly occurring criteria in the literature I reviewed was a mother’s socioeconomic status (SES). Thus, it became apparent to me that when studying any element of music education it is important to

consider the implications of socio-economic status (SES). To explore this factor, I independently studied the websites of two nearby schools in the Detroit metropolitan area – one in Detroit, Michigan (48204) and one in Bloomfield Hills, Michigan (48304). On the website for the school in Detroit, Barton Elementary School, there was no listing of a music education program. On the website for the school in Bloomfield Hills, Eastover Elementary School, there are listings for a specialized music program, a music room, and a music teacher. I then correlated the music program offerings to the SES of the schools. Students are ‘economically disadvantaged’ if they are eligible to receive free or reduced lunch. At Barton Elementary, 92% of students are economically disadvantaged, compared to 14% at Eastover Elementary. Further, Barton elementary has a student to teacher ratio of 23:1, compared to a 12:1 ratio at Eastover Elementary. This stark difference suggests a strong relationship between the SES of a school and the school’s music education program. While this preliminary research does not examine the viability or potential impact of implementing widespread music programs, the reviewed studies indicate that accessible music education is likely to be an important and impactful aspect of education to consider when looking towards the future.

CONCLUSION

The literature reviewed demonstrates a positive correlation between music education and linguistic ability in children under seven years of age. The literature indicates that early music education increases the maturation of the auditory pathway, evident as decreased latency of brainstem responses to noise. Together with other factors, these changes lead to benefits such as sound discrimination ability, an increased vocabulary, and an increased reading ability. Further, the stark difference between music programs based on SES dictates a clear need for accessible music programs for this population. Along with lack of music education, children within this population are often subject to other external factors that negatively impact linguistic development (e.g., lack of books in the household, low parental education level). Because it is known that low SES children typically struggle with language development from an early age, due to an array of factors, early intervention in the form of music education would be a constructive approach. Additional research is necessary to determine whether such an approach would be effective, and how it might

be combined with other activities believed to enhance brain maturation and plasticity for additional benefit.

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The Future of Online Learning Industry After the Pandemic

By Tauria Bao

AUTHOR BIO

Tauria Bao is a rising senior at Lynbrook High School in California. She enjoys learning about business and how it impacts modern society. At school, Tauria is a dedicated member of Future Business Leaders of America and has attended several conferences throughout California. She has also participated in many programs and courses concerning entrepreneurship, marketing, and leadership. In her free time, she turns to art as a creative outlet, and created and taught her own art class in her sophomore year. She hopes to pursue both art and business in higher education and strives to bring joy to others through her hobbies.

ABSTRACT

The COVID-19 lockdown in 2020 uprooted the lifestyles of people all across America, and college students were no exception. Schools were moved online, drastically changing the learning environment. Many students experienced worsening mental health and loss of motivation. These changes were mainly a result of the isolation and disconnection (Akpinar, 2021) that the pandemic caused. However, online learning did not affect student performance as a whole. Thus, online learning has the potential as an easy way for more students to gain access to education, and can cut their expenses by allowing students to stay in their homes. If online learning were to become more widespread after the pandemic, the data shows students must not be too socially distanced from their peers and professors, and students should feel comfortable with merging their personal and school lives. Online learning is not the best option for every student, but it is a life-changing opportunity for students with strong self-management abilities and an even stronger desire to future their education.

Keywords: Online Learning, Online Education, College Students, COVID-19, Mental Health, School Lockdown

INTRODUCTION

The COVID-19 pandemic that arose in late 2019 forced schools across the U.S. to close. By March of 2020, most of them had turned to online education. Many schools and universities remained online for the 2020-2021 school year, making the 2021-2022 year the first full year of in-person courses in two years. However, the impact of remote learning lingered and more students opted to continue their education online. Through the changes brought on by the pandemic, we can see that the online learning industry is projected to keep growing in higher education, which is important because that means the industry will continue to provide more students with more accessible learning after the pandemic, but it will also challenge students' routines and test their self-management, which may be difficult to maintain in the long-run.

Literature Review

Online learning has become a significant contender in the realm of education after the pandemic. As analysts have established, online education comes with its flaws, including challenging students' self-management skills and a negative impact on their mental health. However, it was also proven to have positive aspects. Online learning makes education more accessible and has not been shown to have affected student performance overall.

Soft Skills and Engagement

Students need many skills to be successful in school. These skills can be roughly divided into two categories—hard skills and soft skills. Hard skills might include calculus and physics, which are explicitly included in the students' curriculums. On the other hand, soft skills describe how students learn and interact with others (Laker & Powell, 2011). The ability to turn in assignments on time, time management, and information retainment can all fall under scholastic soft skills. During the pandemic, the level of students' soft skills was tested.

The COVID-19 lockdown caused the primary learning environment for students to change from a school campus to their homes. Students were forced to adapt to the circumstances. Oftentimes, students would watch a recorded lecture and do the associated work on their own time. Since their schooling happened in their homes, their schedules were more self-constructed and their resources more limited. As a result, online

learning allowed for a more flexible schedule, but also called for a higher level of self-discipline from the students. It is often difficult to merge school and personal life while not sacrificing the quality of either. As a result, students struggled to maintain their school skills, which included success in learning, time management, and upkeeping grades (Aguilera-Hermida, 2020; Xu & Jaggars, 2013).

As another consequence, students believed that only their understanding of new technology and tools improved during online learning, not the traditional subjects in which growth would be expected (Aguilera-Hermida, 2020). This is not an unexpected outcome, but it is also not a sustainable method of learning. Students were more likely to turn in assignments late, or not complete them at all, and found they struggled to retain information as easily as they did before the pandemic (Aguilera-Hermida, 2020). Students also faced an increase in procrastination and a general decline in grades and participation, as observed in community colleges as well as other areas of higher education that relied on online learning during the lockdown (Xu & Jaggars, 2013).

The level of apathy observed during this period casts a shadow on online learning, as college students are the next generation of workers. Graduates with an unstable college education will, in turn, form a less stable workforce with more inexperienced workers. Furthermore, a study assessing the impact of self-regulation on the success of online education proves that online education will be much more effective for students with high levels of self-discipline, which not all students have (Albelbisi & Yusop, 2019). This is backed by research from Williams and Hellman (2004), who found that first-generation college students struggled more than second-generation college students with self-regulation and self-discipline, so they were less successful in online learning. America has many first and second-generation college students, and over the pandemic, college students have experienced a learning gap caused by the difference in self-discipline levels, which would ultimately negatively impact the future of the workforce as well.

College is the end of formal education for many students, and thus is crucial for their future careers. Since online schooling negatively impacts so many aspects of students and their learning capabilities, it may be difficult to rely on online

learning in the long term for most students. However, the 2020-2021 online school year was a result of the COVID-19 lockdown and was a rushed temporary solution, so the results should have been expected. If online higher education is to become more prominent in the future of the education industry, there would first have to be a way to ensure the quality of learning and prevent the degeneration of previously acquired learning skills.

Students' Mental Health

For students, the change in their school dynamic was one challenging transition that resulted from the pandemic. However, online education did not just impact students academically, but also mentally (Chu & Li, 2022; Wang et al., 2020). The pandemic restricted students' ability to access interaction and mental health services schools provide. In addition, they could not meet their friends at school, and were often stuck indoors due to lockdown restrictions, so many students suffered from mental illnesses over the 2020-2021 school year (Akpinar, 2021; Chu & Li, 2022; Wang et al., 2020). Although the pandemic was a special scenario, online learning is still less social and interactive than in-person learning and the mental health of students must be considered.

Many students suffered from a form of depression or anxiety during lockdown. According to a survey by Chu and Li (2022), there was an increase in stress and psychological distress during online learning. As schools opened back up for the 2021-2022 school year, students were no longer as isolated as during lockdown and online learning, and students' mental health slowly made a recovery (Center for Collegiate Mental Health, 2021).

A study at Texas A&M assessed the severity of depression and anxiety in students over the pandemic. A majority of students reported that they were under more stress than before, and many experienced signs of either or both depression and anxiety (Wang et al., 2020). One of the major factors in the decline of mental health over the year is social isolation and unfamiliarity with the environment (Akpinar, 2021). On top of the usual stress from coursework, the sense of being alone and hopeless contributed to the increase in depression and anxiety in college students (Akpinar, 2021). However, the Center for Collegiate Mental Health showed in their 2021 annual report that depression and anxiety rates had decreased throughout the 2021 year, which overlapped

with the end of required online learning. This shows that returning to in-person learning had some positive effects on students' mental health.

Online learning as it was implemented over the pandemic harmed students' mental health, and reinforced previous conclusions that it cannot be used in the long term as a solution for all students. Although it would be difficult to completely eliminate the mental health decline, creating a more interactive classroom to simulate an in-person learning environment could at least decrease student anxiety and uncertainty surrounding online education (Unger & Meiran, 2020).

Benefits and Drawbacks

The lockdown of schools in March of 2020 was unprecedented, but debates regarding the benefits and drawbacks of online education have always persisted. The topic became especially popular after the pandemic forced schools across the nation to go online. Supporters of online learning assert that its advantage comes from convenience, allowing students to attend school without having to travel. On the other hand, online learning could be dismissed as access to school resources and guidance may be limited, and not having enough self-discipline may make online education a lot more difficult (Appana, 2008).

Students enrolled in an online MBA program were surveyed about online learning (Kim et al., 2005) and many answered that they valued the virtual experience that they knew would become a big factor in the future. The study was conducted in 2005, but the predictions had come true. Virtual business has become a prominent part of our society in 2022. Our society will only continue to move towards technology, and starting off the period of independence for college students with online education could help them grow further accustomed to technology.

College Enrollment and Graduation

The pandemic and online learning caused mental health decline, degeneration of school-related skills, and had a generally negative impact on students. All of those factors impacted college enrollment and graduation from 2020-2022, as students felt less confident and more apathetic towards school. Even with a negative attitude towards online learning during lockdown, surveys conducted at various schools show there was little harm to the students' performance overall (Bulman & Fairlie, 2021; Hussar et al., 2020;

Juszkiewicz, 2020). This reveals the potential of online education, as the belief that students would perform worse in online environments could often not be backed by research. Instead, the agreed-upon verdict is that grades and scores remain more or less constant between online learning and in-person learning.

When community colleges switched to online learning for the 2020-2021 school year, enrollment decreased by over 10 percent from the previous year (Bulman & Fairlie, 2021). Over the same time period, graduation rates also decreased, as many college students left college or transferred, reaching one of the lowest rates in the decade. The low enrollment and graduation rate may appear to reflect student performance in college. However, before the pandemic, online learning did not correspond to worse performance in community colleges. Studies show many students expect and believe they will do worse in online courses. (El, 2021; Shea & Bidjerano, 2014). On the contrary, online students were seen to complete their degrees quicker than strictly in-person students.

The adaptability and speed in completing degrees of current online college students could be an indicator of society moving more towards technology, and that later generations would be more successful when given the option of online learning. Therefore, online learning would present opportunities in the future for societal improvement.

Data and Methods

The pandemic presented researchers with the opportunity to analyze the effect of online education on students. Hence, there is an abundance of studies analyzing the changes brought on by the pandemic. A research team at the University of California, Irvine (UCI) School of Education conducted two surveys near the beginning of the COVID-19 pandemic. The surveys were sent out a month apart and were meant to measure the students' response to online learning (Moeller et al., 2021).

From May to June of 2020, a different research team conducted a global survey involving students in higher education. The survey covered 133 countries and had more than thirty-one thousand responses (Aristovnik et al., 2021). The topics ranged from adapting to online learning to future plans. To accurately gauge collegiate mental health in the United States, the data was filtered through. There were 392 responses from United States residents, and their

responses regarding mental health were analyzed to identify trends.

Upon combining the two studies, the data spans the first four months of the COVID-19 lockdown in the United States. This would provide a broad outline of how quickly and to what extent online learning impacted college students as they entered a new learning environment.

Results

According to UCI's data, during the first month of online learning, most students expressed that they experienced more stress concerning academics than in any other area. The students also believed that their mental health was mostly unaffected (Moeller et al., 2021). However, there was a shift in the following months, seen in the study that ran from May to June of 2020. Most students found it was harder to focus during online learning, and there was generally no improvement in their performance (Aristovnik et al., 2021). This is evidence of the degeneration of soft skills (Aguilera-Hermida, 2020; Xu & Jaggars, 2013).

When online learning challenged their self-discipline, many students were unable to upkeep the level of productivity they had when school was in-person. In addition to little to no improvement in school performance, the study conducted by Aristovnik et al. (2021) showed that 150 out of 392 students reported they often or always felt anxious and/or frustrated. The negative emotions combined with the increase in school-related stress resulted in less motivated students.

Moreover, close to 200 of the survey's respondents were highly concerned about their mental health and over 100 students reported that they often felt anxious (Aristovnik et al., 2021). The trends observed at the start of the lockdown were an indication of the more dramatic effects of online learning on college students further into the pandemic, especially with the social isolation and decrease in resources.

Unmotivated students and worsening mental health over online learning may be important contributors to the decrease in college enrollment and graduation rates over the 2020-2021 year. Students' focus likely shifted away from school and towards what they felt would be worth their energy and better for their mental health.

CONCLUSION

As the pandemic progressed, it became clearer that the online learning industry will continue to grow in higher education. This is crucial because that means the industry will continue to provide more accessible learning, but it will also change students' lifestyles, which may be difficult to maintain. As a result, students struggle to maintain their learning efficacy when enrolled in virtual education (Aguilera-Hermida, 2020; Xu & Jaggars, 2013).

Online education during the pandemic was one of the major factors in the decline of mental health. Due to the social isolation and unfamiliarity in the environment, many students felt lost or hopeless on top of the standard stress from coursework, which contributed to the increase in depression and anxiety in college students (Akpınar, 2021). Additionally, students reported that they experienced more academic stress and felt frustrated and anxious often after schools moved online (Aristovnik et al., 2021; Moeller et al., 2021). This shows the negative impact online learning during the pandemic had on college students.

The adaptability and speed in completing degrees of current online college students could be an indicator of society moving more towards technology, and that later generations would be more successful when given the option of online learning. Therefore, online learning would present opportunities in the future for societal improvement. However, as the data has shown online education can be a struggle for students and can impact their mental health. Online programs need to create support and programming to support their students in these aspects to ensure future success for both the program and the students. Our society will only continue to move towards technology, and starting off the period of independence for college students with online education could help them grow further accustomed to technology.

Online education will be an important progression, as having the choice of online school will allow students to eliminate traveling fees to universities across the country. and will not draw them as far away from their personal life as in-person school does. However, the consequence is a worsening in school-related skills and mental health issues, making the expansion of the online learning industry a difficult and risky, yet still promising advancement to undertake.

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The Japanese Economic Miracle: From Ruin to Superpower

By Aiden Harpel

AUTHOR BIO

My name is Aiden Harpel, and I was born and raised in Manhattan, New York. I am a seventeen-year-old junior in high school and currently attend Riverdale Country School in the Bronx. I am a member of my school's debate team and am on the varsity tennis team. I am interested in business, government, and the intersection between the two, something which I may wish to study at the undergraduate level in college. In my free time I like to read, cook, play sports, challenge others at board games, hang out with friends, and explore the great city in which I live.

ABSTRACT

After World War II, Japan and its economy were in ruins. Industrial production fell about sixty-five percent compared to pre-war levels. However, in the post-war era the Japanese were able to turn around their economy. Few, if any, governments have achieved economic growth at the levels of the Japanese post World War II. The Japanese Economic Miracle was a period in which Japan's per capita GDP increased at an average annual rate of 7.1 percent and its overall economy grew on average 9.7 percent per year. Japan's economy became the second largest in the world behind only that of the United States. This paper provides an explanation of this unprecedented economic growth, addressing many of its core causes. It then discusses what is today known as the burst of the "bubble", in which real estate prices plunged about seventy percent and the Japanese stock market collapsed by about eighty percent. Ultimately this burst demonstrated that the rapid growth of the Japanese economy was unsustainable.

Keywords: World War II, U.S. Occupation, Dodge Plan, Korean War, Technological Improvements, State-Sector-Firm Coordination, Competition, Bubble

INTRODUCTION

From the end of World War II through the 1980s, the Japanese economy grew at an unprecedented rate. World War II destroyed Japan and its economy. Industrial production fell about sixty-five percent compared to pre-war levels, Japanese investments in Asia became worthless, and urban housing as well as industrial plants were destroyed. To put it lightly, the economy following the war was in ruins. World War II, as a result, forced the Japanese to embark on rebuilding their economy. This reconstruction process led to what is now known as the Japanese “Economic Miracle,” a period of robust economic growth in Japan. Between 1945 and 1956, Japan’s per-capita G.D.P. increased at an average annual rate of 7.1 percent. Between 1956 and 1970, Japan’s overall economy grew on average 9.7 percent per year. While the Japanese economy grew at a considerably slower rate after 1970, it nevertheless would surpass Britain’s economy to become the second largest economy in the world after that of the U.S.

Democratic governments commonly seek to achieve economic growth in their respective countries because it typically correlates with an improvement in domestic living standards. If there is more money circulating in an economy, businesses can make more money and in turn pay their workers more in wages. If workers earn more, they can spend more. And if they spend more, businesses can earn more and, in turn, reinvest in their enterprises by, for example, creating more jobs and investing in innovation. This virtuous cycle can then repeat itself. In recognition of this circular effect, the Japanese government -- aided by the U.S., the Korean War, and technological improvements -- achieved strong domestic economic growth by strengthening industry and turning the country into a manufacturing powerhouse.

Having defeated the Japanese in World War II, the United States military, led by General Douglas MacArthur, occupied Japan between 1945 and 1952. While in Japan, MacArthur, acting on behalf of U.S. interests and those of its allies, imposed reforms on Japan that helped drive the country’s economic transformation.

Under U.S. occupation, Japan reduced its military expenditures through demilitarization. Japan dissolved its standing military and ended the production of military materials and weapons. To

mitigate the risk of re-militarizing, the government removed from positions of power individuals who were militant nationalists. The Japanese government codified its stance on militarization when it enacted the Japanese Constitution of 1947. As part of its signing, Japan permanently renounced the right to use military force and instead agreed to rely on the U.S. for its protection. Japan’s demilitarization was important for the Japanese economy because it allowed monies the government had previously spent on the military to be channeled into the country’s broader economy.

American forces that occupied Japan also contributed to the breakup of the *Zaibatsu*, powerful business conglomerates that dominated many Japanese industries. One reason for their dissolution was to fully destroy Japan’s military power both institutionally and psychologically, as the *Zaibatsu* were responsible for the mass production of military-grade materials and weapons. The main basis for disbanding these business conglomerates, though, was to spark greater competition among Japanese companies. Through breaking up the *Zaibatsu* into independent companies, the number of businesses in Japan’s economy increased and so did competition among them. Two laws were also put in place to create greater competition. The first was an anti-monopoly law, which prevented a single company or a small handful of companies from taking over a given industry. In other words, the law prohibited all cartel activities. The second was a decentralization law, which forced holding companies to shrink if any of the businesses under them amassed too much market power. Competition encourages companies to innovate and improve their products. By increasing competition in various industries, these two laws along with the collapse of the *Zaibatsu* helped foster Japan’s economic growth.

Given the limited number of employers in Japan prior to the U.S. Occupation, the *Zaibatsu* were able to exploit Japanese workers for a long time. However, workers eventually grew angry and formed labor unions with the help of the U.S. The formation of labor unions benefited the Japanese economy because it led to greater employee satisfaction and, in turn, greater workforce productivity. The percentage of workers organized into labor unions climbed from zero in 1945 to about 60 percent in 1948. Clearly labor reforms played a significant role in the creation of labor unions, as there were no labor unions prior to the U.S. Occupation. Lobbying efforts by these unions led to the enactment of the Trade Union Law, which

outlined basic workers' rights -- such as the right to strike and the right to bargain collectively -- and prohibited unfair and exploitative employer practices. Tangible outcomes of the Trade Union Law included higher wages and improved working conditions. With workers earning higher incomes, consumer spending increased which, in turn, contributed to domestic economic growth. In addition, a lifetime employment system was established, and this arrangement fostered loyalty between employees and their employers. Such loyalty increased workforce productivity. In summary, the formation of labor unions improved the relationship between workers and employers. In the end, it boosted Japanese corporate profits and economic growth.

After the U.S. Occupation laid the foundation for the resurgence of the Japanese economy through Japanese demilitarization, the dissolution of the Zaibatsu, and labor reforms, the Dodge Plan was executed. This plan was designed to facilitate Japan's economic recovery without American aid. It accomplished this objective through the introduction of five major policies. The first was to create a more balanced government budget in order to lower inflation, as too much government spending can cause inflation to accelerate. This plan was implemented successfully, as a 90 billion yen budget deficit in 1946 turned into a 155 billion yen surplus in 1949. Second, the Reconstruction Finance Bank refined its lending practices so as to reduce the number of bad loans it granted. Similarly, the Japanese government began to more strictly regulate the issuance of government subsidies, making sure that these subsidies were actually put to use to promote industry. Additionally, a more efficient and strong tax collection system was formed to further discourage tax evasion and to provide the government quicker access to monies received through taxes. Finally, as part of the Dodge Plan, a fixed exchange rate of 360 yen to 1 U.S. dollar was established to keep Japanese export prices relatively low and, in turn, encourage U.S. citizens to buy Japanese goods. While the U.S. Occupation set the groundwork for a Japanese economic rebound, the Dodge Plan was crucial for Japan because it allowed the country to become economically independent.

Shortly after the Dodge Plan was carried out, the Korean War began in 1950. The start of the Korean War resulted in a major stimulus to Japanese production. Before entering the Korean Peninsula, United Nations forces stationed themselves in Japan. While in Japan, they made large-scale purchases of

Japanese goods such as clothing and beds. These orders provided a strong boost to the manufacturers of these goods.

While the Korean War gave the Japanese manufacturing industry a much-needed jolt, the sustained growth of the industry can be attributed in part to technological improvements. Japanese companies imported various technologies from foreign countries, acquired technological know-how from them, and used that know-how to develop their own technologies. Technological advances helped Japanese companies grow more profitable and, in turn, contributed to the growth of the domestic economy overall. Due to technology, Japan transitioned from primarily being a low-productivity, low-growth agricultural-driven economy to a high-growth manufacturing-driven economy. It began producing high-tech, relatively expensive goods such as cameras, televisions, automobiles, and ships. Higher-priced goods meant Japanese companies generated greater revenues. In addition, greater use of technology provided Japanese manufacturers with economies of scale. Japanese manufacturers were able to increase the unit volumes they produced while decreasing their cost per unit of output. In short, technology contributed to G.D.P. growth in Japan because it enabled Japanese companies to increase their profit margins by decreasing production costs, increasing revenues, or some combination of the two.

Considering recent developments in technology, the Japanese government set aggressive goals for Japan's economy. One of these goals involved the Income Doubling Plan of 1960, designed by Prime Minister Ikeda Hayato. The plan's objective was to double per capita income within a ten-year period and to raise the living standards of the Japanese population. In order to achieve this goal, the government sought to achieve annual economic growth of nine percent during the plan's first three years. The government wanted to expand Japanese exports by ten percent annually as well. Furthermore, the government's Economic Stabilization Board aimed to restore levels of production to peak levels prior to World War II. The goals set by Hayato and the Economic Stabilization Board provided Japan with tangible outcomes to work towards and would help guide Japanese economic policy.

The Japanese government adopted an economic development model that involved heavy state-sector-firm coordination. In other words,

the government aided the development of certain industries and specific companies within those industries. It did so through many economic policies. First, it kept interest rates relatively low to encourage Japanese businesses to borrow money. There were three main economic institutions or programs through which businesses received low-interest loans: the Japanese Development Bank, the Export-Import Bank of Japan, and the government's Fiscal Investment and Loan Program. In addition to distributing low-interest loans, the government provided subsidies to Japanese companies. The government also issued domestic companies licenses for foreign technology and maintained low tax rates. Interestingly, Japan maintained the lowest ratio of taxes to national income among all countries belonging to the Organization for Economic Cooperation and Development. Such a low rate of taxation allowed Japanese consumers to spend money that would otherwise have gone to the government in the form of taxes. Low corporate tax rates also enabled companies to re-invest in their businesses. Finally, the Japanese government kept a favorable exchange rate that discouraged imports and promoted exports. All of these policies were intended to support Japanese industry. Without such assistance, many domestic private enterprises likely would not have achieved the level of growth that the government desired.

In addition to these economic policies, the government to some degree regulated domestic and international competition. While competition among Japanese companies benefited the domestic economy, the Japanese government feared that too much competition would be detrimental to the development of the economy. The government supported certain companies in the country's most promising industries and, with too much competition, the government feared that the growth of those specific companies potentially would be hindered. Thus, the government restricted entry of new competitors to sectors that were already overly crowded. In order to protect Japan's domestic industries from foreign competition, the government adopted a policy of protectionism. One measure it took was to impose import quotas, which limited the number of goods that Japan would import from other countries. By 1962, Japan had 492 different products under import quotas. The government also imposed high tariffs on products made internationally to discourage Japanese citizens from buying foreign-made goods rather than domestic manufactured goods. By regulating competition to an extent, the Japanese government turned what

previously was a trade deficit -- where Japan was importing more than it was exporting -- into a trade surplus whereby Japan began to export more than it imported.

While government regulation of competition was certainly a factor that contributed to Japan's trade surplus, this surplus can also be attributed to the many Japanese industries that experienced exponential growth after World War II. For example, the steel industry in Japan underwent rapid growth as annual steel output increased from 22 million tons to 93 million tons between 1960 and 1970. Japanese steel exports increased from 8.8 percent of total world exports in 1960 to a peak of 40.8 percent in 1976. Another industry that grew rapidly post World War II was the shipbuilding industry. During the war, ships were mainly built for military use. After the war, Japanese shipbuilding companies started producing commercial ships for export. By 1957 Japanese shipbuilding production exceeded its 1944 wartime peak. From the 1960s through the 1980s, Japan manufactured about half of the world's new shipping capacity. A third industry that expanded greatly during this same period was the automobile industry. At Toyota, a major Japanese car manufacturer, the number of vehicles manufactured per worker per year tripled between 1955 and 1957 and then increased another 60 percent by 1964. By 1965, Toyota workers' productivity levels actually surpassed those of the Big Three American automakers -- i.e., General Motors, Ford, and Chrysler. An increase in productivity levels was widespread among Japanese car manufacturers, as Japanese annual manufacturing output increased from 70,000 cars in 1955 to 3,146,000 cars in 1967. The steel, shipbuilding, and automotive industries developed into three of Japan's largest industries. In reality, though, the Japanese economy as a whole flourished during this period at an unprecedented rate.

The rapid growth of the Japanese economy, however, could not be sustained through the 1980s. The Bank of Japan's decision to maintain low interest rates backfired, as the easy and relatively cheap access to capital that was made possible by low interest rates caused a lot of business and household borrowing, which in turn led to heavy investment in residential, commercial, and office real estate; stocks; and factories and capital equipment. Robust investment in real estate caused domestic real estate prices to soar and, because of the large land holdings of many Japanese public companies, stocks to soar as well. In addition, Japanese companies used their high stock prices to

raise additional capital which subsequently would be used to drive further investment in real estate, industrial plants, and capital equipment. All of this demand and speculation drove domestic asset prices through the roof. For example, the value of residential real estate in Japan's major cities rose 167 percent between 1985 and 1990. Economic growth in the late 1980s averaged nearly five percent annually, which off a relatively high base of G.D.P. was especially strong.

As is the case so often with speculative booms, people believed that asset prices would only increase and therefore that it would be impossible for one to lose money. However, the surge in asset prices ended when the Bank of Japan realized that it needed to hit the brakes to avoid the risk of inflation spiraling out of control. The Bank of Japan's new Governor, Yasuichi Mieno, commenced a round of steep interest rate increases towards the end of 1989. With access to credit curtailed and the cost of borrowing increasing, Japan's speculative frenzy abruptly ended. Real estate prices, the stock market, and corporate investment activity reversed course and started to fall. Prices of real estate, for example, plunged about seventy percent between 1989 and 2001. Japan's stock market, in addition, collapsed by about eighty percent between its peak in late 1989 and its pre-Global Credit Crisis trough in the early 2000s.

In conclusion, the economic policy implemented by the Japanese government in conjunction with U.S. assistance -- along with the outbreak of the Korean War and the evolution of technology -- resulted in the Japanese "Economic Miracle." Japan's businesses, especially those in the manufacturing sector, thrived in the post-war period and Japan achieved global trade dominance. After experiencing accelerating economic growth from 1980 through 1988, when Japan's growth peaked, the country's "Economic Miracle" began to unravel and its so-called "bubble" burst. From 1989 through 1999, Japan's economic growth decelerated and eventually turned negative. Though the Japanese "Economic Miracle" ultimately proved unsustainable, it was a truly remarkable "event" in Japan's history in that the government took an economy decimated by World War II and transformed it into the second largest in the entire world.

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The Fate Divided: Why feudalism was established not in China but in Japan during each of their late classical eras (the Tang Dynasty of China and the Heian Period of Japan) from the perspective of their different estate systems

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AUTHOR BIO

Wang Zhenghao is a seventeen-year-old high school student who is currently studying in the Experimental High School attached to Beijing Normal University. Inspired by his family, Wang is a vigorous and determined youngster who holds a particular affection for East Asian history and wishes to spread his understandings on the field to the public around the world. This essay, *The Fate Divided*, is the debut work of Wang, saturated with his ambition of further academic historical research in the college and his interest in history.

ABSTRACT

In the Tang Dynasty of China and the Heian Period of Japan, lots of convincing evidence which alludes to both countries' approaching transformation from a statutory empire to feudal countries emerged. However, while Japan, as the evidence indicated, underwent dramatic change during the Heian Period and became feudalism, China maintained a despotic political system for the following thousand years. What differences between China and Japan may account for such divergent developmental patterns, even though both countries shared similar economic and political systems before entering their respective medieval periods? Answering the problem can greatly benefit our understanding of the distinctiveness of the Chinese political system that remained for thousands of years, the patrimonial bureaucracy, and offers us a new insight into Japan's historical pattern to understand its unique status as the only feudal country in Eastern Asia. Moreover, the article will focus on the role of estate systems, the system of how lands get distributed and taxed, in the political shift in both countries, since the changes in the landowning system underly all possible political or social shifts due to the indispensable role agriculture played in ancient orient empires. In short, this paper aims to conclude a persuasive explanation for the difference in feudalization between China and Japan by exploring the influence each of their estate system imposed on the political shifts, respectively.

Keywords: Ancient Eastern Asia History/Tang Dynasty/Heian Period/China/Japan/feudalization/estate system

LITERATURE REVIEW

The feudalization of pre-medieval oriental empires, usually indicating China and Japan, has been a topic consistently focused on by historians due to the significance of the issue. On the one hand, the unique historic development pattern of China, being a statutory empire maintained by a massive professional bureaucracy system since the establishment of the Qin Dynasty in BCE 221 and failed to transform into a feudal empire in the late Tang Dynasty, fired historians' passions for the understanding its causes. On the other hand, as a country remarkably influenced by China in its classical era, Japan eventually developed into a typical feudal country, which also inspired lots of scholars to commit to the study of its reasons. Most efforts were put into discovering the impact of the "land revolution" in China and Japan, how the similar process of privatization of lands begot different ends on the field of the political system in the two empires, at the time, since the shift in ways lands are distributed and taxed was the most relative representation of the political transformation of an ancient oriental empire; other works majorly aimed to understand the question of the feudalization from a minor scope like the influence of the conduct of a specific imperial edict or the change in the military system. However, previous works had no attempts to make a comparison between the Tang Dynasty and the Heian Period to illustrate how diverged developmental paths, the statutory system remained in China and the feudalism established in Japan, emerged from similar conditions. So, the passage aims to assemble the previous research on the field and produce a more comprehensive understanding of the political change, especially the factor that drives China and Japan to different systems, of both orient empires in each of their late medieval eras from the perspective of changes in the estate system, the fundament of the ancient empires' economic system and the predominant factor that determine the social structure throughout the history. Moreover, the passage may inspire readers to make a deeper understanding of China's bureaucrat and statutory system.

China

Tang Dynasty (618 to 907), the last dynasty governed China in its classical era, was regarded as the highest point of Chinese statutory and despotic civilization. However, under the pressure of military and agricultural rebellion, it eventually collapsed in 907. Scholars in both China and Japan contend that

Tang's breakdown resulted from drastic social changes, such as the development of private landholdings and the independence of provincial military governors. According to the conventional historical model, feudal society is supposed to succeed a statutory empire, and there were certain signs of China's upcoming transition to feudalism at the end of the Tang Dynasty such as the flourishing of private manors and the fall of the centralized government. Despite that, China continued to maintain despotism and a statutory system under the following four dynasties until the establishment of the Republic of China in 1911. So, what made the difference?

The earliest study of the phenomenon of land privatization came from the Japanese researcher, Shigeru Katou. He concludes that the landowners in Tang Dynasty would set up the manor outside the urban area to occupy available agricultural land and gather peasants working on these lands illegally in the name of legal manor expansion for recreational use. Based on this assertion, Shigeru claims that these lands privatized by the wealthy should be explicitly distinguished from the "perpetual lands," which were distributed to the nobles justifiably in the Juntian System (A land system regarding all lands belonging to the emperor and the state, used to encourage peasants by distributing and redistributing national land to them to cultivate. In return, peasants had to submit part of their harvest to the government as taxation and undertake obligated manual labor, usually infrastructure construction.), and the awareness that the vast expansion of manors for uses beyond entertainment was not officially permitted by the central government as that Japanese government would do. But since the private manors started their development as early as the first century, it's not surprising that they could still flourish in the Tang, even under the supervision of the empire, Shigeru Katou writes.

Nonetheless, this acclaim about the manor's origin from the first century is controversial and contradicts the idea of MI Jiang. She argues that the development of manor is originated from and prompted by three opportunities brought by the collapse of the Juntian System. First, with increasing tenets started to flee to the private manors for the protection against the harsh imperial taxation, the population census system used to maintain the land distribution in the Juntian system declined, so landlords could occupy more lands and population given the inability of provincial governors to grasp

the explicit data of lands and population. Second, landlords occupied the vast abandoned lands which originally belonged to the cultivators in the Juntian System, thus concentrating more resources and strength. Finally, the extreme shortage of available lands could be used to the distribution process of the Juntian System, majorly due to the prevailed land privatization, forced the royal court of Tang to renunciate the Juntian System and adopt new Double-Tax System, which marks that the manor economy became a system acquiesce by the government.

Another scholar, Wang Jian, made a comprehensive conclusion to the origin of the manor. While admitting that the phenomenon of land privatization has long emerged even before the Juntian System, early to the Han Dynasty, Wang identifies that most landholders before Tang Dynasty were born into noble families, while those in the Tang Dynasty were not. So Early Tang Dynasty was a time period when the conventional aristocrat landlords were rapid declined and the newborn ordinary landlords were not powerful enough to take over their sold property and lost political power, making the nation-host Juntian System possible. But, when it came to the middle and late Tang Dynasty, the ordinary landlords were strong enough to speculate national lands and peasants, directly causing the collapse of the Juntian System and the establishment of the manor system. The succeeding researchers then tried to interconnect the land privatization and the unsuccessful attempts of China's feudalization by discussing how economic shifts may affect the various political conflict between different common-interest groups within the empire.

The most prominent political conflict of the Tang Empire is the central-provincial one. The Fanzhen System, military-controlled administrative areas governed by ambitious military governors and initially established to defend the border from the assaults of the northern nomadic and the Tibetan Empire, gradually grew into enormous self-governed realms that always resisted the central government and even dared to wage rebellions to obtain greater power. Scholars from China Yuan Yingguang and Han Guopan, in each of their works, analysis the economic bases those military officers relied on to maintain an independent status: their own private manors. The sufficient wealth and resources military governors absorbed from their private estates, with some support from the local landlords affiliated with them, upheld the rebellion and independence of those military officers

The second effect of the rise of manor imposed on imperial politics is the rise of the eunuch which is often seen as the extension of the emperor's power because of their personal and political dependence towards the emperor. In the middle Tang Dynasty, to confront the increasing political pressure from the provincial military governors and central bureaucrats, the emperor admitted eunuchs to the officialdom. Including crucial occupations like the military inspectors. To absorb more power from the emperor, eunuchs preferred to immerse the emperor in personal enjoyment so that they can absurd the emperor's power without his recognition or restrain. As a result, the eunuchs deliberate indulgence towards the emperor greatly weakened his authority and thus foster the formation of a more decentralized political structure.

Niu Zongping made research to reveal the relationship between rise of the manor and the political power of eunuchs. He believes with the collapse of the Juntian System and the flourish of the manor; the national military system which was based on the original estate system soon transformed from the conscription system to the voluntary system and career-soldier system. Unlike the previous conscription system, which only convened the soldiers when needed, the conscription system made the empire maintain a large standing army around the nation, producing a need for emperor to allotted the eunuchs as military inspectors to supervise the troop. So, eunuchs obtain the power of intervening the military, in the name of the emperor, to achieve their political ambitions. More importantly, the occupation of military inspectors exploited a new way for the them to absorb political interest besides the favor from the emperor, thus enabling them to exercise their power beyond the constraints of the emperor. As the conclusion, the rise of the manor led to the empowerment in the eunuch, resulting in the further decline of imperial strength.

In general, it seems like the rise of the manor caused detrimental effects on the original land system and imperial authority, thus producing a new feudal estate system and powerful decentralization force, two necessary factors for feudalization. Whereas all elements required to feudalize were well prepared in the Middle and Late Tang Dynasty, China remained despotism for the following thousand years. This phenomenon ignites scholars to discover why widespread manor in China eventually did not institute the feudalism system like what had happened in Western Europe and Japan?

Deng Guangming tried to illustrate the question by analyzing three significant differences between manor of China and that of Western Europe and Japan, which prevented China from entering feudalism era. The first was the methods cultivators pay the land tax to their landlords. In a western European manor, part of the landlords' lands was distributed to the villeins for them to cultivate, while others were kept holding by the landlords themselves and taken care by their cultivators who were asked to do so. By the season of harvest, villeins had to submit a given portion of agricultural yields from their own lands to the suzerain, while grains produced on the seignior's private lands would all be considered as his personal property and thus entirely acquired by him. In contrast, in a typical Chinese manor, all available lands were rented to the cottiers who only required to submit part of their harvest to the landlords. Needless to stay in the manor all the time to work on the private lands of their landowners, cultivators in a Chinese manor were fortunate enough to receive a looser personal appendant relation to their suzerains, resulting in more population transfer in the Tang society and therefore making the formation of stationary feudalism more difficult. The second difference was whether manor could achieve a relatively independent social status. In Western Europe, manor included every industry one could find in the society, like agriculture and handicraft, enabling its self-sufficient operation. By contrast, a Chinese manor contained only agricultural places and living areas, making a self-sufficient and secluded manor a whimsy. So, there's no way for a Chinese manor to acquire relatively independent and private position required to form feudalism. The final difference was on the power of sealing the manor. While the suzerains of Western Europe could stop anyone from entering his manor, the Chinese seignior had no right to shut his manor and refuse the governmental request to enter his manor. Again, this destructed the independent position of a manor, preventing its transformation to the private realm of the seignior or the steady economic basis of the feudalist system.

Ishimoda then demonstrates why the emergence of serfdom, a feudalist economic mode, in China did not lead to the establishment of the separated and stratified political power, a feudalist political mode. He perceives that since most of the lands in a manor were rented by the seignior, and all the revenue a manor absorbed was from the grains tenants submitted, the landlords were greatly dependent on these cultivators to maintain their

life. Fortunately, the collapse of the Juntian System offered the landlords a great chance to acquire abundant exiled peasants and force them to work for him, greatly bulging the distribution of the manor and strengthening the landlords' political influence. However, the seigniors' exploitation of his serves resulted in extremely severe class contradictions (according to spontaneous writing materials, landlords would charge fifty to eighty percent of agricultural yields from the cultivators as their rental). Due to the developed commodity economy and a massive population of the land-holding peasants, which were absent in spontaneous Western Europe and Japan, Chinese cultivators were surprisingly strong enough to fight against the repression from the landlords and frequently launched uprisings. A somehow contradicted situation occurred: on the one hand, landlords had to exploit their serves to maintain the regular operation of the manor; on the other hand, they had to beware of the potential uprisings of the cultivators, which they were not capable of pacifying. As a result, suzerains chose to seek support from the central government to cope with the rebellion. In return, they would not seek to exceed political power, which secured the supreme position of the emperor and the central government. This finely explained why the succeeding Song Dynasty remained as a statutory empire even when the private manor was widely spread around the nation. Hence, Ishimoda believes the compromise between the landlords eventually resulted in Chinese Feudalism, which was economically feudalist but politically despotic.

In spite of China's estate system in the Late Tang Dynasty, we have to notice that the rise of the separated provincial military governors mentioned in the previous paragraph, in reality, did not benefit the formation of feudalism in China as well. Although abundant troops and wealth obtained from the provincial military governor's private manors, which supported them to factually split from the empire, could not be neglected, Yang Zhijiu and Zhang Guogang point out that most of the economic basis, political influence, and the military strength were orientated from the peculation to the national power. According to their essay, the independence of an army-controlled section was based on the regular local taxation of the machinery, handicraft industry, and agriculture. In other words, these provincial military officers were still using the remaining taxation system to maintain their territories. The population and agricultural yields from their private manors might support their independence to some extent,

but the major portion of revenue was still acquired from the original national taxation system, which was applied to their realms. Moreover, the military power martial officers relied on was unexpectedly based on the national military system: most troops a military governor conscripted were technically the national army that embezzled and abused by him. Additionally, the legitimacy of the military governor's ruling originated from the imperial admission instead of the proprietorship to the lands he governed, like Western Europe. Yang and Zhang's point of view totally refuted that of Han Guopan, claiming the basis of the military governor's ruling was its private estate. Yang and Zhang contend the source of the separatist's power was the imperial bureaucratic system, not their private manor, indicating the governing class of China was professional bureaucrats instead of suzerains. This remarkable difference in the separatists' source of power between China and Western Europe eventually prevented China's transition from a statutory empire to a feudalist one.

Japan

On the eastern side of China, Japan, a country deeply affected by China, also experienced a drastic social change in its latest period of the classical era, the Heian Period (CE794-1085). But the intense economic and political change in Japan, however, fostered the establishment of feudalism. Then why could Japan achieve feudalism while China could not, and what idiosyncrasy of Japan's estate system enabled it to build up a feudalist society, which was the same as that in Western Europe? I will try to answer these questions by a comprehensive analysis of the previous research works in the following paragraphs.

To fully understand the social and economic changes Japan experienced during the Heian Period, the national estate and political system Japan used before Heian Period must be introduced. In CE605, the Japanese royal court launched the Taika Reform, aiming to consolidate the power of the imperial court by applying China's political and estate system. In the reform, the Japanese government imitated the Chinese Juntian System and started a new estate system named Handen Shūju-hō. The Handen shūju-hō stipulated that all land initially belonged only to the central government, distributing national lands to the peasants to cultivate and carrying out redistribution on the basis of every six years. Despite of the distributed lands, the government would also provide the peasants with necessary agricultural implements and seed rice. In

return, these peasants were demanded to pay taxes, including the agricultural yields from the lands, handicraft products (like ingenious cloth and silk), and the corvée (conscripted manual labor). Another improvement issued in the Taika Reform was the establishment of despotic bureaucracy, known as the ritsuryo code. The system was designed to divide the country into hundreds of provincial administrative units which were managed by the official appointed directly by the central government. These governors were obligated to collect taxes, suppress the local landlords and peasant uprising within their province, and report the data on provincial population and acreage on which the central government depended to calculate the annual tax and decide the redistribution of the lands. In general, the ritsuryo code greatly strengthened the Tenno (Emperor of Japan) and secured his supreme authority, as Tenno could rely on his loyal bureaucrats instead of the ambitious aristocrats to govern Japan after its establishment.

However, the estate and political systems only functioned effectively for decades before their gradual collapse. Mi Jiang perceives the causes of the decline of the Handen Shūju-hō were similar to those responsible for the collapse of the Juntian System in China: the unreliability of the national census, landlords occupying the national lands, and the shortage of available land for the regular distribution. However, there were some subtle differences among them, and the most influential one was the final destination of the fleeing peasants. While most of them in China were hired to cultivate for the locale seigniors, in Japan, despite kemmons (local elites, usually refers to landlords), a lot of peasants were gathered by the provincial military organization, known as the emon-fu. By taking advantage of these fleeing peasants and their abandoned lands, emon-fu grasped some political power beyond the bureaucracy system originally gave to them, strengthening them and finally enabling them to fight against the imperial decree and provincial governments. Besides, it is quite noteworthy that the military officers of the emon-fu, unlike the provincial military governors in Tang Empire, mostly relied on their private estate instead of the national taxation and military system to maintain their relatively independent positions. Thus, they were more likely to entirely cease their connection to the empire and hence formed feudalism.

Another researcher Ethan Segal believes the empire's land-opening movement which was launched to consolidate the statutory system may

unexpectedly contributed to the final establishment of feudalism. In 743, the imperial court proclaimed that the new-opening lands could be held exempt from taxation in perpetuity to encourage the agricultural activity within Japan, inspiring people, mostly wealthy kemmons who are the only groups being able to afford the consumption during the land exploitation, to exploit new lands. By participating in the land-opening program, kemmons acquired not only vast lands and rights of free-tax but also some political privilege: the power of entering rejection. The imperial Council (Dai-jōkan) and the Ministry of Popular affairs (Minbushō) gave kemmons the right to reject provincial officers' request to enter their shōen, granting suzerains' authority to exercise their judicial and political power within his shōen limitlessly and thus transforming shōen from solely an economic production unit to an independent political realm. So, the growing political power of provincial kemmons brought down the imperial strength and the bureaucracy, fostering the formation of succeeding Kamakura feudalism.

But according to Ethan Segal, the most prominent factor that pushed Japan into feudalism was a distinctive system, the commendation of the shōen. originated in the intense conflict between the provincial officers and the kemmons within their territories. By the eleventh century, the once effective way to encourage agricultural production by proclaiming new lands to cultivate became impractical, as it was quite difficult to find more available lands to exploit. But meanwhile, the provincial governors maintained their desire to get more lands for taxation, so they would claim the private property as the national estate which escaped from taxation. Hence, shōen managers had to seek protection to secure their private estate and independent political power, and the method they found was the commendation of shōen: "commending" part of their political power and private property, in most cases a regular payment, to a more powerful individual, known as ryōshū or ryōke, in exchange for his protection. Sometimes, the ryōshū, usually the temples or the local elites, might not be politically influential enough to fully grantee the effective protection, so he would commend his rights and income to someone even more powerful, such as a member of the Fujiwara or the imperial family. Historians refer to those who submit part of their rights and wealth for protection as patrons or guarantors(honke); and, just like ryōshū, they received part of other's estates' yields and offered protection to them as well. Eventually, commendation of the shōen

led to the rapid spread of private estates around the nation and the establishment of Japanese feudalism, with the formation of an enormous common-interest group that strive to maintain their private shōen and the revenue they acquired from the commendation. The time of shōen thus arrived.

Lu, David J, in his work "the Rise of the feudal institutions," points out another factor that promoted the establishment of feudalism in Japan: the emergence of myo, meaning the rights attached to the lands. In a typical private shōen, peasants, aggregated by the owner of the private landholdings, known as tato, carried out most of the estates agricultural and cultivating activities, ranging from growing grains, vegetables, and other foodstuffs to producing goods such as cloth incense and tatami mats. Not surprisingly, their positions were tenuous, and their work was painstaking. Moreover, some estate administrators may not choose to renew the contract with the tatos, forcing them to renunciate their lands and leave the shōen.

However, disease, poor harvests, and other climatic problems kept the population from growing, so managers could rarely afford the cost of dismissing laborers and sometimes had to compromise to tato's demands. As a result, ordinary cultivators in a shōen started to hold the rights of occupation of the land and production tools, which were unimaginable before. In the late tenth century, such rights were officially confirmed by the holder of the shōen in writing. Gradually through custom, the ordinary tato's claim towards the land became stronger: they could hold the lands without cultivating the field themselves, indicating that they were transformed into landholders who practiced some of the same rights as a landlord. Eventually, the rights attached to the name of the lands emerged (myo), saying it was immaterial whether or not the landowner cultivated his land as long as it could remain as a taxing unit. The myo, in the process of its development, created a concept of freely disposable property that could be traded or tenant freely.

The occurrence of myo was crucial to the development of feudalism in Japan from two perspectives. In the initial Handen shūju-hō, the lands being cultivated by the individual were regarded as private lands, and those which were not grown were considered the national property, meaning the private lands could be transformed into the national or public estates once no one was working them. Nevertheless,

with the emergence of myō, rights attached to the lands, the individual's ownership of lands was secured no matter whether it was available or occupied. This absolute ownership of the private estates signified the confirmation of the shōen system in Japan and offered convenience to the land transaction and tenancy system, thus prompting the formation of feudalism. Moreover, the emergence of the rights and power attached to the ownership of the private estates meant the zuryō and provincial military officers could govern their territories not because they were the officers appointed by the imperial court but their ownership of the realms. Be different from Chinese provincial military governors who required the justifiability from the government and depended on the national bureaucracy to maintain their armed independence, Japanese kenmons and rising martial classes could support themselves only with the acquisition of their private landowning, making the only connection between the central government and provincial governors the contract of fixed-income revenue that locale officers demanded to submit. Feudalism has thus originated and flourished in the Kamakura era.

CONCLUSION

In conclusion, though the private manor was rapidly developed in China and the imperial authority was declined with the collapse of the Juntian System, since the ruling class was still majorly constituted by professional bureaucrats and the provincial landlords renunciate independent political positions in exchange for the protection from the central government under the threat given by their tenants, China remained a despotic system. Nonetheless, in Japan, while experiencing something similar to China like the vast land privatization and the decline of the imperial power, the ruling hierarchy, with no concern for the cultivators' severe rebellion, the kenmons gradually annexed most of the lands and usurped the power of provincial administration through the lands they own. Moreover, with the help of commendation of the shōen, landlords discovered a way to protect themselves against the imperial tax and administrative system by transferring part of their wealth and power to greater landlords. Eventually, even the members of the imperial court and the Fujiwara Family who also hold large acreage of lands were embroiled in the process, being part of such a feudal-like commendation maintained by commitments and concords. Getting additional power beyond the national bureaucracy and

administrative system, the officials, mostly composed of the family members of the kenmons, seemed to have no motivation to maintain the existing system. Statutory Japan hence collapsed with the rise of a feudal empire.

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Music Therapy's Effect on Cognitive Performance

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AUTHOR BIO

Inchara Hosanagar is a junior at Newark Academy in Livingston, New Jersey. She is currently Captain of the Women's Varsity Fencing Team, and she is the president of the Pop-Up Book Club, vice president of the Cancer Awareness Club, and she is the grade appointed member of the Equity & Inclusion Team as well as the Community Service Council at Newark Academy. Apart from school, Inchara has a deep passion and interest in the STEM field where she spends time on ongoing research projects and internships. Inchara, while being a full-time high school student, attempts to gain more insight and depth of understanding in the STEM fields. This specific research project was under the mentorship of Yale professor- Dr. Roger Worthington. She focused on the cognitive impacts of music therapy as she is deeply interested in the relatively new subject.

ABSTRACT

In a clinical setting, music therapy has been shown to improve cognitive function and improve mental health in some patients who are suffering from psychiatric symptoms. It is one of the non-pharmacological approaches to treating a range of disorders. With a long history of use, music therapy has been shown to improve cognitive function by interacting with a variety of different brain functional networks and cognitive domains. I will discuss the various mechanisms of music therapy, the advantages of music therapy's influence on neural plasticity, and some studies that are currently being done about music therapy and cognition in this paper, with an emphasis on an improvement in cognition. Numerous studies have shown that music therapy can slow cognitive deterioration, particularly in the areas of global cognition, psychomotor speed, executive function domains, and autobiographical and episodic memories. A promising intervention for the treatment of various illnesses and disorders is music therapy. However, additional data from prospective, randomized, blinded, consistent, and methodologically focused investigations are required.

INTRODUCTION

Music is often considered a form of entertainment; however, there is another angle that I learned: that music is used as expressive therapy. Music therapy is essentially an application of music in a clinical environment, where the use of music intervention methods is used to accomplish individualized results. Music therapy is generally administered by a credentialed professional as part of an approved program. Music therapy is used to influence cognition, which can improve language skills. I was generally interested in music therapy because it seemed to be a relatively newer therapy that I didn't know much about. Doing some research about it, it was clear that music therapy has a high influence on the brain, which ends up boosting many aspects of the mind and body. While it is clear that music therapy has a high influence on the brain, which ends up boosting many aspects of the mind, it was particularly interesting to see how music therapy does not just change the brain but also lets parts of behavior and function adapt. Because music therapy affects the brain in many different ways, its relevance includes that it can non-invasively and easily enhance cognitive function in a variety of disorders and diseases. In addition to this, it is also able to help alleviate psychiatric symptoms in some patients and improve mental well-being.

Some of the objectives of this paper include describing different aspects of music therapy as well as the distinct functional networks and structural components that are affected. It will also detail how the functional networks translate into positive effects. Furthermore, I will be introducing future and current research on music therapy by detailing specific case studies that are trying to make the therapy more specialized and individualized. There is a need for therapeutic interventions to provide adaptive strategies to sustain the quality of life, decrease neurologic impairment, and maintain or slow cognitive decline and function due to degenerative neurologic diseases (Mahoney 2013). Musical interventions with adults with cognitive impairments have received increased attention over the past few years, with music being used as a tool to decrease agitation and anxiety and aid in certain cognitive functions by forcing neurons to create new pathways for themselves (Cortes, Bartel 2018). These approaches indicate the expanding scope and efficacy of music therapy and the potential mechanisms involved (Cortes, Bartel 2018). Music therapy is used for many individuals with a

variety of disorders and diseases because it has shown significant results in boosting cognition and improving executive functions. This is done by having an effect on several distinct areas of the brain as it strengthens neural connections and increases brain plasticity. Certain studies are being conducted on how to create a more specialized and individualized music therapy experience. The idea of sound as a healing influence for health and behavior has been prevalent since the twentieth century, during the World Wars, for veterans suffering from physical and emotional trauma. However, music therapy is a relatively new discipline, as it is stemmed from the historically prevalent sound therapy. The earliest known reference for soundgma therapy was in 1789 when it was used in institutions to alter sleep and wake cycles as a form of psychotherapy (Peng 2013). As it is known to be one of the oldest treatment methods and is used to treat diseases in many different cultures, it regulates physiological functions such as blood pressure and respiratory rhythm and regulates brain oxygenation and blood supply by positively affecting hormones such as serotonin, dopamine, adrenaline, and testosterone (Peng 2013).

Music therapy allows for the objectives of this paper to connect music therapy's impact on cognitive function with how this effect can translate into improved and advanced care for many different disorders and diseases.

Methodology

This project included a literature review and analysis, using search engines like Google Scholar, PubMed, and the National Library of Medicine. When searching for sources, I put around a ten-year restriction on the research because there are always new research findings about music therapy and cognitive performance, as it is a relatively new topic of research. While many case studies fell within this timeframe, I did not exclude any sources that were close to the period because they would still provide new information and insights that would help to add to my analysis. Keywords that I used to locate my sources include cognitive performance in music therapy, music therapy, cognitive function, music cognition, binaural beats, and music cognition. To categorize my research, I observed multiple case studies and qualitatively analyzed many resources to notice certain variations and similarities between the sources, which guided me in my conclusions.

DISCUSSION

What Is Music Therapy?

Music therapy is regarded as an “expressive therapy,” which is when the use of creative arts is implemented as a form of therapy, and unlike some traditional arts, the process of creation is more emphasized than the final product. Music therapy is used in a variety of different places and by different people. It is being used for a multitude of disorders and diseases, so it is used in some medical hospitals, cancer centers, schools, drug rehab programs, psychiatric hospitals, and correctional facilities. Music therapists often use music and its different facets—physical, emotional, mental, social, and spiritual—to help patients improve and maintain their health. Music therapy provides a non-invasive and cost-effective technique that has contributed to improving cognitive function through its cultural role in facilitating social learning and emotional well-being (Fang et al. 2017). As previously stated, music affects many different parts of the brain, which explains why it has so many different benefits (such as improved memory, motor function, and mood) that cover our entire human experience mentally, physically, and socially. Some of the fallbacks of music therapy include overstimulation, false memories, and anxiety. Music therapy consists of many different factors, such as volume, acoustics, and many instruments, which can sometimes provide overstimulation, causing neurological stress. In addition to this, it can create false memories and anxiety in patients suffering from disorders and diseases like post-traumatic stress disorder (PTSD) and Alzheimer’s, which can cause distress (Fang et al. 2017). However, while there may be some drawbacks to music therapy being used, its boost in cognitive function over time outweighs the negative aspects, as it is proven to improve multiple domains of cognition, including attention, memory, psychomotor speed, orientation, and executive functions.

For example, in a study by Särkämö, 89 patients with mild dementia were randomized to a singing group, a music listening group, and a usual care group for 10 weeks (Swayne 2014). Compared to usual care, both music listening and the singing group improved orientation, attention, executive function, and general cognition, as proven by an increase in Mini-Mental State Examination (MMSE) scores, a test that is used extensively in clinical and research settings to measure cognitive impairment (Swayne 2014).

Figure 1: Factors Contributing to Neural Plasticity and Its Effect on Cognitive Domains (Hosanagar 2022)

Functional Networks and Structural Components

Many of the positive effects that music therapy has on these structural components have to do with something called brain plasticity, also known as cognitive plasticity, conveying how the different functional networks and structural components are utilized by music therapy (López-Caballero, Escera 2017). This is the ability of the brain to adapt to certain experiences and interactions by building new neural pathways. Early exposure to music therapy allows for a greater difference in the gray matter, effectively boosting brain plasticity (López-Caballero, Escera, 2017). As shown in Figure 1, music therapy causes structural and functional changes in the brain through an increase in brain plasticity, which can lead to improved cognition but also growth and changes in brain circuitry and connectivity. Some of the different parts of the brain that are affected are the temporal lobe, which includes specific gyri that help process tone and pitch; the cerebellum, which helps to process and regulate rhythm, timing, and physical movement in music therapy; the amygdala and hippocampus, which regulate and evoke emotions and memories; and the brain’s reward system. Cognitive improvement by listening to music has been linked to the relationship between the orbitofrontal cortex and the dopaminergic mesocorticolimbic circuit (Sharma et al. 2018). These parts of the brain vary in function, which conveys how music therapy reaches different audiences and can help with many diseases and disorders because of its extensive reach to different parts of the brain, as well as what all these different parts entail. For example, its effect on the amygdala and regulating emotion has been studied, and there have been clinical studies with patients with depression feeling happier because of music therapy (Sharma et al. 2018). Comparing two case studies: one was being performed by a research team at UCLA, and the second one was being performed in an elderly home by a team of researchers. And in the first one, an elderly population was only subjected to short-term music therapy, while the second one had two groups that were subjected to short-term and long-term, respectively; generally, the short-term effects of music therapy do not contribute to a boost in cognitive function; it is the long-term exposure that initiates improved cognitive function (Lyu et al. 2018). Short-term exposure to music therapy does not cause growth in cognition, and it can only be done when there is long-term exposure. While

we may not be able to revive atrophied tissue from strokes, developmental, or neurodegenerative diseases, we can activate, or modulate, the signaling in certain areas of the brain involved in emotional processing, cognitive flexibility (or abstract thinking), attention, reward, and motivation (Lyu et al. 2018). Over time, if the brain continues to fire in new ways, it can create new neural pathways.

Translation into Positive Effects

Three factors of how music therapy affects cognition are that it involves higher cortical and subcortical areas to produce and process music, it engages all known cognitive and emotional processing, and it activates certain neurochemical activities in the brain (Stegemöller 2014). These factors contribute to “neural plasticity,” where the cognitive, social, and executive domains of the human body are greatly increased. People who are exposed to long-term music therapy are proven to have an increase in brain plasticity as the neural pathways in their brains change as neurons learn how to fire in different ways or strengthen previous connections (Stegemöller 2014). This can be extremely helpful for patients that suffer from neurological diseases like Alzheimer’s, Parkinson’s, strokes, etc. due to an increase in the gray matter, which leads to improved cognition.

A newer aspect of music therapy and sound therapy includes “binaural beats,” which are a part of auditory beat stimulation. Binaural beat therapy makes use of the fact that the right and left ear each receive a slightly different frequency, yet the brain perceives these as a single tone (Kayaaslan, Lok 2019). Auditory beat stimulation, a significant aspect of music therapy, allows for certain cognitive functions to be significantly boosted. For example, Wahbeh tested verbal memory performance using the Rey Auditory Verbal Learning Test, where participants are asked to repeat a list of 15 unrelated words over several trials (Smith 2019). They reported that binaural-beat stimulation at 5 Hz, for fifteen-minute sessions, resulted in a significant increase in the number of words recalled post-stimulation, as measured in the Wechsler III Memory Scale (Smith 2019). These results may suggest that prolonged exposure to auditory beat stimulation may affect verbal memory performance and recall (Smith 2019). Due to a lack of research, because it is a relatively new therapy, there are not many studies on how it can boost cognitive function. However, it is more individualized and specialized compared to some of the more traditional

aspects of music therapy, like singing and playing instruments. There are five categories of brain waves (delta, theta, alpha, beta, and gamma), in which each brain wave is associated with a different activity (Wilbrecht, Shohamy 2010). For example, gamma waves show promise for helping with increased cognitive flexibility and divergent thinking (Wilbrecht, Shohamy 2010). By focusing on certain brain waves, different cognitive abilities can be boosted depending on one’s needs.

Figure 2: A model of response mechanisms to music (Bartel, Clements-Cortes 2018)

Music is implicated in many different types of interventions relating to health and well-being. It looks at treating the whole person and is broader than music medicine, which can be considered to be more of a prescribed approach to music applications. Some mechanisms are responsible for and involved in the effectiveness of music therapy (Zhang et al., 2019). The cognitive response is oftentimes connected with how one can associate an emotional response with the music they are listening to. As seen in Figure 2, Level 2 in the model involves mechanisms of neural circuitry activated by cognitive processes (Flo et al. 2022). For example, when a person loses the use of language due to a stroke, music with language activates a different circuit in the brain and can thereby rehabilitate language function. This circuit-based approach can focus on movement, speech, language, and other cognitive processes such as memory and critical thinking (Flo et al. 2022). The practice of NMT is based on neural mechanisms for cognitive processes. Levels 3 and 4 are more speculative as they are the responses to music therapy at a vibrational, rhythmic level. Listening to and participating in music therapy allows for these mechanisms to come into play (Flo et al. 2022). As they are being utilized, several different neurons and pathways in the brain are being activated, causing a boost in cognitive and executive functioning as it allows for reinforced responses.

Brain plasticity allows us to be more adaptable and ready to experience new environments, which also causes brain plasticity. This is because music therapy allows for more verbal and emotional fluency. After all, music therapy is interpreted as a new language by the brain. There is research being done on whether certain music types or certain aspects of music therapy can be used to control which areas of the brain can be changed. In addition to this, music therapy can be used to help normalize brain function

in states of disease or optimize brain function in states of wellness (Kayaaslan, Lok 2019). This is done because music therapy is shown to better regulate the executive control sections of the prefrontal cortex even in a non-music-related task, and this, along with the altered activation of sensory and motor regions of the brain, translates into an improved cognitive function (Kayaaslan, Lok 2019).

Future and Current Research

Music therapy and its research have mainly been conducted using Western compositions and many classical styles, like Mozart and Bach. While music is oftentimes considered a universal language, it is important to highlight the need to recognize the importance of musical diversity and that musical preferences vary by culture, although there has been little research undertaken into multicultural music therapy. However, researcher Laksmidewi performed a study that involved the Balinese elderly by separating two groups and having western classical music for one and instrumental Balinese flute music therapy for the other (Schlaug 2010). As music is linked to one's identity, it can help to connect with a past sense of self. Because of the immeasurable results, it was quite difficult to see if there was a difference in cognition between the two groups. Some research is being done on whether certain parts of the brain and cerebral circuits can be specifically accessed through music therapy to provide more individualized care. For example, Thaut and Altenmüller developed a new brain circuit named Neurologic Music Therapy (NMT). NMT uses the perception of auditory structures and patterns in music as specific circuit activators to retrain brain function, which is organized into three main areas: sensorimotor training, speech/language training, and cognitive training (Zhang et al. 2019). A specific example of this is when Poeppel proposed the right hemisphere of the brain is potentially more advanced at handling slowly modulated signals in individuals with expressive aphasia, so the sensorimotor network will be more easily activated with music therapy, which is exposed to the left side of the body (Schlaug 2010). This is research that has been going on for many years to see if we can optimize what type of music to select to invoke a certain cognitive, motor, or emotional response in a patient by activating certain circuits. This can then allow us to use music to help normalize brain function in states of disease or optimize brain function in states of wellness. For example, in an epilepsy case study conducted by Dr. Ovary (2009), he found

more about music therapy and its effect on epilepsy specifically. Because patients with epilepsy have different cerebral rhythms and limbic activity, there is more research being done on music therapy and its specific effects on many disorders and diseases, and how to adapt music therapy accordingly.

CONCLUSION

Music therapy can be considered a non-pharmacological intervention that has the potential effects of reducing cognitive decline and improving neuropsychiatric symptoms. Research has demonstrated that music therapy, while it naturally has some fallbacks, clearly boosts cognitive function. Also, certain mechanisms of music therapy allow for different facets of cognition to be conveyed, especially through an increase in neural plasticity and gray matter. As music therapy is a relatively newer therapy, it is crucial to keep up with current and future research as it is aiming to provide more specialized and individualized care for individuals, especially those with neurological disorders and diseases. Certain mechanisms and aspects of music therapy can also translate into different effects, as it positively affects individuals and their executive functions. Music therapy causes the cognitive function to be increased as it affects different functional networks and structural components of the brain, which relay positive effects on the different domains of cognition. While I was researching for this paper, one particularly interesting aspect of music therapy is that it is constantly changing due to new studies being found. It also adapts to each condition that it treats, and while it is crucial to see the benefits that music therapy provides, such as a boost in cognition, it is imperative to modify music therapy as these new studies bring more insight and perspective into how to create more advanced, specialized, and focused care for patients with disorders and diseases.

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Solving Healthcare Data Fragmentation To Drive Better Patient Outcomes

By Suved Wali

AUTHOR BIO

Suved Wali is a junior at Newark Academy in Livingston, New Jersey. He is passionate about technology specifically artificial intelligence, machine learning and blockchain. Suved is a strong proponent of Environmental sustainability and has made a foray into social entrepreneurship through his business venture Crescendo, which is an eCommerce marketplace that brings together buyers and sellers to transact around used musical instruments. This allows budding musicians to afford instruments which are otherwise un-affordable for them. Outside of his academic pursuits, Suved is also a trained musician and plays electric guitar with his school band. I thank Professor Jean-Claude Franchitti, New York University Courant Institute, for being my mentor for this research. The completion of this research paper would not have been possible without his guidance, review, and feedback.

ABSTRACT

The fragmentation of patient medical information is the most critical and pressing issue for the healthcare industry. Some of the challenges due to this issue include patient misdiagnoses, inappropriate medications, duplicate tests, and an overall decline in providing the best medical care to patients. The magnitude of this problem is colossal, with an estimated \$530 billion spent every year on fixing problems resulting from incorrect prescriptions and usage. [1] In this paper, I have outlined the pertinent reasons behind this issue and remediations that have been put into place over the years by the federal government as well as the medical industry. This research paper goes on to describe the role of innovative technologies to improve the experience for both patients and healthcare professionals. Specifically, this paper outlines the architecture for an integrated healthcare data platform and details out the technical components that will perform aggregation, cleansing and synthesis of patient medical information. This integrated data platform needs to be made available to participating hospitals and doctors, so they have a full understanding of patient's prior medical history including prescriptions, medical test reports, and doctor notes. The platform can help reduce the cost of serving medical care, improve accuracy of diagnosis, foster collaboration between hospitals, and elevate the overall delivery of medical experience for patients.

Keywords: Data Fragmentation; US Healthcare; Electronic Health Record; HIPPA; AWS Cloud; Interoperability; Patient Data

INTRODUCTION

US healthcare is in a state of paradox. The country has by far the highest healthcare expenses as a percentage of GDP and the highest drug prices, yet it has shockingly subpar healthcare outcomes compared to other developed markets in terms of highest rates of avoidable deaths and lowest life expectancy. [2] In an extensive study conducted by Harvard University, it pointed out that the US healthcare system suffers from excessive fragmentation due to lack of data sharing among healthcare professionals. An average patient sees around two physicians and five specialists in a year, and those with more chronic illnesses are seeing up to thirteen physicians a year. [3] [4] In absence of any integration between various healthcare systems, patients are shouldering the responsibility of interlinking their medical history information across physicians. The fact that we are counting on patients to orchestrate the various components that will help achieve the desired medical outcome is far from optimal and leads to subpar results for everyone involved. The recent pandemic has further highlighted the perils of the siloed healthcare data model. As people got infected with the deadly virus across states, there was no easy way to share data across various healthcare entities, draw insights around the epidemiology of the disease, understand demographic patterns, and ultimately come up with data driven strategies to combat the virus in a more effective manner. [5]

This is not a recent challenge, rather has been well documented for over a decade. Some of the key reasons that have led to data fragmentation include:

- Lack of data transfer standards between EHR systems, therefore limiting the ability to seamlessly exchange information.
- Healthcare providers perceive data silos and fragmentation to be a competitive advantage and a way to lock-in patients.
- EHR vendors have no incentive to build HIE (Health Information Exchange) enabled systems and charge exorbitant fees for building these capabilities.

As early as 2009, Obama administration acknowledged the enormity of this issue and passed the HITECH act which was supposed to pave the way for modernization of electronic medical records.

[6] This act pledged to bring in widespread reforms around healthcare records modernization. With an outlay of \$35 billion, this act incentivized hospitals and providers to adopt electronic health records (EHR) systems. While it did help jumpstart the adoption of EHR systems, the act failed to achieve the interoperability of medical data, which was one of its key objectives. [7] [8] Before going further, it's equally important to understand the work done so far from a technological standpoint to solve interoperability and potential gaps that still need to be resolved. There are three key areas that need to be highlighted:

- Rapid adoption of electronic medical healthcare record and associated digitization has been very high, creating a strong foundational base and momentum to implement the next set of frameworks
- Technological advancements in cloud infrastructure unleashing high compute capabilities and lower costs have incentivized healthcare providers to move underlying systems to cloud. This has led to adoption of new integration frameworks and protocols that allow data exchange between different systems to become relatively seamless.
- Artificial Intelligence and Machine learning technologies have moved out of research labs into mainstream hospitals to provide better patient outcomes especially for critical medical conditions. This underlines the need to have access to large batches of data across hospitals and providers to understand patterns and come up with critical insights. This has helped to break down some of the data barriers and pave the way for collaboration

With these advancements already in place, the question that remains to be tackled is how we take these innovative technologies and point solutions and orchestrate an end-to-end data platform that provides a comprehensive medical data footprint for any given patient.

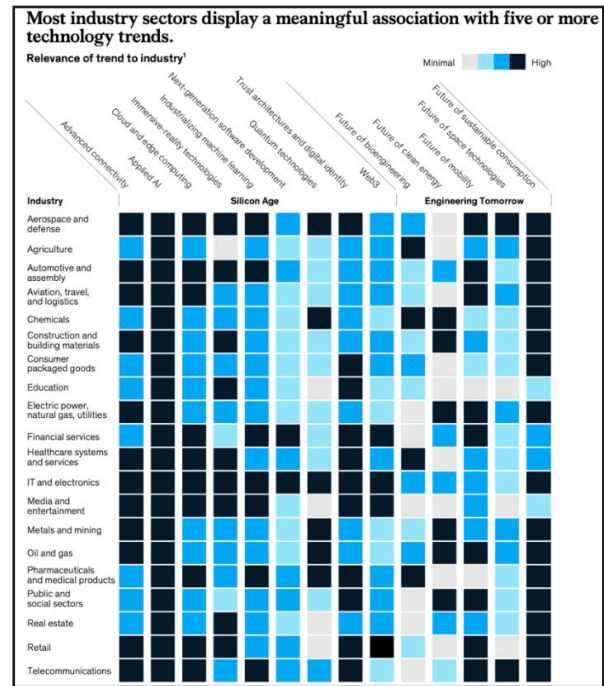
The Opportunity:

We are living in a technology driven world. In the last few years, we have witnessed groundbreaking technological innovation that has disrupted existing business models and triggered novel ways of doing things. It is no coincidence that some of the biggest

disruptors in the last few years such as Uber, Tesla, and Robinhood are technology led, and are re-imagining various aspects of our life from ordering a cab, to driving cars and buying stocks. The healthcare industry has also seen a massive uptick in technology adoption in the last decade. New technologies such as AI, VR, Genomics, and the Internet of Medical Things (IoMT) are helping solve complex medical disorders and paving the way for new innovations in genome engineering and therapy, DNA sequencing, and robot assisted surgeries. [9] [10]

In a 2022 report published by McKinsey & Co, they have outlined 14 technology trends that will dominate and disrupt every sector. [11] The healthcare sector is expected to heavily leverage some of these influential technologies in an exponential manner.

- Industrializing Machine Learning:** The usage of AI / ML in medical healthcare has been ongoing for the last decade. The next frontier will be to move from experimentative point solutions to more rapid scaled up enterprise grade solutions that will increase productivity and reduce overall time to market. In the context of Medical Healthcare sector, this will enable processing of big data, provide near real time diagnosis, remove algorithmic bias, deliver precision medicine rather than a one size fits all approach, and come up with prediction models to calculate potential medical outcomes. [12]
- Next-Generation Distributed Computing:** It's expected that 70% of companies will move to hybrid or multi-cloud platforms in the coming years with the deployment of micro services-based architectures. This will pave the way for interoperability, containerization, reduced complexity, and seamless data exchange between multiple disparate systems. [13]
- Trust Architecture:** Ensuring data privacy and avoiding breaches will be of paramount importance, especially when dealing with sensitive patient data. Deployment of technologies such as Zero Trust Architectures (ZTA) and digital identity systems will enable securing access to sensitive patient data and foster effective care coordination between providers.



Tech trends affect all sectors, but their impact varies by industry.

Image: McKinsey & Co

Solution – Next Generation Healthcare Data Platform

As outlined in the above section, breaking down data silos in the healthcare industry is needed to drive better patient outcomes. This calls for the implementation of a healthcare data platform that will unify multiple sources of patient data across EHRs including prescriptions, doctor notes, medical reports, images, with the end goal of hydrating a single unified record.

Key Components:

Description	Function
Security	<p>This component will help in accomplishing the governance objectives especially as it relates to data privacy, access, and consent. The technology components included here will be responsible for authorization, authentication, and access management. Amazon Cognito allows to control access to AWS resources and integrates with enterprise identity providers such as Active Directory. Necessary IAM roles will be applied to Lambda functions to access and write data to S3 buckets and Dynamo DB.</p> <p>This sample application demonstrates the developer-authenticated functionality of Amazon Cognito. Use this sample in conjunction with the CognitoSyncDemo sample:</p> <p>https://github.com/aws-samples/amazon-cognito-developer-authentication-sample</p>
Tracking and Audit	<p>This component will also help in accomplishing the governance objectives as it relates to data privacy, access, and consent. The technology components included here will enable audit, logging and debugging. AWS CloudTrail records all the events within AWS account while AWS X-Ray provides end-to-end request message tracking and enables debugging. This will also help with generation of audit reports required by internal policies and external regulations.</p> <p>Documentation for using the AWS CloudTrail Processing Library to build a CloudTrail log processor in Java: https://github.com/aws/aws-cloudtrail-processing-library</p>
EHR Transformation	<p>This component will help in accomplishing the key objectives around data unification and interoperability which will ultimately improve the customer experience for patients and healthcare professionals. The specific capabilities for this component will be the transformation and storage of EHR records.</p> <p>Serverless AWS Components that convert the clinical notes provided in text or audio format to FHIR (Fast Healthcare Interoperability Resource).</p> <ul style="list-style-type: none"> • Amazon S3 triggers to run a Lambda function when a new object is created. The Lambda function performs the orchestration of the various steps depending on the type of the object. It will make API calls to Amazon Textract to process text notes and to Amazon Transcribe Medical to transcribe audio notes. The results of the transcription process will be saved to the target Amazon S3 bucket. After the output is saved to the target • Amazon S3 bucket, an Amazon S3 again triggers a call to a Lambda function. The text that is generated by Amazon Transcribe Medical or Amazon Textract will be stored in a JSON structure representing a FHIR DocumentReference in Dynamo DB. • Serverless AWS Components that converts the data from HL7 or other format messages to FHIR. The Lambda function processes the request and saves the output of Amazon Dynamo DB. <p>Sample code using Amazon Textract to process documents after successful upload of documents to the source S3 bucket. Makes intelligent flow-control decisions after classifying the input document type: https://github.com/aws-samples/amazon-textract-comprehend-stepfunctions-example</p> <p>Demonstrates how to build more robust solution using Amazon Textract for processing documents: https://github.com/aws-samples/amazon-textract-enhancer</p> <p>Sample project that includes transformation from FHIR Resource to HL7v2 Message: https://github.com/aws-samples/fhir-hl7v2-integration-transform</p> <p>Sample code to leverage Amazon Comprehend Medical to convert clinical records to FHIR resources: https://github.com/aws-samples/amazon-comprehend-medical-fhir-integration</p>
AI/Machine Learning	<p>This component will help in accomplishing the key objectives around data governance and AI. The AWS technologies will analyze the clinical data to derive medical insights. Amazon SageMaker will use the data stored in AWS S3 buckets to build and train machine learning models. The results of SageMaker predictions will be stored in Dynamo DB to be available to healthcare providers. Using AWS Glue Elastic Views, we can use familiar Structured Query Language (SQL) to quickly create a virtual table—a materialized view—from multiple different source data stores.</p> <p>Documentation for Installing SageMaker Python SDK: https://github.com/aws/sagemaker-python-sdk</p>

CONCLUSION AND FUTURE WORK

In this paper, I have designed an extensible architecture that brings together cloud based microservices to build out an integrated data platform. Given the complexity of disparate data sources that need to be considered for aggregating medical health records, the proposed architecture provides a foundational starting point and will require revisions to accommodate various scenarios. Some of the FaaS (Function-as-a-Service) components included in the architecture will have to be revisited when productionizing this architecture and are currently referenced for rapid prototyping. Each of the platform components are modular, therefore we can easily modify the architecture to activate new features or channels. Additionally, the cloud hosting approach will ensure that we are able to rapidly scale up resources to handle large volumes of data. Given that many of the components are out of the box, the platform will allow for faster deployment and can be implemented in a rapid, iterative fashion. The first version of the architecture is designed for healthcare professionals as the key consumers of the platform. There is a future use case wherein healthcare research organizations can be onboarded on the platform. That will allow them to train new machine learning models on the vast amounts of data and aid with early disease detection. In essence, the goal of this platform is to enable better healthcare outcomes for patients and streamline cohesive communication between the healthcare community.

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Suicidal Thoughts Detection from Social Media Using AI

By Rishav Biswas

AUTHOR BIO

Rishav Biswas is a high school student from Kolkata, India. He is 17 years old and very passionate about swimming. From childhood, he was always interested in computers. As he grew up, he got to know about the different divisions of the computer. He is fascinated with the concept of Artificial intelligence. Only a few months ago, he got to know about writing a research paper and publishing it, while reading in high school. As this thing is not common in his country. He has some personal reasons which motivated him for doing this research. Through this research, he got to learn so many things, which are not taught in his school. He has a dream of reducing the suicide rate in this world. He thanks Dr. Ganesh Mani, a professor from Carnegie Mellon University, and Alfred Renaud for helping me to do this research project.

ABSTRACT

Suicide is one of the top leading causes of death worldwide. Early detection and prevention of suicide attempt should be addressed to save people's life. Nowadays, people on social media are posting posts that include suicidal thoughts. To detect this kind of post, we used an AI model which can do this by analyzing text involving them. In this study, we will be going to learn about how the model works and the results of testing the model. The study will be covering every aspect of the model so that everybody can understand it. The study also includes a proper explanation of GloVe, which is used for word embedding. We have also discussed the weaknesses of our model. There are some pre-existing models for suicidal thoughts detection but their accuracies are not as high as our model. Our model can detect suicidal thoughts with a recall of 0.93(93 percent) and a precision of 0.94(94 percent).

Keywords: Machine Learning, AI modeling, suicide, suicide thoughts, suicide detection, social media, AI, suicidal ideation, suicidal thoughts detection

INTRODUCTION

Suicide is among the top three causes of death among youth worldwide. According to the WHO, every year, almost one million people die from suicide and 20 times more people attempt suicide; a global mortality rate of 16 per 100,000, or one death every 40 seconds and one attempt every 3 seconds, on average. The rates of suicide have greatly increased among youth, and youth are now the group at highest risk in one-third of the developed and developing countries.

Due to the advances of social media and online anonymity, an increasing number of individuals turn to interact with others on the Internet. Online communication channels are becoming a new way for people to express their feelings, suffering, and suicidal tendencies. Hence, online channels have naturally started to act as a surveillance tool for suicidal ideation, and mining social content can improve suicide prevention. In addition, strange social phenomena are emerging, e.g., online communities reaching an agreement on self-mutilation and copycat suicide. For example, a social network phenomenon calls the “Blue Whale Game” in 2016 uses many tasks (such as self-harming) and leads game members to commit suicide in the end. Suicide is a critical social issue and takes thousands of lives every year. Thus, it is necessary to detect suicidality and to prevent suicide before victims end their life. Early detection and treatment are regarded as the most effective ways to prevent potential suicide attempts.

Social media has become an integral part of our lives, especially for the youth. We use it to share photos and funny stories, talk about our political viewpoints and catch up with friends. It can also be a place where we feel comfortable talking about struggles or our pain. It may be easier to write about how we feel behind a screen than to share it with someone in person. When we are struggling, we may isolate ourselves and social media becomes one of our only connections to others.

There has been an increase in the number of posts where people are telling about emotional problems. These posts sometimes go one step further where people are expressing their suicidal thoughts. There is a high chance that these people may be involved in a suicidal attempt in the future. If we can detect these types of posts, we may help in suicide prevention.

Now to detect suicidal thoughts, we have to take the help of an AI model. AI model is used for training and deployment of machine learning algorithms that emulate logical decision-making based on available data. To build an AI model, we need a dataset that can be used for training and testing purposes of it. The text, involved in a post, is the primary source of data to be used as a data set.

In this study, we have taken the dataset from subreddits on the Reddit platform. We have used GloVe for word embedding [3]. In natural language processing, word embedding is a term used for the representation of words for text analysis, typically in the form of a real-valued vector that encodes the meaning of the word such that the words that are closer in the vector space are expected to be similar in meaning. Then the model has been created to detect suicidal thoughts.

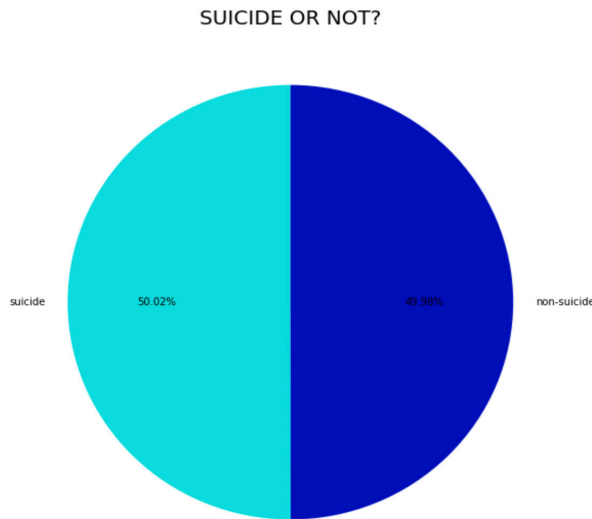
METHODS

Data Collection and Preparation

We have collected the data from (<https://www.kaggle.com/datasets/nikhileswarkomati/suicide-watch>). The dataset consists of 232,074 posts, which are classified into two classes. The two classes are suicide and non-suicide. The dataset is a collection of posts from “SuicideWatch” and “depression” subreddits on the Reddit platform. The posts are collected using Pushshift API. All posts that were made to “SuicideWatch” from Dec 16, 2008(creation) till Jan 2, 2021, were collected while “depression” posts were collected from Jan 1, 2009, to Jan 2, 2021. The dataset is illustrated in the table below.

#	Text	Class
29	yeaputting a knife to my wrist didn't give me any hesitation like how it used to, i am free from tha...	Suicide
30	I am ending my life today, goodbye everyone.I am 36 almost 37, I am on disability for PTSD and Rheum...	Suicide
37	Guys I want friends That's it , I'm alone and don't talk to anyone dm me or anything, I'm just tired...	Non-suicide
4	Finally 2020 is almost over... So I can never hear “2020 has been a bad year” ever again. I swear to...	Non-suicide
25	I'm scared. Everything just seems to be getting worse and worse. I'm young and I think I'm transge...	Suicide

In the above table, we have three columns: the first column is unique values assigned to every text, the second column is text, and the third column is about the class in which a particular text falls. To demonstrate the percentage of text fall into two classes, there is a pie chart below.



We get to see that the two classes have the almost same number of data around 50 % each. This is important for any kind of biased results for our model. There are some changes made to the original dataset due to mismatches of data. This is quite significant for the accuracy of our model.

The dataset was split into two subsets for training and testing of the model. Then we cleaned the text data by removing special characters or any stopwords (There are a lot of commonly used words, such as ‘the’, ‘is’, ‘that’, ‘a’, etc., that would completely dominate an analysis, but don’t offer much insight into the text in your documents; these words, that we want to filter out before we analyse our text, are called ‘stopwords’) and converting it to lower case. After that, it was divided into tokens by the process of tokenization (Many TDM methods are based on counting words or short phrases. However, a computer doesn’t know what words or phrases are – to it the texts in your corpus are just long strings of characters. You need to tell the computer how to split the text up into meaningful segments that will enable it to count and perform calculations. These segments are called tokens and the process of splitting your text is called tokenization).

For pre-processing the text data, we have used the `pad_sequence()` function from the Keras library [2]. It is done to ensure that all inputs are of the same size. Then we used Label Encoder, from the scikit-learn library, to convert labels (words of the text are labeled) into a numeric form to convert them into the machine-readable form. It will be helping the model to decide in a better way how those labels must be used. The data is now collected and prepared for the model to be used.

Word Embedding and GloVe

Word Embedding is the process of converting high-dimensional data to low-dimensional data in the form of a vector in such a way that the two are semantically similar. In its literal sense, “embedding” refers to an extract (portion) of anything. Generally, embeddings improve the efficiency and usability of machine learning models and can be utilized with other types of models as well. When dealing with massive amounts of data to train, building machine learning models is a nuisance. As a result, embedding comes into play.

We have used GloVe for word embedding. GloVe stands for Global Vectors [3]. The GloVe is essentially a log-bilinear model with a weighted least-squares objective. The main intuition underlying the model is the simple observation that ratios of word-word co-occurrence probabilities have the potential for encoding some form of meaning. For example, consider the co-occurrence probabilities for target words ice and steam with various probe words from the vocabulary. Here are some actual probabilities from a 6-billion-word corpus:

Probability and Ratio	K = Solid	K= Gas	k = Water	K = fashion
$P(K ice)$	1.9×10^{-4}	6.6×10^{-5}	3.0×10^{-3}	1.7×10^{-5}
$P(K steam)$	2.2×10^{-5}	7.8×10^{-4}	2.2×10^{-3}	1.8×10^{-5}
$P(K ice)/P(K steam)$	8.9	8.5×10^{-2}	1.36	0.96

As one might expect, ice co-occurs more frequently with solid than it does with gas, whereas steam co-occurs more frequently with gas than it does with solid. Both words co-occur with their shared property water frequently, and both co-occur with the unrelated word fashion infrequently. Only in the ratio of probabilities does noise from non-discriminative words like water and fashion cancel out, so that large values (much greater than 1) correlate well with properties specific to ice, and small values (much less

than 1) correlate well with properties specific to steam. In this way, the ratio of probabilities encodes some crude form of meaning associated with the abstract concept of the thermodynamic phase.

The training objective of GloVe is to learn word vectors such that their dot product equals the logarithm of the words' probability of co-occurrence. Since the logarithm of a ratio equals the difference of logarithms, this objective associate (the logarithm of) ratios of co-occurrence probabilities with vector differences in the word vector space. Because these ratios can encode some form of meaning, this information gets encoded as vector differences as well.

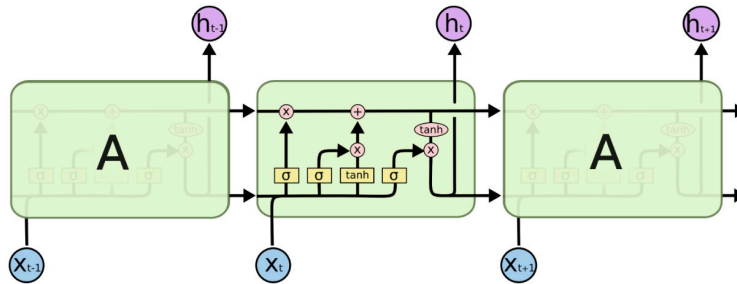
We have used a pre-trained GloVe Embedding taken from (<https://www.kaggle.com/datasets/authman/pickled-glove840b300d-for-10sec-loading>) to build our model. It was of size 2.3 Gb. It was trained on a dataset of 84 billion tokens(words) with a vocabulary of 2.2 million words and an embedding vector size

of 300 dimensions. We can seed the Keras (a library) Embedding layer with weights from the pre-trained embedding for the words in our training dataset. Then we can define the examples, encode them as integers, then pad the sequence of similar length. Keras provides a Tokenizer class that can be fit on the training data, can convert text to sequences consistently by calling the `texts_to_sequences()` method on the Tokenizer class, and provides access to the dictionary mapping of words to integers in a `word_index` attribute.

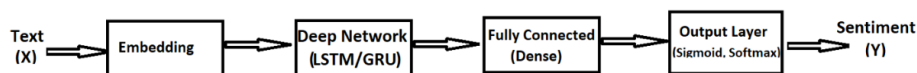
We need to load the entire GloVe word embedding file into memory as a dictionary of words for the embedding array. After that, we need to create a matrix of one embedding for each word in the training dataset. We can do that by enumerating all unique words in the `Tokenizer.word_index` and locating the embedding weight vector from the loaded GloVe embedding. This `embedding_matrix`, we will be using in our model.

Model Training and Working

We want to build a sequential model with help of the Recurrent Neural Network (RNN) method. Sequence models are machine learning models that input or output sequences of data. Keras is the main Library that we have used to build this model [2]. To use the RNN method, we have used a built-in RNN layer of Keras (a library) named LSTM(Long short-term memory).



In the above picture, we can see a typical LSTM unit that is repeated over the whole length of a sequence. In our model, we first created layers, and with help of LSTM and `embedding_matrix`, which was already created, we can train our model. We performed 20 epochs with a `batch_size = 256` on the training dataset. After that, for testing, we used the testing data set. This data set was already split earlier.

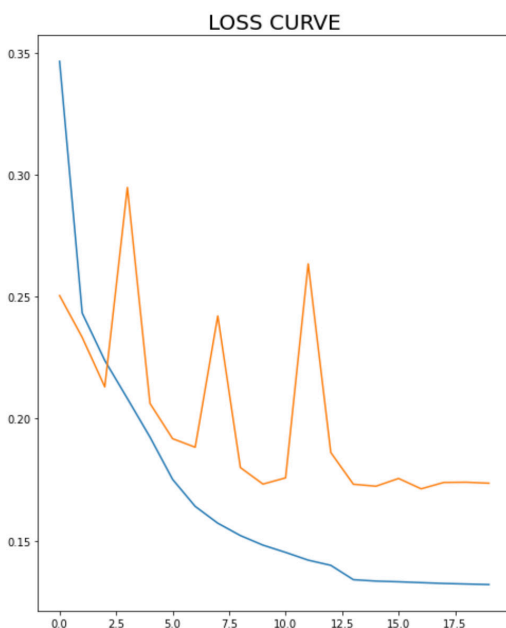
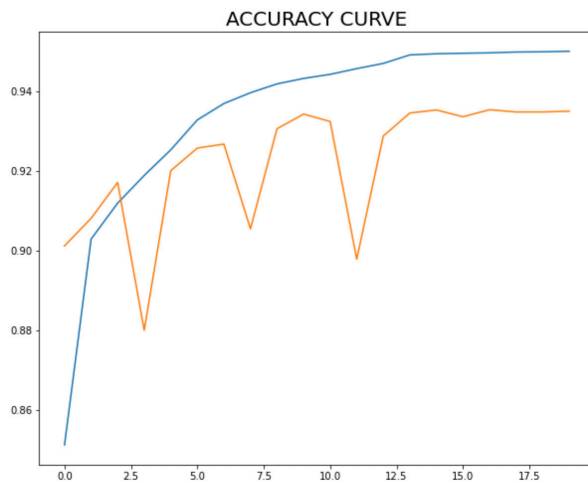


From the above picture, we can clearly understand how our model works. At first, there is the text which is our input data and then there is an embedding layer in which we use word embedding. Thirdly we have a Deep network (LSTM) that takes the sequence of embedding vectors as input and converts them to a compressed representation. The compressed representation effectively captures all the information in the sequence of words in the text. Fourthly, the fully connected layer takes the deep representation from the LSTM and transforms it into the final output classes. Lastly, it displays its sentiment as either suicide or non-suicide.

RESULTS

In the below graph, the blue line is the accuracy of the training set and the orange line is the validation set accuracy. The x axis is for accuracy and the y axis is for epoch.

The Model has achieved a weighted average precision of 0.95(95 percent), recall of 0.95(95 percent), and f1-score of 0.95(95 percent) on the training set. For the testing set, the precision, recall, and f1-score are 0.94(94 percent), 0.93(93 percent), and 0.93(93 percent) respectively. The precision for the suicide classes is high than the non-suicide classes for the testing set, while the recall is just the opposite. In the training set, both the precision and recall are the same.



In the above graph, the blue line is the accuracy of the training set and the orange line is the validation set accuracy. The x axis is for loss and the y axis is for epoch.

Discussion

This study gives a clear picture of how a model is created and how it works. The accuracy of the model is slightly high in comparison to other works on suicidal thought detection. There was a significant change in accuracy when we made some changes to the dataset. Our next step will be to analyze the dataset for more scope of improvement in the accuracy.

We will be using more datasets in the future to test and improve the accuracy of this model. From the results, it is unclear why there is a difference between precision and recall. We will be looking into that. There will be always uncertainty about the reality of the text means somebody may be for fun posting suicidal thoughts or sarcastically doing this. For these reasons, we should focus on future studies for making a more efficient model. We will also be working on the reduce the loss of the model during its work.

The ultimate aim of suicidal thoughts detection is intervention and prevention. One of the applications of this study is Proactive Conversational Intervention. Very little work is undertaken to enable proactive intervention. Proactive Suicide Prevention Online (PSPO) [4] provides a new perspective with the combination of suicidal identification and crisis management.

An effective way is through conversations. To enable timely intervention for suicidal thoughts, automatic response generation becomes a promising technical solution. Natural language generation techniques can be utilized for generating counseling response to comfort people’s depression or suicidal ideation. Reinforcement learning can also be applied for conversational suicide intervention. After suicide attempters post suicide messages (as initial state), online volunteers and lay individuals will take action to comment the original posts and persuade attempters to give up their suicidality. The attempter may do nothing, reply to the comments, or get their suicidality relieved. A score will be defined by observing the reaction from a suicide attempter as a reward. The conversational suicide intervention uses policy gradient for agents to generated responses with maximum rewards to best relieve people’s suicidal thoughts.

CONCLUSION

The study is successfully able to interpret the model. The study also gives every detail about the model building, which will be helpful to beginner students. The model has an accuracy of around 94 percent, which can further be increased. Overall, if we look into the study, it is quite evident that AI can successfully detect suicidal thoughts from social media. Online social content is very likely to be the main channel for suicidal ideation detection in the future [1]. It is therefore essential to develop new methods, which can heal the schism between clinical mental health detection and automatic machine detection, to detect online texts containing suicidal ideation in the hope that suicide can be prevented.

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A Review of Takotsubo Cardiomyopathy

By Thomas Xiong

AUTHOR BIO

Hi, my name is Thomas Xiong, a grade 11 student in Toronto, Canada. I want to join the healthcare profession in the future, and I am working hard to gain experience in this field. I have completed biology summer programs and a proud competitor of British Biology Olympiads. In addition, I volunteered at multiple cancer organizations, where I lead a team of students to create educational poster and presentation slides on various types of cancers and their treatment options. Outside of this aspiration, I also enjoy many hobbies, including Clarinet, band, travelling, reading, and art. Through publishing these articles, I hope to gain experience in the research, which includes but not limit to, developing my own ideas, discussing them with colleagues, and articulating a comprehensive argument from my thoughts. I really appreciate that you review my work and would love to hear about your comments and suggestions.

ABSTRACT

Takotsubo cardiomyopathy, also known as apical ballooning syndrome, stress cardiomyopathy, and more commonly, broken heart syndrome, is a temporary heart condition that occurs when an individual experiences sudden extreme emotion that rapidly weakens the left ventricle. The goal of this article is to provide a general overview of takotsubo cardiomyopathy and discuss its history, stressors, clinical and underlying symptoms, populations at risk, clinical studies, and potential treatments. These factors are important to understand, as the effects of Takotsubo, although rare, could be devastating to patients' health. By learning about the mechanisms of Takotsubo, effective treatment plans could be implemented quicker and improve prognosis. This article presents that Takotsubo contains many similar qualities to heart attacks, and some treatment options could be considered for both diseases. It is difficult to prevent Takotsubo through medication, since the cases are mostly acute and unpredictable. However, treating maladies that often come with Takotsubo could lessen the effects on the patient.

OVERVIEW AND HISTORY

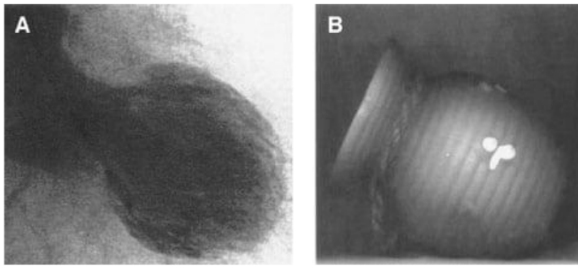


Figure 1. (A) Ventriculogram (B) Octopus pot “Takotsubo”²

First described in Japan by Hikaru Sato, MD, Ph.D. in 1990, Takotsubo cardiomyopathy derived its name from a traditional octopus trap with a narrow neck and wide base¹. The condition causes apical ballooning of the left ventricle, which gives it a shape similar to the octopus trap on a cardiac ventriculogram (Figure 1).

Interest in Takotsubo cardiomyopathy spiked in 2004 after the Niigata Chuetsu earthquake in Japan, where cases diagnosed in the week following the quake equalled the number of patients diagnosed in the previous decade (1994-2004)¹. A rise in rates of Takotsubo also accompanied recent earthquakes in New Zealand. These statistics indicate that physical and emotional stressors may cause Takotsubo. While most people with this condition experience a stressful trigger, around 30% of patients do not have an identifiable trigger³. Emotional stressors of Takotsubo include, but are not limited to^{3,4}: Grief, fear, anger, and extreme emotions. Physical stressors of Takotsubo include, but are not limited to^{3,4}: High fever, stroke, seizure, difficulty breathing, significant bleeding, and low blood sugar. These stressors are prevalent conditions among populations that have recently experienced natural disasters.

Ever since 2006, diagnosed cases of Takotsubo have been on the rise⁵. This could be partly attributed to the increased awareness of Takotsubo but could also reflect the rising trend of emotional stress and a lack of capacity to deal with such pressures. For example, in the United States, reports of loneliness have increased linearly since the 1970s⁶. Takotsubo only occurs in 2% of patients seen with a suspected heart attack⁷. However, this figure is most likely under-recognized as the condition is sometimes undiagnosed. Moreover, the risk of Takotsubo is often underestimated and its pathogenesis unclear.

Hence, it is important for further research on Takotsubo to be conducted. Many misconceptions about the disease has emerged, partly due to the lack of knowledge and disproven results from earlier reports. As a whole, Takotsubo is incorrectly considered to be a benign disease of “clean” coronary arteries caused by an emotional trigger that can “self-heal.” In reality, Takotsubo is not a benign disease⁷, is not always preceded by an emotional trigger⁷, and does not require “clean” arteries. Based on current literature of Takotsubo, this study will focus on presenting a comprehensive view of the disease to reduce some pitfalls and misinterpretations during diagnosis and management.

Post-menopausal women, and women in general, are most at risk of developing Takotsubo, with the risk of development increasing five times after the age of 55⁷. In fact, up to 90% of Takotsubo diagnoses are of women¹. Although the exact reason for this is unknown, it is hypothesized that the female hormone estrogen protects the heart from the harmful effects of stress. For example, estrogen clears up LDL (Low-Density Lipoprotein) and increases the presence of HDL (High-Density Lipoprotein). It also removes free radicles within the blood, which may improve takotsubo symptoms, as it might lower the local oxidative stress¹. As women grow older, their estrogen levels decline, and they become vulnerable to Takotsubo. Other risk factors of Takotsubo include depression, anxiety, or other mental illnesses⁷.

Despite the disease being described over 30 years ago, the cause of the disease, its exact physiological processes and courses of standard treatment are still unclear. However, with more cases being identified, a symptoms and diagnostic criteria has been established.

Symptoms and Diagnostic Criteria

Symptoms of Takotsubo closely resemble those of a heart attack, for example, sudden, severe chest pain, shortness of breath, intense sweating, and dizziness. However, Takotsubo may be felt within minutes up to hours of the trigger, whereas heart attack symptoms are felt as soon as blood and oxygen supply is cut off⁸.

The Revised Mayo Clinic Criteria are widely used for the diagnosis of Takotsubo. To be diagnosed with Takotsubo, four of the following conditions must be met⁹:

1. Transient dyskinesia of the left ventricular mid-segments, with or without apical involvement; the regional wall-motion abnormalities extend beyond a single epicardial vascular distribution, and a stressful trigger is often, but not always, present
2. Absence of obstructive coronary disease or absence of angiographic evidence of acute plaque rupture
3. New ECG abnormalities (ST-segment elevation and/or T-wave inversion) or modest elevation in the cardiac troponin level
4. Absence of pheochromocytoma and myocarditis.

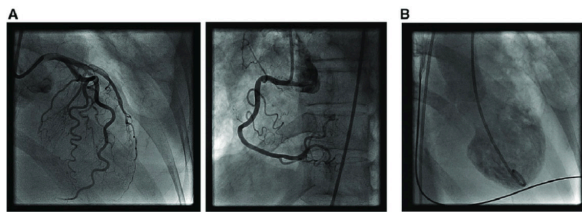


Figure 2. (A) Coronary angiogram demonstrating normal left and right systems. The heart is functioning as normal (B) Left ventriculogram demonstrating apical ballooning consistent with Takotsubo,¹⁰ with the left ventricle being enlarged

In practice, Takotsubo is most commonly diagnosed when cardiac catheterization of a patient with a suspected heart attack reveals no blockage, as shown in figure 2.

Potential mechanisms of action (MOA)

Although Takotsubo and heart attacks share similar symptoms, their underlying causes are different. Heart attacks are generally caused by a

complete or near-complete blockage of a coronary artery. While in Takotsubo, arteries are not blocked, though arterial blood flow may be reduced due to a weakened left ventricle.

During Takotsubo, the heart muscle suddenly becomes weakened and the left ventricle balloons at the heart’s apex. The shape change affects the heart’s ability to pump blood and may lead to permanent changes to the heart’s pumping motion. Takotsubo may delay the twisting motion of the heart, and its squeezing movement may be reduced. Parts of heart muscle were also found to be replaced with fine scars, reducing the heart’s elasticity and preventing it from contracting properly. These results may explain why Takotsubo survivors have similar long-term life expectancies to survivors of heart attacks¹¹.

The specific mechanism of action (MOA) leading to Takotsubo is unknown. However, catecholamines, the chemicals released during the stress condition, such as epinephrine and norepinephrine, are hypothesized to contribute to apical ballooning of the heart, leading to Takotsubo. The administration of catecholamines in animal heart models has been shown to cause Takotsubo-like changes¹. There have also been reports of humans experiencing Takotsubo after being administered high doses of catecholamines¹².

However, it is unlikely that catecholamines are the sole cause of this syndrome, as most humans exposed to stressful situations, which result in the release of catecholamines, do not experience Takotsubo.

Potential treatments

Currently, standard-of-care for Takotsubo has not been established, as its definitive MOA is unclear. However, a battery of treatments is existed to manage the known pathophysiologic consequences and complications after the occurrence of the disease (Table 1)^{13,14}.

Complications	Recommended Therapy
Asymptomatic/Normotensive/Normocardic	Supportive care, void anticoagulants, continuous ECG Monitoring for emergence of arrhythmias and QTc prolongation
Angina	Sublingual or intravenous nitroglycerin, organic nitrates, β- blockers

Dyspnea	Monitored closely. Diuretics, nitrates, and β -blockers, depending on the presence/absence of tachycardia, hypertension, bradycardia, hypotension, and evidence of LVOT, mechanical respiratory support
Hypertension	Short or ultrashort acting β -blockers
Hypotension	Monitored closely. Intravenous fluid intake, α 1-agonist
Bradycardia and/or Atrioventricular Blocks	Small doses of atropine
LVEF < 30% and/or Large Apical Akinesis/Dyskinesis	Closely monitored for HF, cardiogenic shock, atrial arrhythmias and lethal MA, and thrombus formation
Thrombus and Prevention of Embolism	Unfractionated heparin, low-molecular-weight-heparin (LMWH), vitamin K antagonists, aspirin, and/or P2Y12 receptor antagonists such as clopidogrel, prasugrel, or ticagrelor, or the new oral anticoagulants
Left Ventricular Outflow Tract Obstruction	Intravenous metoprolol, esmolol, or landiolol
Heart Failure	Aspirin, avoid Positive inotropic agents and vasodilators
Mitral Regurgitation	Follow principles of therapy for LVOTO
Right Ventricular involvement	Monitored for hypotension, RV failure, RV thrombus
Cardiogenic Shock	Estimating or measuring cardiac output, SVR, and organ perfusion
Heart Rupture	Avoided by early employment of β -blockers
Atrial Arrhythmias	β -blockers
Ventricular Arrhythmias	Short-acting β -blockers
Cardiac Arrest	Monitor thoracic ECG signals indicative of stellate ganglia nerve input to the heart
Pericarditis	Thrombolytic therapy, anti-coagulants, and glycoprotein IIb/IIIa inhibitors
adrenergic cardiac innervation	α -lipoic acid therapy

Prevention

When preventing recurrence of Takotsubo, it has been shown that β -blockers, ACEi/ARB, and aspirin have not prevented a recurrence, lowered its severity, or improved survival. There has also no clinical data supporting the use of estrogens to prevent Takotsubo¹³. Instead, endocrinological and malignant comorbidities should be treated to reduce the impacts of Takotsubo.

Case Studies

Three case studies of Takotsubo patients will be examined. Although Takotsubo often presents with other physical stressors, such as illnesses, it is possible for the disease to appear acutely with no warning. The first two patients are presented alongside other stressors, while the third patient is presented with Takotsubo alone.

The first case study is of a 63-year-old female presented with an 8-10 hour history of progressive dyspnea. She has completed her third cycle of Perjeta plus Herceptin and Abraxane chemotherapy for HER2-positive breast cancer. The high burden of disease in the left breast metastasized to the chest wall, lymph nodes and lungs. Her blood pressure was 142/92 mmHg, her heart rate was 110BPM, and oxygen saturation was 91% in room air. She had no preexisting cardiovascular disease except for “white coat” hypertension, which was well controlled. Approximately two months ago, a baseline acquisition scan about two months ago demonstrated an ejection fraction >65% with no wall motion abnormalities. The patient showed apical ballooning consistent with Takotsubo, and standard heart failure procedure was initiated while cancer therapy was ceased. The patient chose to pursue comfort care and died approximately one month later¹⁵.

In combination with the emotional and psychological stress associated with a cancer diagnosis, combination therapy with anti-HER2 antibodies could have contributed to the occurrence of Takotsubos, as it does possess cardiotoxic properties¹⁵.

The second case study is of a 66-year-old female with mild coronary artery disease, emphysema, hypertension, and pancreatic cancer who presented to the hospital with worsening dyspnea, chest tightness, and diaphoresis. She recently started Capecitabine as part of her pancreatic cancer treatment and received one dose about three days before symptoms. Her heart rate was 140BPM, but otherwise, she was vitally stable. She was eventually diagnosed with Capecitabine-induced Takotsubo. Capecitabine was discontinued while heart failure therapy was started. One week later, she recovered¹⁶.

Although Takotsubo is rare, it may be potentially devastating to the patient. Whether Capecitabine is a bystander or the offending chemical

agent, it must be stopped, and heart failure therapy must be initiated. A new treatment plan must be created for the patient to improve the prognosis.

The third case study is of a previously healthy 49-year-old female who suddenly complained of chest discomfort stretching down to both arms. Her EKG showed ST segment elevation and there was evidence of possible inferolateral myocardial infarction. A cardiac catheter was inserted but showed no evidence of coronary artery disease that impacted circulation. Her residual ejection fraction was 30% and she showed profound left ventricular dysfunction. No physical or emotional stressors were identified and she was treated with nitrates and ACE inhibitors¹⁷.

Takotsubo could appear acutely with no perviously identifiable stressors. Therefore it is important to conduct more research into the mechanisms of action of the disease so it could be quickly identified and treated with appropriate medications, and so that conditions would not go undiagnosed and potentially recur in patients.

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Titan and Europa: Candidates as Habitable Moons for Humanity

By Daniel Hu

AUTHOR BIO

Daniel Hu is a rising senior at Brunswick School in Connecticut. He is passionate about physics and astronomy, especially astrophysics. He started his own astronomy club at school to inspire people to discover the universe above their heads. Daniel enjoys volunteering at a local observatory, where he operates their telescope and teaches the public about the night sky. He also likes to conduct research on asteroid occultations. He has his own telescope setup, and regularly takes part in astrophotography, particularly nebulae and star clusters. Outside of academics, he is an avid hockey player for his high school team, one of the top in the nation.

ABSTRACT

One major reason humans want to explore potentially habitable extraterrestrial objects is to ensure the survival of our species. Moons of Saturn and Jupiter, such as Titan and Europa, are less known compared to Mars and Venus but have promising features that could make them habitable for humans. Titan has a thick atmosphere similar to Earth's, and Europa is speculated to have a vast subsurface liquid water ocean. However, challenges such as long travel distances and cold surface temperatures are also present on these moons. This paper will analyze features in depth on Titan and Europa that make them ideal candidates as potential places that could support human life. Challenges of exploring and inhabiting these moons are also considered. Two future missions to Titan and Europa, Dragonfly and Europa Clipper, their instruments and information they can gather, and what these new discoveries can mean for human exploration are also discussed.

Keywords: Titan, Europa, Extraterrestrial Habitability, Subsurface Ocean, Atmosphere, Dragonfly missions, Europa Clipper mission, Sensing With Independent Micro-Swimmers

INTRODUCTION

On Earth, problems such as global warming, resource depletion, and even human conflict threaten the survival of our species. Although these problems may not lead to immediate catastrophe, they are problems that should be prepared for. In terms of identifying candidates for habitable planets, Mars and Venus have received a large amount of attention in past and present missions. For comparison, NASA has had 23 missions to Mars (NASA Mars Exploration Program, 2021), while only six to Europa (NASA Europa Clipper, 2014). These two planets seem to have conditions that could have harbored some sort of life in their earlier years: water and more moderate climates. However, Mars and Venus are anything but habitable in the present day. Mars has no atmosphere and freezing temperature, while Venus has a suffocating atmosphere and is hot enough to melt lead (NASA Solar System Exploration, 2022). Titan and Europa are moons of Saturn and Jupiter, respectively, and have promising features to sustain human life. Heat is important as it allows extraterrestrial objects to have liquid water. Both Titan and Europa generate heat internally through a process called tidal heating. Tidal heating is the result of the larger planet compressing and contracting the much smaller moon, causing friction inside the planet to generate heat (Lunine, 1997). Europa, for example, is speculated to have an enormous subsurface liquid water ocean as a result of tidal heating (NASA Europa Clipper, 2014). Titan is also believed to have a subsurface ocean, but it also has a thick atmosphere. While the origins of Titan's atmosphere is still being researched, having one is important to sustain life, as will be discussed in this paper. These two qualities make Europa and Titan attractive candidates for habitability. However, these moons also present challenges for exploration and serving as habitable places. These moons are further away than neighboring planets, causing both transportation time and cost to increase dramatically. Jupiter has the strongest radiation belt out of all the planets and consequently its moons receive dangerously high doses of radiation (Roussos, 2022). Surface temperatures are well below freezing and oxygen is not present in the atmosphere (NASA Solar System Exploration, 2022). With all that said, Titan and Europa have conditions that make them ideal candidates as habitable places for humans in the future, and will be explored further in future missions.

A moon is a type of extraterrestrial object that orbits a larger planet that has not met the three criteria

for being classified as a planet: orbit the Sun, have sufficient mass so its gravitational force is enough to form a roughly round shape, and have cleared its path of similar sized objects (IAU Resolution B5, 2006). While Earth's Moon is spherical, the gas giants have moons that are unusual looking and/or irregular. For example, Saturn's Prometheus is extremely elongated while Pan resembles a ravioli (Leleu, 2018). Jupiter has a number of irregular moons that were formed from asteroids captured by its immense gravitational field, and have large, highly eccentric and/or inclined orbits. Saturn's unusual looking inner moons were formed from collisions of similar sized moonlets (Leleu, 2018). These irregular moons are noticeably different from regular moons, which formed along with the parent planet from an accretion disk and have roughly circular and uninclined orbits (Jewitt, 2007).

DIFFERENT MOONS OF THE SOLAR SYSTEM

Earth's Moon

Earth's Moon has been studied extensively in human history, and is a stark contrast to Titan and Europa. The Moon is believed to have formed through what is known as the impact theory. Scientists believe that through evidence between the similarity of lunar rocks and those on Earth, the moon was formed from the debris of an impact by a large body, Theia, on Earth (Jones, 2000). Earth's Moon has been explored extensively by many countries, with much data and information collected. Based on all of the data and research, the Moon is a relatively barren and desolate place. Its atmosphere is so thin that the surface can essentially be considered a vacuum. Because of this lack of atmosphere, the surface pressure is 2.96×10^{-15} atm (Stern, 1999), compared to the surface pressure of Earth, which is one atm. With no source of internal heat and the lack of an atmosphere, temperatures on the moon's surface range from 127 C to -173 C (NASA Solar System Exploration, 2022). Deadly amounts of radiation from the Sun and outer space also blast the Moon's surface. Water has been found on the surface of the Moon near the poles, where it exists as rock hard ice inside of permanently shadowed craters. There is so little water discovered on the Moon from missions that the Sahara Desert has 100 times as much. (Wasser, 2020). All in all, the Moon lacks features that make it possible for humans to survive for long periods of time.

Titan

Titan is the largest moon of Saturn, larger than Mercury and similar in size to Mars. Titan is one of the few objects in the solar system that resembles Earth. Its dense atmosphere is made of mostly nitrogen (95%), with hints of methane (5%) and trace amounts of other carbon-rich compounds (NASA Solar System Exploration, 2022). Having a dense atmosphere benefits Titan in many ways. This dense atmosphere, along with Saturn's magnetosphere, protects Titan from dangerous radiation from the Sun. The high density creates a surface that is around 60% more pressurized than Earth's, making Titan the only object which has a similar surface pressure to Earth (NASA Solar System Exploration, 2022). As a result of this high pressure, humans can walk around on Titan without the need of a pressurized suit. Liquid methane lakes and oceans are present on the surface, making Titan the only other object besides Earth to have liquids on the surface. The methane on Titan has a cycle similar to the water cycle on Earth, going through the process of starting as a liquid, evaporating, and then raining back down (NASA Solar System Exploration, 2022). This abundance of methane can potentially be used as a source of energy, as methane is a key natural gas here on Earth. Electricity is generated through methane when the heat produced from burning methane powers a turbine, which in turn generates electricity (Kondaveeti, 2019). Methane in the atmosphere also acts as a greenhouse gas, which heats the moon. Besides the abundance of features above the surface, Titan is also speculated to contain a subsurface liquid ocean as a result of tidal heating. This ocean, along with the rest of Titan, will be studied further in the Dragonfly mission. I believe that new discoveries from the Dragonfly mission will further enhance Titan as a candidate for humans to inhabit.

Disadvantages of Titan

With all of these conditions that are potentially suitable for humans, there are challenges on Titan. The most obvious one is the cold temperature on the surface, with an average of -180 degrees Celsius (NASA Solar System Exploration, 2022). At this temperature, humans can not survive without protection, and any form of shelter would need to be more cold resistant than those used on Earth. While Titan has a robust atmosphere, it is made of mostly nitrogen and lacks oxygen. Oxygen can potentially be split from the subsurface water ocean, but doing so is difficult and energy consuming. Another issue is that

Titan only has around 14% of Earth's gravity (NASA Solar System Exploration, 2022). Spending long periods in low gravity environments can cause muscle loss and a decrease in bone density, among other negative impacts (Wolfe, 1992). Titan may also host some sort of life, which can develop into a problem if humans come into contact with them. Tholins are a type of organic compounds that form after high energy particles from cosmic rays split apart methane and nitrogen in the atmosphere. These compounds are rich in nitrogen and carbon, which provide the building blocks for life (Waite, 2007). On Earth, bacteria called anaerobic methanotrophs consume methane and single carbon compounds to survive (Guerrero-Cruz, 2021). The liquid methane and tholins on Titan can provide suitable conditions for life to arise. While finding extraterrestrial life forms is exciting, it can also be dangerous for humans to coexist with them on the same moon as humans and these potential life forms can negatively impact each other. All in all, Titan is a great candidate for humans to inhabit in the future with its abundance of promising features, some of which even resemble Earth. However, Titan is not without flaws, and will have to be explored further. NASA is in the works of making a lander mission specifically to explore Titan in more detail than previously.

Dragonfly Mission

The Dragonfly mission was proposed by John Hopkins's Applied Physics Laboratory to NASA in 2017 and selected as the fourth mission in the New Frontiers program. It is set to launch in 2027 and arrive at Titan in 2034 (JHUAPL Dragonfly, n.d.). The purpose of the Dragonfly mission is to search for extraterrestrial life and habitability on Titan. Dragonfly will be a dual-quadcopter design to take advantage of aerial travel, made easy by Titan's thick atmosphere and low gravity. Dragonfly can cover tens of miles during the day and recharge during the night. Sunlight does not penetrate Titan's thick atmosphere easily, so Dragonfly cannot use solar panels as an effective power source. Instead, it uses a Multi-Mission Radioisotope Thermoelectric Generator, the same one as on the Curiosity rover on Mars (JHUAPL Dragonfly, n.d.). A Multi-Mission Radioisotope Thermoelectric Generator works by converting the heat generated from the decay of plutonium-238 into electricity using the temperature difference between two different, electrically conductive materials in a closed circuit (NASA Radioisotope Power Systems, 2022). Scientists took data from the Cassini mission and analyzed it to predict the optimal timing for a

calm weather period, as well as identifying a landing site. Dragonfly will land at the Shangri-La dune fields, which is similar to the dunes in Namibia and offers a large sampling of materials. After landing, Dragonfly will perform flying missions of more than five miles to reach the Selk impact crater. Along the way, Dragonfly will use instruments such as a mass spectrometer, meteorology sensors, and cameras. These will enable Dragonfly to collect data on both the surface composition and atmospheric conditions, as well as seismic activity to study subsurface activity and structure (JHUAPL Dragonfly, n.d.).

Titan Habitability

Planetary scientist Dr. Amanda Hendrix, a senior scientist at the Planetary Science Institute, expressed her opinions about Titan as a habitable world in her article “Confession Of A Planetary Scientist: ‘I Do Not Want To Live On Mars’”. I agree with most, if not all, of the logical conclusions reached in the paper. For example, the line “these damaging particles cannot make it to Titan’s surface; they’re absorbed by the atmosphere, meaning that it’s a safe environment for humans” (Hendrix, 2017) makes perfect sense as ultraviolet radiation is deadly to humans in space. Titan’s thick atmosphere blocks these particles that would otherwise easily make the moon inhabitable. Another point that I agree with is the acknowledgement that sending humans to Titan is still a process in the making. Many challenges are in the way, such as low gravity and the lack of a food source. A mission like Dragonfly will allow scientists to gain further knowledge of the moon, and I believe any more information will only strengthen Titan’s candidacy as a habitable moon for humans.

Europa

Europa is a Galilean moon of Jupiter characterized by its large amount of water, both in ice form and liquid form. Europa is around 5.2 AU from the Sun, resulting in sunlight being 25 times fainter there than on Earth and causing temperatures on Europa to average around -160 degrees Celsius (NASA Europa Clipper, 2014). A rock-hard icy water shell, estimated to be 10 to 15 miles thick, covers the entire moon (Nasa Europa Clipper, 2014). However, there is strong evidence from the Galileo mission that Europa has a vast subsurface liquid water ocean. Data gathered from the Galileo mission showed that Jupiter’s magnetosphere is disrupted around Europa. The best explanation for this is that Europa is inducing

a magnetic field internally, most likely through the rotation of a salty liquid water ocean underneath its ice surface (NASA Europa Clipper, 2014). Similar to Titan, a subsurface liquid ocean water can be made possible by the heat generated through tidal heating. Salty water is not drinkable by humans, but fresh water can be generated through a process called ocean thermal energy conversion (OTEC), a type of technology used on Earth to both desalinate ocean water and generate electricity. OTEC works by using the difference in temperature of salt water, which should be present on Europa. Warm salty water is turned into steam by reducing its pressure. This steam drives a turbine generator to produce electricity, before being turned back into a liquid in a condenser cooled with cold water. While heating and condensing sea water, salt and other impurities are removed to produce fresh water (Ocean thermal energy conversion, n.d.).

Besides having a speculated ocean, Europa’s surface may hold more than it seems. While the surface appears mostly smooth, images from NASA’s Galileo spacecraft revealed jagged double ridges spanning thousands of kilometers and rising hundreds of meters tall (NASA Solar System Exploration, 2022). These double ridges may be formed by warm liquid water rising through the ice, forming a pocket inside the sheet of ice. This pocket of liquid water inside the ice will have temperatures higher than the surface. Almost similar to an igloo, these pockets can protect humans from the frigid cold and high levels of radiation on the surface. Europa also has a thin atmosphere that contains oxygen, but humans cannot breathe without oxygen tanks as the atmosphere is too tenuous. Europa’s biggest strength is its large subsurface liquid water ocean and pockets of warmer water within the icy surface. However, frigid temperatures, high levels of radiation, and a lack of oxygen are among main issues humans face. NASA is planning the Europa Clipper mission to explore the ocean world in further detail.

Europa Clipper Mission

Europa Clipper is a NASA mission set to launch in 2024. It will be the first NASA mission to exclusively study a moon besides Earth’s. Europa Clipper will send a spacecraft into orbit around Europa, where it will spend three years flying around Europa 45 times (NASA Europa Clipper, 2014). The spacecraft has an arsenal of instruments to study the icy moon. Its primary mission is to determine if Europa has conditions suitable for life, which

scientists highly suspect it does. Europa Clipper's ten instruments can be grouped into four sets based on their function. Cameras and spectrometers create high resolution images and maps of Europa's surface and atmosphere (NASA Europa Clipper, 2014). These images can allow scientists to further explore sections of the surface such as ridges in the ice sheets, as well as identifying areas for future lander missions. Ice penetrating radar, a magnetometer, and plasma sensors allow the spacecraft to explore the ocean and interior of the moon. The plasma sensor studies the distortions of Europa's magnetic field caused by Jupiter, and the magnetometer studies the magnetic field induced by Europa. Scientists will use the data collected by the plasma sensor to factor out any distortion from the data by the magnetometer to achieve a cleaner final result. This final result can produce proof of a liquid water ocean underneath the surface, as well as measure its depth, salinity, and the thickness of the ice shell (NASA Europa Clipper, 2014). A thermal imaging camera will identify regions of warmer ice (NASA Europa Clipper, 2014). By determining where warmer ice exists and if ridges are present at these locations, there is further proof that ice pockets exist underneath these ridges in the ice sheet. A dust analyzer and mass spectrometer measure the chemical properties of particles in Europa's atmosphere (NASA Europa Clipper, 2014). These instruments will provide valuable insight into the possibility of Europa harboring life, and also explore the feasibility of human settlement and future lander missions.

Europa Habitability

Dr. Tom Kerwick stated in his journal article "Colonizing Jupiter's Moons: An Assessment of Our Options and Alternatives" that Europa poses an interesting balance between having many great and also less than ideal qualities. I agree with the idea of Europa having a mix between good and bad factors. For example, the line "At 670,000 km from Jupiter, Europa receives 540 rem of radiation per day from the Jovian belts" (Kerwick, 2012, p.12) proves that Europa has harsh surface conditions that would make unshielded living impossible. Other parts of the articles are more optimistic, as in "The abundance of water is significant not only as a source of drinking water, but it could also be broken down to provide breathable oxygen" (Kerwick, 2012, p.12). Europa is an interesting case. It has many features that make it seem perfect for human colonization, yet it also has many that makes it inhabitable. Future missions like Europa Clipper will allow scientists to gain more information to unravel the mysteries of the moon.

Sensing With Independent Micro-Swimmers

Sensing With Independent Micro-Swimmers (SWIM) is a concept in development at NASA's Jet Propulsion Laboratory (Greicius, 2022). As the name suggests, SWIM is a concept that will use tiny swimming robots to explore ocean worlds, such as Europa and Titan. Exploring Europa's ocean in more detail will allow scientists to determine if the ocean already contains life or have conditions suitable for life, such as hydrothermal vents on the ocean floor.

The goal of SWIM is to employ wedge-shaped robots around the size of a smartphone. They will be roughly five inches long and three to five cubic inches in volume. Because of their small size, around four dozen of them can be fitted into a 4-inch-long section of a cryobot. A cryobot is a robot that uses a high temperature nuclear battery to melt through layers of ice in order to reach the subsurface ocean. After these robots are deployed into the ocean, they can either swim off to different areas, or conduct research in a group. To achieve this, each individual robot contains a communication, intelligence, power, and sensing component (Greicius, 2022). Using large numbers of tiny robots like SWIM benefits missions by allowing larger areas of the ocean to be explored, and thus increasing the possibility of finding life or conditions suitable for future human development. SWIM also allows more accurate data to be collected from different parts of the ocean as opposed to collecting data right from the cryobot, which may cause data to be inaccurate as the hot battery can produce chemical changes. SWIM is a very useful piece of technology that is being developed to enhance the productivity of future missions to ocean worlds.

CONCLUSION

Humans want to explore habitable extraterrestrial objects to find a safe haven for future generations. While seemingly unlikely candidates in the outer reaches of the solar system, Titan and Europa have features that are promising for future humans to potentially inhabit. Titan has a dense atmosphere and an abundance of methane, as well as a possible subsurface liquid water ocean. Europa is speculated to have a huge liquid water ocean under its ice crust, and may also have pockets of warmer liquid water within its icy surface. NASA is planning to explore these two unique moons with the Dragonfly mission to Titan and Europa Clipper missions to Europa. New technology, such as Sensing With Independent Micro-Swimmers, is also being developed by NASA to increase the productivity of future missions. These missions will provide invaluable information about these moons, and further accelerate humanity's quest to one day live amongst the stars.

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Impact of the COVID-19 Pandemic On Vaccination Rates and Immunization Services

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ABSTRACT

The coronavirus disease 2019 (COVID-19) pandemic is affecting international public health, particularly in fields concerning vaccination rates and immunization services. Upon the release of the Sustainable Development Goals Report for 2022 from the World Health Organization (WHO) and United Nations International Children's Emergency Fund (UNICEF), it was revealed that 23 million children did not receive essential childhood vaccines in 2020, a 3.7 million increase from 2019 (UNICEF) [1]. In addition, necessary health services were disrupted in 92% of countries. It is crucial to maintain and expand vaccination services to prevent disease outbreaks and morbidity. This review will discuss the impact of the pandemic on vaccination rates, immunization services and campaigns, and the consequences of these disturbances, specifically the resurgence of vaccine preventable diseases (VPDs), in greater detail.

Keywords: COVID-19, Vaccines, Vaccination Rates, Vaccination Campaigns, Vaccine Preventable Diseases, Sustainable Development Goals, Public Health, Global Health

INTRODUCTION

The impact of the coronavirus disease 2019 (COVID-19) global pandemic on healthcare is not limited to infection and transmission management. Upon the release of the Sustainable Development Goals Report for 2022 from the World Health Organization (WHO) and United Nations International Children's Emergency Fund (UNICEF), it was revealed that 23 million children did not receive essential childhood vaccines in 2020, a 3.7 million increase from 2019 (UNICEF) [1]. Alarming, it is likely that around 17 million of these children did not receive a single vaccine throughout the year. In addition, necessary health services were disrupted in 92% of countries. These disturbances among vaccinations are mainly attributable to the pandemic. Furthermore, it is crucial to maintain and expand vaccination services to prevent disease outbreaks and morbidity. COVID-19 is a challenging public health crisis that has not only taken millions of lives but has halted and reversed focused efforts in global health responses and health services, specifically in vaccinations.

Impact Of COVID-19 on Routine Medical Services

Most countries implemented restrictive measures to prevent further transmission of COVID-19. National lockdowns initiated by many countries at some time during the pandemic restricted people's movements besides those involved in providing important services. In addition, the pandemic's widespread effects on commercial activities put an economic strain on individuals and companies. While such pandemic restrictions have had a beneficial impact, at least in the short term, on reducing COVID-19 transmission, there are also many indirect effects [2]. For instance, many could not access medical services when available due to financial hardships and unwillingness to leave home or visit medical facilities out of caution of COVID-19 exposure [3].

A survey conducted by the World Health Organization (WHO) during the initial phases of the pandemic reported significant reductions in all routine health services, with a 70% reduction in routine immunization services [4]. Other studies estimate that interruptions to malaria, tuberculosis (TB), and HIV services in vulnerable countries will lead to higher mortality rates over the next five years, with malaria by 36%, TB by 20%, and HIV by 10% [5]. Furthermore,

research predicts that a reduction in essential child healthcare services in low and middle-income countries (LMIC) can lead to an increase in mortality in children younger than five years old at 9.8% each month. Much of the projected impact results from an increase in infection by vaccine-preventable diseases (VPDs) due to immunization service disruption [6]. The effects of COVID-19 on immunization services present grave concerns, especially with the threat of VPD resurgence.

Impact of COVID-19 On Immunization Services

Routine immunization services have been restricted due to the massive influx in demand for COVID-19 vaccines. In fact, COVID-19 vaccine production is projected to reach at least 14 billion doses per year [7]. Prior to the pandemic, roughly 5 billion doses of vaccines were produced annually across the world. The increase in COVID-19 vaccine manufacturing affects the production of vital non-COVID vaccines.

Shortage Of Input Materials

Suppliers for specific vaccine-manufacturing components are based in only a few countries, causing access to be problematic during the pandemic due to constrained goods distribution. As a result, consumable components, including bioprocessing bags, filters, and laboratory supplies, have undergone delays in delivery. Supplies such as vials, syringes, and culture media—an important raw material for many vaccines—have been back-ordered, with delivery times as long as 18 months. Manufacturers depend on sophisticated consumable components like single-use assemblies and bioprocessing bags that are typically not interchangeable, limiting the potential for alternative products to be used [8,9]. Additionally, emergency measures may have placed the manufacture of COVID-19 vaccines over the production of other goods, further contributing to the shortage of input materials for essential vaccines [10].

Production Capacity Constraints

In some situations, delays in equipment availability hinder the capacity expansion for non-COVID-19 vaccines. Contract manufacturing organizations (CMOs), which provide drug development and manufacturing services [11], have limited availability to address capacity constraints for other vital vaccines because they are being utilized

extensively for COVID-19 vaccine production. A shortage of human resources has also led to delays in the manufacturing, testing, and releasing of vaccines. Experienced personnel, including laboratory staff and engineers, have not only been reassigned to address COVID-19 vaccine production and testing but were also unable to work due to facility lockdowns and absences due to quarantines and illnesses [8].

Anticipated and Current Disturbances

Supply disruptions burden the production of pneumococcal conjugate vaccines, measles-containing vaccines, diphtheria and tetanus-containing vaccines, and inactivated poliovirus vaccines [8]. Although the pandemic's impact on vaccination production has been reduced, consumables and single-use materials such as bioprocessing bags remained difficult to obtain in the second half of 2021. These factors may lead to vaccine shortages, making immunity gaps harder to close and raising the risk for VPD outbreaks [12].

Consequences of Disrupted Immunization Services

Estimates indicate that immunization programs prevent approximately 2.7 million cases of measles, 2 million cases of neonatal tetanus, 1 million pertussis cases, 600,000 cases of poliomyelitis, and 300,000 diphtheria cases annually [13]. High infant immunization rates via routine immunization and supplementary immunization activities play a significant role in achieving these benefits. However, methods incorporated to prevent further spread of COVID-19 have caused pronounced disruptions among immunization services. For instance, in some areas, clinics have been closed or hours reduced in response to the pandemic [14].

A survey conducted in Saudi Arabia on parents of children under two years of age revealed that 73.2% of the participants scheduled appointments for their child's vaccination during the pandemic. Approximately 47.8% of the parents reported a delay of more than two weeks in child immunization appointments. A significant delay of more than one month was observed in 23.4% of the cases [15]. The same survey from Saudi Arabia displayed that the fear of being infected with COVID-19 (60.9%) was the most common reason for delaying vaccinations [15].

Several reports suggested impacts on childhood vaccination by the pandemic. A study analyzing the impact of the pandemic on Brazilian

infants disclosed the presence of incomplete immunization among children less than 12 months old in Brazil [16].

The progress made in recent years on VPDs is threatened to be reversed by immunization service disruption. Infections with higher introductory reproductive rates and vaccine coverage for herd immunity are at risk [17,18]. While the COVID-19 pandemic is an immediate concern, it is crucial to remain alert for other diseases. Before the coronavirus pandemic, measles mortality reached over 200,000 deaths in 2019, nearly a 50% increase from 2016 [19,20]. Halting planned vaccination campaigns such as immunization activities targeting measles in Kenya [21] and interrupting routine programs due to the pandemic only worsen VPD concerns.

Importance Of Immunization Campaigns

Vaccination campaigns rapidly vaccinate many individuals and promote the benefits of one or more vaccines [22]. Mass vaccination programs operate on herd immunity: vaccinating a large portion of a population disrupts the person-to-person disease transmission by surrounding the infected individual with vaccinated people [23].

Mass immunization programs successfully reduce 57 million deaths tied to infectious diseases annually worldwide. Such initiatives have eliminated smallpox and reduced the incidence of measles-related deaths by 73%, from an estimated 536,000 in 2000 to 142,000 in 2018 [24].

Impact Of COVID-19 On Immunization Programs

In an attempt to minimize the impact of the COVID-19 pandemic, the World Health Organization (WHO) issued guidelines to temporarily suspend immunization campaign operations globally [25,26]. The enforcement was necessary but likely threatened various programs' progress [27]. In April of 2020, it was documented that twenty-three countries suspended their measles campaigns. Consequently, 78 million children were predicted to miss out on the vaccine. In May 2020, 105 of 184 vaccination efforts in 57 nations were canceled or postponed, with an anticipated 796 million missed or deferred vaccine doses. Over a year later, in December of 2021, it was revealed that 77 out of 472 immunization campaigns in 54 nations were still canceled or postponed, particularly in African regions, due to the pandemic, with nearly 382 million missed or postponed vaccine doses [28].

CONCLUSION

In the current landscape of vaccination rates, action against COVID-19 disturbances is critical. The COVID-19 pandemic has deprived millions of immunity against life-threatening diseases and reversed hard-earned progress in global health. To push against it and the disconcerting future it entails, efforts to enable access to input materials and reduce production capacity constraints are crucial. In addition to these actions, mass vaccination campaigns should continue to be enforced and potentially prioritized in developing countries where VPDs are prevalent so that people can lead healthier and safer lives no matter where they reside.

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Psychosocial Stress and its Correlation With Coronary Heart Diseases

By Stephanie Zhao

AUTHOR BIO

Stephanie Zhao is a senior at Magee Secondary School in Vancouver, Canada. She is very passionate about psychology and interested in biology and hopes to pursue both in the future. In the summer, she was able to take a psychology course at Columbia, which further consolidated her interest in the field of psychology. Aside from being a student, Stephanie is also an athlete. She grew up participating in multiple sports (competitive swimming, traditional Chinese dance, tennis, badminton, figure skating, etc.) and is now playing squash competitively during the school years. Outside of academics and sports, you can find her reading, rewatching Brooklyn 99 for the 10th time, and crying to love songs.

ABSTRACT

Times are becoming increasingly stressful, and cardiovascular diseases (CVDs) are the leading cause of death globally. This article examines the relationship between stress and cardiovascular diseases. We will look into the different theories of stress, including the Life-Events Theory, the Hardiness Theory, and the Social-Support theory. There are also a handful of different types of stressors and how these stressors might have direct and indirect effects on cardiology health. Hypertension, hypercholesterolemia (high cholesterol), and smoking all seem to play the most crucial role when it comes to coronary heart disease (CHD). Although seen as the villain, stress is not all harmful. “Eustress” is a term coined for stress that is actually beneficial to the human body. Regardless, stress is a major issue derived from work, school, and a fast-paced society, leading management methods to be more crucial than ever. One can choose from a plethora of coping mechanisms such as exercise, yoga, dietary changes, medications, relaxation techniques, etc.

Keywords: Cardiovascular disease; stress; coronary heart disease; atherosclerosis; hyperhomocysteinemia; hypertension; life-events theory; hardiness theory; social support theory; psychological stressor; physiological stressor; social stressors

INTRODUCTION

Cardiovascular diseases (CVDs) are the leading cause of death globally. Cardiovascular disease is defined by various disorders: cardiac muscle and vascular system diseases controlling the heart, brain, and other vital organs 1. Approximately 17.9 million people die from CVDs each year, contributing to 32% of yearly deaths 2. To put this number in perspective, this is about the same number of people as Ecuador or Guatemala's current population. This has been the case for quite some time. In 2006, cardiovascular disease accounted for the deaths of close to a million people, around 39% of the total deaths in the United States 3. A paper in 2017 by Kivimaki and Steptoe showed that there was a 14.5% increase in deaths from cardiovascular disease from the year 2006 to 2016 4. It is not difficult to extrapolate that the number of CVDs will continue to increase, particularly in today's stressful social environment.

Like many other students worldwide, stress has become a regular part of my life. An increasing amount of fixation on reaching perfection in school, sports, and extracurriculars place most students in pressured environments. Not just students but everyone in society today is significantly impacted by stress. A study conducted by Penn State researchers 5 published in 2019 clearly demonstrated that there is an increase in stress levels when comparing stress levels of adults from the 1990s and the 2010s. In the study, the data was collected by interviewing two groups of participants, one in 1995 and the other in 2012. At the time of the interviews, the participants were the same age respectively. They were interviewed at the end of the day for eight consecutive days. Psychologists then recorded the stressful events and stress levels of each participant in the past 24 hours. The results showed that overall, adults in the 2010s presented a higher amount of stress than did the adults in the 1990s.

Although existing stressors like finances and diseases seem to be shared across all generations, new stressors are constantly emerging. The advancement of technology, social media, increasing work-life imbalance, and more rigorous academic demands profoundly affect how stress is perceived and experienced. For example, after the invention of the internet, new problems like cyberbullying and identity theft arose. More recently, our planet was struck by a worldwide pandemic, which became a common origin of stress.

Although a well-known term, recent publications of stress research showed that "stress" as a concept has been broadened to encompass a range of behaviors: everything ranging from a mild response to a small-scale stressor to a severe reaction to a life-altering event. For the purpose of this paper, "stress" strictly refers to the unpredictable and uncontrollable psychological and physiological response where an organism experiences an exceeding amount of environmental demand 6.

Though, not all stress is harmful to the human body. The nerves that kick in before public speaking or a test are called "eustress," a term coined by Hans Selye that describes a moderate level of beneficial psychological stress 7. Conversely, chronic stress is harmful to the body; it elevates the susceptibility to mental illness and other health issues, influences cognition 8 and increases the prevalence of cardiovascular diseases. Cardiovascular disease continues to be the leading cause of death globally; there were approximately 523.2 million cases of cardiovascular disease in 2019, and the numbers are only seeing an upwards trend 9. This paper will look more closely at human coronary heart disease and its relation to stress.

Stress Theories

Before we begin discovering the relationship between stress and cardiovascular disease, we must understand the essence of stress: what causes stress and its effects on an individual's health.

The Life-Events Theory on stress developed by Holmes and Rahe 10 advances that stress is caused by situations that require more resources than are available. As an example, an individual may experience stress if they walk into a test that they did not study for. Holmes and Rahe designed a stress scale called the Social Readjustment Rating Scale (SRRS) 11 that measures the impact of different life events on a person's stress level. There are a total of 43 accumulated stress events, some of which include the death of a spouse, divorce, marital separation, injury or illness, and retirement. Increased stressful life events are more likely to trigger a higher chance of illness, suggesting that stress can lead to poor health.

Another theory revolving around life events is allostasis: a body state that is readjusting to external forces 11. A state of allostasis is described by allostatic load and allostatic overload. Chronic exposure to

environmental challenges that cause an individual to react in a particularly stressful way results in chronic allostatic load. Allostatic load increases vulnerability to mental illnesses. According to the theory, stress response mediators, such as glucocorticoids, catecholamines, and proinflammatory cytokines, manifest imbalances as these systems become overtaxed and dysregulated. In addition to causing damage to tissues and major organ systems, chronic dysregulation poses a cumulative physiological risk for disease and disability 12.

Then there is the Hardiness Theory. According to Maddi and Kobasa 13-14, hardiness - commitment, control, and endurance - can decrease illnesses that are initiated by stressful life events. Instead of seeing a stressful event as a threat, seeing it as a challenge can decrease the negative impacts such events can have on a person's overall well-being.

Lastly, there is the Social Support Theory. The term "social support" is defined as "an exchange of resources between two individuals perceived by the provider or the recipient to be intended to enhance the well-being of the recipient" 15. Social supports include but are not limited to emotional support, financial aid, and acts of service. Regardless, social support can help to cope with the event and therefore decrease your stress level.

Stressors

There are three environments that can play a role in terms of stressors in life: social, psychological, and physiological environments 16.

1. Social stressors

Social stressors are defined by Ilfeld, Jr. 17 as life events resulting in situations that are generally perceived as problematic or undesirable. In his article, he discussed how each individual has their own varying responses to stimuli; it is then hard to measure the response rather than the stimulus itself. Similar to Ilfeld's view on the accuracy of measuring stress, Hans Selye 18 believes that diverse external stimuli may induce different physiological and mental responses from different people. This idea initiated the discussion amongst psychologists, therefore leading to studies done in social epidemiology (e.g., Holmes and Rahe 1967; Dohrenwend & Dohrenwend, 1981; Myers, Lindenthal, Pepper, and Ostrander 1972). Researchers have collectively found that stress from

social environments influences mental and physical well-being in a significant manner.

It is well known that work causes stress and therefore makes someone increasingly vulnerable to coronary heart disease (CHD) 19. The chances of getting CHD can be elevated through direct causes such as biological responses and indirect causes like lack of exercise, drinking, and smoking. One of the primary stress responses of the body is the activation of the autonomic nervous system (ANS), which contributes to what is known as the "fight or flight" response. When the ANS is activated repeatedly, heart rate variability is lowered, which is a marker for cardiovascular diseases. Some work-related social stress examples include, but are not limited to: excess amount of work, long working hours, experiencing workplace discrimination or harassment, giving speeches or presentations in front of coworkers or superiors, and constant fear of being laid off.

Another rising social stress factor in today's society is school. With the growing obsession with getting into "prestigious" schools, students today deal with more stress than ever. The time that used to be spent on hanging out with friends and doing leisurely activities is now spent on studying and homework. Academic success is actively threatened by challenges, demands, and expectations. For example, a study 20 showed that there is a correlation between psychosomatic symptoms (some include excessive thoughts, digestive issues, headaches, elevated blood pressure, and dizziness) and school-induced stress in 862 Norwegian adolescents (ages 13-15).

2. Psychological stressors

A person's sense of mastery, feelings of competence, self-esteem, and locus of control have been recognized as personality factors that affect their reactions to stressful situations. Psychological stress can increase health problems. In a paper by Mellinger et al. 21, psychological stress or "psychological vulnerability" could result in physical illness. In this study, Mellinger et al. conducted a nationwide cross-section survey of U.S. adults. Data was collected on the relationship between psychic distress and life crisis among all ages, races, and demographics. This study used a shortened version of the Holmes-Rahe Social Adjustment Rating Scale, as we mentioned above.

3. Physiological stressors

The term physiological stress refers to any condition that changes a cell's or organism's homeostasis. Examples of physiological stressors can include fluctuations in oxygen levels, temperature, and traumatic events. Aside from external stressors, physiological stressors can occur internally as well. For example, organisms can experience physical stress from inner chemistry changes during development (most common amongst adolescents). On top of that, aging is also a common physiological stressor experienced amongst humans. With aging comes molecular damage, which can lead to other health problems, such as decreased effectiveness of the nervous system and immune system.

Stress and its relationship to cardiology health

It is not surprising to learn that stress can cause physical damage to the body, such as heart attacks and strokes ²². When stressed, people experience increased heart rate, elevated blood pressure, higher cholesterol level, and increased blood volume. These contribute significantly to CHD. Batteries of studies have concluded that three factors - hypercholesterolemia (high cholesterol), hypertension, and smoking - play the most critical role in CHD ²³. Specifically, hypercholesterolemia and hypertension can easily be influenced by chronic stress.

Although hypercholesterolemia, hypertension, and smoking are the conventional vital factors that may lead to CHD, two researchers ³⁰ found that half of the patients with CHD do not present any of the above clinical symptoms. In fact, 91% of heart attacks were caused by work-related stress. Therefore, work stress is believed to be a more significant cause of CHD than the conventional risk factors we hear about ²⁴.

Table 1: Incident of various factors in patients who had coronary attacks and in control groups ²⁴

Table 1 shows that 91% of the 100 patients in the "coronary group" have struggled with their jobs, either from long working hours or emotional instability. This is a significant difference compared to the 20% of the control group who had heart attacks due to work-related stress.

In the study done by Henry I. Russek and Linda G. Russek, they concluded that emotional stress

is a significant factor in CHD. Interestingly, they talked about the evolution of homo sapiens and the role natural selection plays in humans' adaptation to new environments. From living in forests to farms to factories, getting used to new environments and lifestyles inevitably takes thousands of years. The Russeks made the connection that CHD might be one mechanism that nature poses as a means of eliminating those who fail to withstand the stress from the new world that we live in. Like learning how to hunt and staying away from vicious animals are skills humans had to learn centuries ago, coping with stress is also a symbolic challenge we would have to learn how to overcome. They also mentioned that even before the turn of the century, scientists have described men with coronary diseases as "ambitious" and "competitive" with "intense emotional drives." Coincidentally, the adjectives that the scientists used tie in with another concept: a correlation was found between CHD and stress and Type A personality. Type A personality is defined as being driven, persistent, involved in work, competitive, aggressive, and time-urgent. This type of behavior proves that there is a relationship between CHD and stress ²⁵.

Stress could induce biological and physiological changes in the body, which can cause additional health issues. For example, hypercholesterolemia - increased serum cholesterol - is known to clog the arteries (atherosclerosis) and decrease the elasticity of arteries (arteriosclerosis). Cholesterol is a fatty and waxy substance that is a component of all the cells in the body; it is vital for making cell membranes and many hormones. Cholesterol can come from both the liver and the foods we eat. The clogs caused by high cholesterol can later lead to a heart attack or a stroke. Both atherosclerosis and arteriosclerosis overwork the heart muscle, pumping oxygen extra hard to other places and leaving less oxygen for itself. Similarly, increased blood pressure, blood volume, and accelerated heart rate can all lead to an excessive workload on the heart.

In addition, homocysteine is another biological molecule that stress could affect and influence. Stoney ²⁶ found a positive relationship found between anger and hostility and homocysteine levels. The production of plasma homocysteine is closely related to CHD. Researchers H. Refsum and P. M. Ueland found that "An elevated level of total homocysteine (tHcy) in blood, denoted hyperhomocysteinemia, is emerging as a prevalent and strong risk factor for atherosclerotic vascular disease in

the coronary, cerebral, and peripheral vessels, and for arterial and venous thromboembolism” 27. The amino acid homocysteine is formed by the metabolism of plasma methionine. Hyperhomocysteinemia (unusually high levels of homocysteine) can lead to ischemic injury (caused by blood supply unable to reach muscles, tissues, or organs of the body) and, therefore, CHD. Blood clots, heart attacks, and strokes are also associated with hyperhomocysteinemia.

Stress can affect the heart in indirect ways as well. Someone might have a habit of smoking after a stressful day or skip exercising because of experiencing too much stress. As a result, stress often exacerbates heart diseases by introducing other heart-damaging behaviors into the mix.

Stress management

People often make the mistake of coping with stress by suppressing negative emotions, which is proven to be counterproductive as it increases vulnerability to developing CVDs 28. Stress levels can be managed by using different strategies. Although no primary coping strategy was established to prevent CVDs, there are some secondary preventive methods proven to be efficacious in patients with congenital heart defects (CHD). Some of these secondary methods are even shown to be effective in reducing myocardial infarction levels 29-30. These techniques include relaxation procedures and cognitive behavioral methods 31-32, such as exercise, yoga breathing techniques, changing diets, progressive relaxation, imagery, behavior and anxiety management techniques, or medications 33.

CONCLUSION

Coronary heart disease will continue to be an issue globally, and stress will continue to be present. This study looked into the correlation between stress and CHD. We analyzed the difference between “good” stress and “bad” stress, the different stress theories that other scientists had developed to explain stress, the main types of stressors, and stress’ relation to cardiovascular health. We also discussed specific stress management methods that could diminish, not wholly, the amount of stress and its adverse effects on the body.

Through the articles this paper has covered, it is clear that there is a correlation between stress and cardiovascular diseases. Bodily functions such as heart rate and blood pressure can be affected by the amount of stress someone goes through. Furthermore, high cholesterol levels and increased blood volume - which are known to have negative impacts on the heart - can be caused by an increased level of chronic stress. Even though some evidence is not as direct as others, there is still a link between heart health and stress.

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Biology of Rationality and Irrationality

A prefrontal cortex research paper

By Ziling (Vicky) Lyu

AUTHOR BIO

Ziling (Vicky) Lyu is a senior student at Qibao Dwight High School, who is interested in behavior economics and the mechanism behind how conditions and the presentation of information would change individuals' decision-making. Many social experiments (such as the experiment about the theory of time discounting and present bias) have been carried out by Vicky to prove the certain theory, making sure that the theory established in the past can still be applied with the development of society. As the person in charge of the School Yearbook, Vicky writes/proofreads the content and coordinates the publishing of the Yearbook.

ABSTRACT

This article focuses on and analyzes the physiological causes of human rational or irrational behavior and decision-making. By focusing on the study and analysis of the functions of the prefrontal cortex and its subregions, this paper demonstrates their important roles in the process of making value-based rational decision that ventromedial prefrontal cortex (vmPFC) first represent the reward values, orbitofrontal cortex (OFC) then encodes the value of choices and updates the value when needed, and anterior cingulate cortex (ACC) also measures the choice value and choice predictions, etc. Moreover, damage or anomaly in a certain part in prefrontal cortex would cause individuals to make mistakes in the process of value-based decision making, including the lack of ability to anticipate expected rewards, combine relative value with reward, determine the effort needed for get the reward, integrate information to decide whether the reward is worthwhile, or lack the ability to be motivated to perform certain actions to get rewards, etc. Because of the lost of these abilities list above, individuals thus making irrational economic decisions.

Keywords: Rational, irrational, prefrontal cortex, decision-making, valued-based decision making, brain anatomy, ventromedial prefrontal cortex, orbitofrontal cortex, anterior cingulate cortex

INTRODUCTION

Decision making is the process of making choices by identifying a decision, gathering information, and assessing alternative resolutions [1]. In psychology, decision-making is regarded as the cognitive process resulting in the selection of a belief or a course of action among several possible alternative options [2].

It is generally categorized to two types: the rational decision making and irrational decision making. Rational decision making refers to the leverage of objective data, logic, and analysis instead of subjectivity and intuition to help solve a problem or achieve a goal [3]. However, irrational decision making refers to making decisions that counter to logic.

In economics, economists tend to assume that individuals are rational thinkers and have rational behavior, who always make decisions that provide them with the greatest personal utility or benefits [4], that is economic utility maximization. However, the concepts in behavior economics challenge this idea and prove that individuals all have bounded rationality. Plenty of experiments, including The Economist experiment carry out by Dan Ariely, proves that the framing trap can profoundly affect individual's decision making [5]. For example, decoy option is priced to make another option more attractive in order to nudge customers towards the desired and more profitable option. When there are three options presented (including one decoy option) with spending \$10 to purchase an online version of the textbook (option 1), spending \$18 to purchase a physical copy of the textbook (option 2 the decoy option), and spending \$18 to purchase both an online version and physical copy of the textbook (option 3). Since most consumers may fall for the framing trap because of the presence of option 2, they would choose the more attractive and cost-effective option (option 3), indicating that consumers may act irrationally and making irrational decision. If all consumers are rational thinkers, they should not fall for the framing trap and should rationally purchase the one they initially preferred or really needed, which is considered as making rational decision.

The regions that affect decision-making

Overall, reward-based decision making is the rational decision-making method that individual

mostly would use to make rational decision. Actions are chosen based on the expected rewards that individual will trigger. Multiple brain regions were found to be activated during reward-based decision-making, including but not limited to the ventrolateral prefrontal cortex (VLPFC), orbitofrontal cortex (OFC), anterior cingulate cortex (ACC). However, if the brain regions in the prefrontal cortex are being damaged, the dysfunction of prefrontal cortex may occur, causing individuals to make irrational decision.

Ventromedial prefrontal cortex (vmPFC) (Figure 1), an interconnected network of regions in the lower medial and orbital prefrontal cortices, involves in the decision-making process for its role in influencing the value people place on choices [6].



Figure 1: Illustration of the ventromedial prefrontal cortex (vmPFC).

The orbitofrontal cortex (OFC) (Figure 2) is the part of the prefrontal cortex that occupies the base of the anterior cranial fossa on the frontal lobe's ventral surface. It mainly serves as a link for sensory integration, regulation of visceral responses, and participation in learning, prediction and decision making in emotional and reward-related behaviors. The orbitofrontal cortex is an important structure in the nervous system that supports decision making. It combines multiple sources of information about the outcome of a reward to arrive at a value signal. [7]

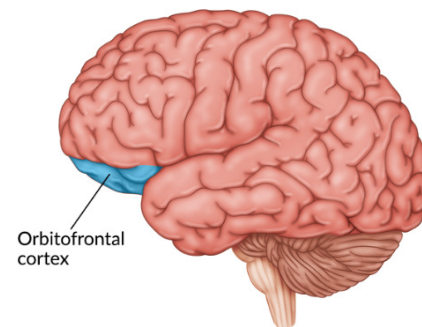


Figure 2: Illustration of the orbitofrontal cortex (OFC).

The anterior cingulate cortex (ACC) is located on the medial surfaces of the frontal lobe of the brain and contains subdivisions that play significant roles in events including motor, cognitive, and emotional processing [8]. When making decisions, the anterior cingulate cortex (ACC) is used to enhance information for better control of behavior and for outcome assessment in order to help to achieve the optimal decision-making .

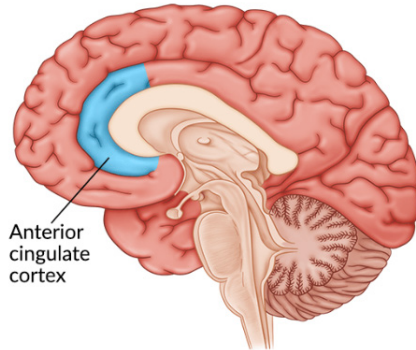


Figure 3: Illustration of the anterior cingulate cortex (ACC)

The mechanism of value-based Rational decision-making

According to Professor Ian J Bamford and Nigel S Bamford mentioned in the journal article The Striatum’s Role in Executing Rational and Irrational Economic Behaviors, the rewards-based decision making could be classified as cortical processing rational behavior [9]. In economics, this behavior of comparing different options and selecting the optimal solution can satisfy one’s greatest benefits and interests, which is called a rational decision-making.

Reward or value-based decision-making refers to the evaluation process of making a specific choice from a set of alternatives based on the specific reward (or value) expectation of each choice [10]. The relationship between a choice and its outcome can be known by learning from the individual’s prior experience with the choice (choice history) and the outcomes associated with it. Individuals are able to make choices by assessing the relative value of each option, a way to determine the value of a asset by consider the value of similar assets, allowing individuals to choose the option that provides the greatest value. The outcome of the selection of subjects may provide benefits, but may also carry high risks. Therefore, the value-based decision-making behavior includes individual nerves’ evaluation of

return and risk in the processes of positive feedback (reward) learning, negative feedback (punishment) learning, response persistence, and exploration versus exploitation [10]. Research has shown that distinct subregions of the prefrontal cortex (PFC) -- including ventromedial prefrontal cortex (vmPFC), orbitofrontal cortex (OFC), frontal lobe, anterior cingulate cortex, lateral prefrontal cortex, etc [11] -- contribute to specific process in value-based decision-making as mentioned above.

Role of ventromedial prefrontal cortex (vmPFC) and orbitofrontal frontal cortex (OFC)

According to Jaryd Hiser and Michael Koenigs, research shows that through the mutual effect with ventral striatum and amygdala, ventromedial prefrontal cortex (vmPFC) is crucial for the representation of positive and negative outcomes of value-based decision-making [12]. The relationship between blood oxygen level-dependent (BOLD) signals (Figure 4) and behavior (or internal state inferred from behavior) can be shown through functional magnetic resonance imaging (fMRI). The result demonstrates that the vmPFC BOLD signal is correlated with the chosen reward value, indicating its important role in value-based decision-making [13].

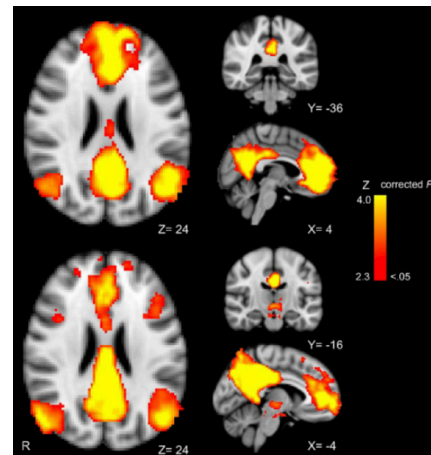


Figure 4: Illustration of the networks of vmPFC blood oxygen level-dependent (BOLD) signals

In the experiment with rats carried out by scientists, the function of different regions of the rodent prefrontal cortex was investigated in a probabilistic reversal learning task. A probabilistic reversal learning task is a computer-based decision-making task in which participants have to choose between two different stimuli on each trial [14]. In this situation, the rat had to choose between two nose poke holes, one giving 80% to get a reward and the other

giving 20% to get a reward. By pharmacologically inactivating several subregions of the PFC, which is the direct inhibition to specific neuronal activity by using nerve-blocking drugs [15], the data suggest that inactivation of these distinct regions affects the animal's response structure by showing a reduction in learning reward and punishment. The number of reversals was reduced with pharmacologically inactivation of the infralimbic and lateral orbitofrontal cortex, indicating its role related to response duration. Also, the number of rewards received decrease with the inactivation of the prelimbic and medial orbitofrontal cortex, reflecting their role in reward learning and punishment learning [16].

Role of frontal lobe

The frontal lobe contributes to decision-making and its executive control, which is the coordination and selection of goal-directed behavior [17]. In terms of decision-making learning and reasoning, the role of processing information about rewards and punishments is being completed by frontal pole, as the experimental result and pattern shown in monkey and human subjects. In terms of the executive control of decision-making process, the activity of frontal lobe not only increase when dealing with reward outcome, but the frontal pole activity also enhances after avoiding a punishment successfully, which shows that preventing the outcome of a negative consequence (negative reward) "can be seen as the intrinsic reward correlation" [18]. Specifically, the anterior cingulate cortex (ACC) included in frontal lobe also play significant role in reward-based decision making. By conducting the fMRI experiment in healthy individuals, Behrens et al. (2007) asked participants to experience gambling tasks with varying reward rates. Through tracking of uncertainty associated with volatility estimates, ACC activity is being shown, suggesting the role of ACC might be providing actual feedback for informative value. Also, importantly, ACC is responsible for detect the error or response to conflict theories.

Overall Mechanism

In a reward system where two options with different probabilities of getting the reward, monkeys were asked to perform a two-choice visually guided saccade task. As a result, monkeys rationally assessed the value of the outcome guided by each goal based on their historical choices. Regardless of the changes in the amount of reward between the two options, the

monkeys were able to identify and consistently chose the higher-reward option [11], confirming that the monkeys were using a value-based decision strategy in this task to make a rational decision and this decision-making process is being achieved with the functioning of several subregions of prefrontal cortex. During the process of reward-based decision making, vmPFC first represent the positive or negative reward values. Kennerley et al. (2011) pointed out that then anterior cingulate cortex (ACC) and the orbitofrontal cortex (OFC) are responsible for encoding and calculating the value of different kinds of choices, represented by prefrontal neurons. Then, the OFC is also responsible for evaluating the current choice and always updating the value to keep it clear and precise. Also, ACC is responsible for encoding choice predictions and prediction errors, which refers to the difference between the reward received and the reward predicted [19], etc. In addition, the findings of Donahue and Lee (2015) pointed out that the DLPFC is also involved in value-oriented decision-making, such as its participation in task-related activities is affected by the reward outcome, thereby helping to choose the option that is conducive to obtaining the maximum reward. In conclusion, many parts of the prefrontal cortex are involved in value-based decision making, and each has a different contribution to the final decision.

The mechanism of irrational decision-making: dysfunction of prefrontal cortex

Different parts of the prefrontal cortex are responsible for completing different steps of reward-based decision-making. Therefore, any deficit in specific brain region that engage in the decision-making process may prevent individuals from participating in goal-directed rewarding actions, leading to irrational behavior. For instance, an individual may lack the ability to anticipate expected rewards, lack the ability to combine relative value and costs with reward, lack the ability to determine the effort needed for get the reward, lack the ability to integrate this information to decide whether the reward is worthwhile, or lack the ability to be motivated to perform certain actions to get rewards [20].

More than 150 years ago, the case of Phineas Gage — a railroad worker who suffered a traumatic accident in which an iron rod was pushed into the front of his brain — emphasized the importance of medial and ventral region of prefrontal cortex in the process of value-based decision making. Since then, more

cases of patients with brain injuries, including the ventromedial prefrontal cortex (vmPFC), orbitofrontal cortex (OFC), and peripheral and infragenital anterior cingulate cortex (ACC), have been documented. While these patients performed normally on neuropsychological tests of intelligence, memory, and cognitive function, those with frontal lobe brain damage behaved not normal when came to value-based decision-making in life: swaying while making decisions, investing money in risky ventures, etc. Their characteristic can be concluded as that they always make bad choices or make irrational decision-making [19].

Nowadays, these irrational decision-making which result in prefrontal cortex (PFC) dysfunction or deficits can be shown through Anhedonia. Anhedonia refers to the inability to feel pleasure, which is a common symptom among individuals with depression or other mental health disorders [21]. For schizophrenia patients, individual with severe mental disorder and interpret reality abnormally [22], as self-reported anhedonia severity increase, the orbitofrontal cortex (OFC), ventromedial (vm) PFC, and dorsolateral (dl) PFC activity reduce, which indicates a negative correlation between anhedonia severity and certain brain activities [20]. Because these subregions monitor rational decision-making, dysfunction in these regions can lead to disturbances in individual thinking and behavior. For example, reduced activity in the orbitofrontal cortex may lead to reduced value encoding and reduced learning of rewards and punishments, leading individuals to engage in irrational behavior (choosing the option without clearly perceiving the magnitude of the reward).

Similarly, the severity of anhedonia in opioid-dependent subjects (individuals with a kind of neurobehavioral disorder) was negatively correlated with activity in the ventral anterior cingulate cortex (ACC), dlPFC, and anterior PFC regions. Also, the results contrasted with those found in healthy individuals [20]. The ACC receives input from the OFC to determine the effort required to earn the reward. Neurons in the dorsal ACC encode previous choice and outcomes to instruct future decision-making process [23]. Therefore, ACC lesions may cause individuals to prefer low cost/low reward options over high cost/high reward options, which result in the abnormal calculation of effort needed and finally lead to irrational decision-making.

In reward-based decision-making, behavioral and decision-making deficits because of focal vmPFC lesions are being recognized through a gambling task that requires subjects to learn about rewards and punishments in different kinds of tasks including risky, ambiguous, and simple binary item preference, etc. Electrophysiological recording studies in monkeys and rats show that the vmPFC encodes stimuli for reward studies and that impairment of the monkey vmPFC disrupts reward-guided decision-making. This has led to the obstruction of reward research, resulting in individuals unable to make accurate judgments about the rewards of options, leading to irrational decision-making behavior. While demonstrating decision-making deficits in patients with these vmPFC lesions, numerous human functional imaging studies showed the connection between vmPFC activity and the representations of value and reward processing in various decision-making situation. Furthermore, animal study had indicated that the vmPFC plays an important role in representing and updating the reward value of stimuli and outcomes. For example, electrophysiological recording studies in monkeys and rats have shown that reward studies of stimuli is being done by vmPFC, and targeted vmPFC impairment disrupts reward-guided decision-making [12].

As a result, patients with damages in prefrontal cortex (PFC), particularly the ventral and medial regions of the prefrontal cortex, often show the inability to make choices that achieve their goals and aims. These insufficient learning of the consequences of choices and the insufficient ability to adjust future choices based on its value of current choices may cause decision barriers, thus leading to irrational behavior making [19].

Neurobiological basis of rationality through economic lens

Combined with the economic decisions people make in life, any problems with the prefrontal cortex can affect whether people can successfully make rational economic decisions. According to economic utility maximization theory, which argues that choice must conform to the General Axiom of Revealed Preference (GARP), that is the situation in which, given a level of income and/or price, the individual obtain the same level of benefit from multiple consumption bundles [24]. Overall, alignment of subjective values and choices is the foundation of economic decision-making and rationality.

VLPFC involves in the value-based (utility maximization) decision-making process, and I will use this as an example to illustrate how its integrity relates to economic decision-making. By estimating GARP violations in 39 healthy older adults, Chung et al. examine the causes of irrational decision-making by using a routine use paradigm used in experimental economics. In this task, subjects were shown bundles with different quantities of two consumables (e.g., 4 books + 2 puzzles or 5 books + 1 puzzle) and asked them to choose their preferred bundle. Each trial consisted of 3-7 different combinations, while each experiment consisted of 11 selection sets. The experimenter assessed the frequency and severity of GARP violations by determining whether participants were consistent in their choices when offering different combinations of commodities. The experimental results show that 42.11% of the samples caused two or more GARP violations [25].

In this regard, the authors used whole-brain voxel-based morphometry, a neuroimaging technique to study focal differences in brain anatomy [26], to explore the relationship of economic rationality with gray matter integrity. The scientific findings shows that more frequent and severe GARP violations are associated with reduced gray matter in the ventrolateral prefrontal cortex (VLPFC), leading to the conclusion that the integrity of the VLPFC is an important determinant of economic rationality in the tested population [25].

It is thus demonstrated that damage and the occurrence of anomalies anywhere in the prefrontal cortex can lead to irrational behavior in economic decision-making, as in the framing trap example mentioned earlier. When there is no decoy option, people can continue to choose the option they most want to buy, indicating the presentation of utility maximization theory. However, when there is a decoy option, people's choices will be changed due to the different presentation of the options, making irrational choices, resulting in inconsistency of option and thus mismatching with the utility maximization theory (and GARP). Overall, problem in VLPFC would cause high violation in GARP test, thus leads to inconsistency of option and irrational economic decision-making.

CONCLUSION

It can be concluded from different research results that many parts of the prefrontal cortex play a role in the process of value-based decision making, enabling people to make rational economic decisions. However, the dysfunction of prefrontal cortex can cause problems in the process of value-based decision making. Deficits in any of these processes or any related regions may prevent the individual from completing the reward-based decision making, leading to irrational behavior. However, in some brain regions (including vmPFC/mOFC and aPFC, etc.) little is known. In future studies, further studies of neurophysiology and enhanced understanding of the interconnections and interactions between different frontal regions or across the brain are needed.

For example, when determining vmPFC activity through measuring anhedonia, in fact, multiple studies have shown conflicting results, reflecting increases and decreases in PFC activity in subgenual PFC in depressed individuals. In addition, other studies have shown that deep brain stimulation (DBS) of the subgenual PFC reduces depressive symptoms in patients with treatment-resistant depression, but it is unclear whether this treatment affects anhedonia. It is unclear whether the underlying mechanism of DBS in this brain region involves the inhibition or excitation of neural activity [20], thereby affecting measures of anhedonia. Therefore, it is important to further demonstrate existing knowledge and research needs as the focus of future research.

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Alzheimer's Disease: What's the Difference Between Early and Late Onset Alzheimer's?

By Kavya Tharshanan

AUTHOR BIO

Kavya Tharshanan is a current Junior at California High School. Her interests are mainly centered around the medical field, with neuroscience and neurology being of particular interest to her. As well as taking interest in researching Alzheimer's Disease further. She has been a part of organizations, such as the Red Cross and the American Cancer Society, as a volunteer. She would like to go into the medical field as a neurosurgeon, since she loves the neurology field as well as the hands-on experience a surgeon is able to have. She also loves to immerse herself in the fine arts through singing and writing songs, where she discovered her love for expressing herself through writing.

ABSTRACT

This paper will mostly focus on Alzheimer's Disease, or specifically on Early-onset and Late-Onset. Alzheimer's Disease (AD) is a neurodegenerative disease that can deteriorate brain functions; one well-known symptom is memory, as well as being a leading cause of dementia. Alzheimer's Disease is mostly influenced by genetics, but other head injuries and factors could lead to Alzheimer's. Even though Alzheimer's can be seen in a broader topic, there are still major differences seen in Early versus Late-onset Alzheimer's. In this paper, the differences between Early and Late-onset will be shown the difference in genetics and factors between the two onsets. Furthermore, looking at the regions of activation during the progression of Alzheimer's and see how it differs from Late-onset and Early-onset. Although there is no known cure for AD, there will still be discussions on different treatments that are used to manage Alzheimer's, such as treatments that are used to manage the excess tangles produced or even the psychology and management of emotions. Not only will the physiology and anatomy of the brain in developing Alzheimer's be mentioned, this paper will show the different statistics in different age groups, genders, and locations to see the differences of Alzheimer's Disease in Early and Late while showing the different statistics for the stages, mainly early-stage and late-stage, not to be confused with early-onset and late-onset, the stages would be the period of time the disease progresses based upon the symptoms exhibited by the patient. This paper will mainly be based upon the differences between Early and Late-onset Alzheimer's and why these differences could impact Alzheimer's research.

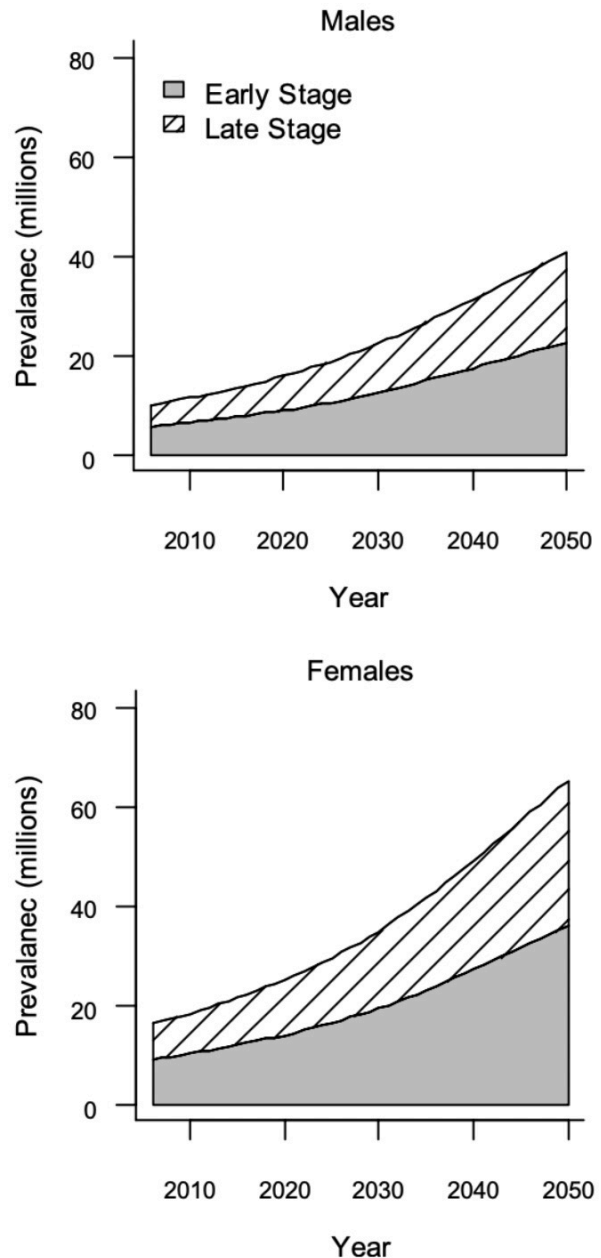
Keywords: Early-Onset Alzheimers, Late-Onset Alzheimer's, Alzheimer's, Memory, Brain Degeneration, Neurofibrillary Tangles, Senile Plaques, Genes

INTRODUCTION

In this paper, I will review the literature on AD. I will first present an overview of the different types of Alzheimer's, and I will discuss the differences and similarities of early-onset and late-onset Alzheimer's. Based on empirical research, Early-onset Alzheimer's and Late-onset Alzheimer's has evidence that they are not the same disease, rather two similar disease that is Alzheimer's, which is important because knowing that late-onset and early-onset Alzheimer's is not correlated shows better treatment plans to better suit the individual variations.

Alzheimer's Disease (AD) is by far the most common neurodegenerative disease that develops into Dementia, specifically in elders. Over 26.6 million people over the age of 60 to 95 globally are diagnosed with AD and (about 1/85 people) with the mortality rate at about 11% (Brookmeyer et. al., 2007). Some symptoms of Alzheimer's can be shown in a loss of memory or cognitive functions, such as memory loss, personality changes, and communication issues. Alzheimer's is a slow and progressive disease and the average timeline for the disease to progress is about 5 to 10 years, but many stages are seen throughout the progression, early-stage, middle-stage, and late-stage (Frazier & Drzymkowski, 2013). The stages are how the disease is marked in its progression. It is also seen that people who have been exposed to head trauma in the past or have the genetic markers of Alzheimer's have a greater risk of getting the disease. In the brain, Alzheimer's Disease is shown to have sensory and motor deficits, as well as the anatomy of the brain where the sulci are more wide and enlarged ventricles.

Alzheimer's Disease can be separated into two categories, Early-onset Alzheimer's and Late-onset Alzheimers. Early-onset is most prevalent in elders at or above the age of 65, and about 5 to 6% of elders who have Alzheimer's would have Early-Onset Alzheimer's. In contrast, Late-onset occurs in ages above or at 85 and it accounts for 45% of elders over 85 and 34% of elders over or at 65. Early-onset is shown to be even more prevalent than Late-onset. Specifically, it is shown that females have a higher prevalence rate as the years continue. However, when we look at gender differences, we can see that females are more susceptible to both early-stage and late-stage Alzheimer's (Brookmeyer et. al., 2007). In particular, a study conducted by Ron Brookmeyer, Elizabeth Johnson, Kathryn Ziegler-Graham, and H.Michael



Arrighi predicted that by 2050, more females will be diagnosed with Alzheimer's than males (see Figure 1).

Graphs showing the prevalence (predicted) of early-stage and late-stage AD through precedent years, comparing male and female (Figure 1) (Brookmeyer et. al., 2007)

Due to the fact that there are multiple components and differences in Early-onset and Late-onset Alzheimer's, it could mean they could be two different diseases that have similar properties. Previous research has shown that Early-onset and Late-onset

have different symptoms and genetic influences. In addition, existing data show that the prevalence rate of Early-onset increases with age. In addition, findings from previous studies (e.g., Brookmeyer et. al., 2007) suggested that the prevalence rates for both Early-onset and Late-onset Alzheimer's are significantly higher in Asia, compared to other countries. (see Figure 2). Early-onset has been found to be associated with more severe impairment of non-memory skills, such as language and visuospatial skills. By comparison, late-onset is associated with impairment of memory skills. Although types of Alzheimer's have complex mechanisms, it has been shown that Early-onset has more contributing factors and more complex mechanisms (Kodam et. al., 2009).

	Prevalence (in millions)					
	2006			2050		
	Overall	Early Stage	Late Stage	Overall	Early Stage	Late Stage
Africa	1.33	0.76	0.57	6.33	3.58	2.75
Asia	12.65	7.19	5.56	62.85	34.84	28.01
Europe	7.21	4.04	3.17	16.51	9.04	7.47
Latin Am. / Caribbean	2.03	1.14	0.89	10.85	5.99	4.86
North America	3.10	1.73	1.37	8.85	4.84	4.01
Oceania	0.23	0.13	0.10	0.84	0.46	0.38
Total	26.55	14.99	11.56	106.23	58.75	47.48

Data table showing the prevalence of early-stage and late-stage AD in different countries (2006 vs. 2050) (Figure 2) (Brookmeyer et. al., 2007)

Factors associated with Alzheimer's Disease

Neurofibrillary tangles and senile plaques are important factors in Alzheimer's Disease. The tangles could be a sign that abnormalities are happening in the brain, especially shown in the hippocampal region, which is known for creating short-term or newer memories. Abnormalities in the hippocampal region can correlate to Early-Onset AD and it shows signs/symptoms of Early-onset AD (Munoz & Feldman, 2000). Senile plaques, on the other hand, involves a more complex process since it relates to the deposits of amyloid-beta that is monitored through genes. Another difference from the tangles is that plaques don't develop through age. Therefore, showing signs of these plaques could mean serious genetic degeneration in the brain.

Alzheimer's is known for the degeneration of regions in the brain, especially memory. This degeneration is caused by the abnormal production of two different types of proteins, TAU and Amyloid Beta, and genetics can be an important factor. Usually, Chromosome 21 is the main producer of

Amyloid Beta and the main cause for early-onset Alzheimer's (Munoz & Feldman, 2000). In early-onset Alzheimer's, three different genes are found to be related to the development of Alzheimer's, APP (amyloid precursor protein), which manages amyloid-beta production, PSEN1 (presenilin 1), and PSEN2 (presenilin 2) (Rovelet-Lecrux et. al., 2006). In particular, people who have down-syndrome are more vulnerable to Early-Onset due to the CAA gene, which is located on chromosome 21, where the APP gene is also located. In a study, researchers found that people with a mutated CAA gene had a duplication of a mutated APP Locus (Rovelet-Lecrux et. al., 2006). With the duplication, in brains that were affected, many deposits of amyloid-beta plaques were found in the hippocampal cortex area (Munoz & Feldman, 2000). There are also other genetic factors associated with Early-onset, such as the SORL1 gene responsible for Golgi trafficking. Head trauma is a major cause since it has been shown to be related to the build-up of amyloid-beta and TAU protein (another protein that builds up in the progression of Alzheimer's). Furthermore, Down syndrome has been shown to have an effect on the occipital lobe, which is associated with visuospatial skills, as well as the APP gene, which can deposit more Amyloid-beta plaque.

In comparison, we can see in Late-onset Alzheimer's that there is a different gene involved called APOE. APOE is found on chromosome 12 and comes in three variants (e2, e3, and e4) (Munoz & Feldman, 2000). The APOE gene is mainly responsible for maintaining lipoprotein production. In APOE, the APOE e4 gene carries the highest risk for Alzheimer's Disease, while e3 carries a relatively lower risk. By contrast, e2 has more protection against the disease. Late-onset can also be caused by stress in the environment and head trauma in the past (Munoz & Feldman, 2000).

Effect

MCI (mild cognitive impairment) is shown to have a major impact on the development of Alzheimer's disease, by affecting the Medial Temporal Lobe, posterior cingulate, and hippocampus. Studies have shown that the activation of the Medial Temporal Lobe correlates with the impairment in cognitive tasks and visuospatial skills (Johnson et. al., 2005). Also, studies have shown that the activation of the hippocampus was related to the impairment of memory, and the posterior Cingulate affected visuospatial skills. As for the language

skill impairment, there were studies that showed that Broca's area had some impairment too (Johnson et. al., 2005).

Early-Onset Alzheimer's Disease

Early-onset AD has many similar components, yet still has major differences compared to Late-onset. In a study, scientists found that the genes involved with EOAD (Early-onset Alzheimer's Disease) are APP Locus, PSEN1, and PSEN2 (Rovelete-Lacroix et. al., 2006). Although the APP Locus gene is similar to LOAD, EOAD doesn't contain many mutations with the APOE gene, instead, EOAD has mutations with the PSEN1 and 2 genes. The APP Locus has been significant in duplication, especially in CAA (cerebral amyloid angiopathy) deposits. There were also correlations with down-syndrome in that same study. Where LOAD doesn't have any known correlations with down syndrome but has correlations with head trauma. There were also correlations with EOAD being more aggressive and longer than LOAD as well as EOAD being based on autosomal dominant transmission, by having more genetic components (Mendez, 2019).

Amyloid-beta can have two different types of mutations, amyloid-beta 40 and amyloid beta 42, both of the protein chains have different areas it can affect. In a study, they found amyloid 40 is more abundant in the vasculature, while amyloid 42 is mainly found in parenchymal plaques. It has also been seen that LOAD has those amyloid chains similar to the mechanism for AD as well, but LOAD has other factors like TAU protein which was not prominent in EOAD as shown in another study (Roks et. al., 1999).

Late-Onset Alzheimer's Disease

Late-onset AD (LOAD) also has many complex factors, as with EOAD, but LOAD also includes different genetic factors. From a study, shows there are two different pathways, the serial and dual pathways, the serial pathway first raises the Amyloid Beta production then rises the TAU production which leads to synapse death, and finally cell death/loss (Small & Duff, 2008). While the dual pathway, shows that it can either lead to a rise in TAU or Amyloid Beta production, and both lead to cell and synapse death. In order to get this raise in the production of proteins, there would have to be mutations in the genes involved, in this case the genes involved are the APP and APOE genes. The APOE gene is mainly correlated

to LOAD, which is a difference between LOAD and EOAD. The APOE gene has three different variants, APOE e2, e3, and e4. Even though the other variants have a risk, the APOE e4 is shown to have the greatest risk as well as increasing deposits in Amyloid Beta. APP also has a factor in amyloid-beta production.

Other factors in the process of the APOE gene are the GSK3 and LPRs, where both of them bind to the APOE e4 gene. Studies show GSK3 (glycogen synthase kinase 3) is one of the proteins that binds to the APOE gene, GSK3 has two forms as well, both related to the production of Amyloid Beta. Then for LPRs (LDL receptor-related proteins) that also bind to the APOE gene (Small & Duff, 2008).

Treatments

As mentioned before, Early-onset has mutations for the genes PSEN1, PSEN2, and APP, which affect the amyloid-beta production, while Late-onset has a mutation in the APOE gene and the Preslin genes (PSEN1 and 2), which are predicted to be a major cause for Early-onset Alzheimer's. Treatments targeting certain aspects of Alzheimer's have been examined in previous studies. A study shows, drugs such as NDMA manage the psychology of the brain, including cognitive functions. However, there are also anatomical therapies that target the specific deposits for amyloid beta and regain control of those deposits (Sandro et. al., 2016). One example of this gene would be BACE1 which maintains the APP production. There are also treatments for amyloid-beta production, including NEP, ECE, and IDE, although studies show that NEP is more effective for amyloid-beta production management (Sandro et. al., 2016).

CONCLUSION/DISCUSSION

By all counts, and results for many studies, it has become apparent that early-onset Alzheimer's Disease and Late-onset Alzheimer's Disease have few similarities but have many differences, which can give the impression of EOAD and LOAD not being the same. Yet, there are still many implications and questions throughout the research, such as many sources say the APOE gene is mainly shown in LOAD, on the other hand, many contradicting sources say that the APOE gene can be seen in EOAD and LOAD. Regardless, there are many sources that have done studies and seen the immense significance of the APOE gene in LOAD exclusively, rather than EOAD.

EOAD has also been shown to have more aggressive traits than in LOAD, especially since EOAD is longer lasting and starts at an earlier stage than LOAD. Furthermore, EOAD is shown to have different genes, with the exception of the APP Locus, then LOAD. There are differences in the quantities of deposits of proteins in the brain with LOAD and EOAD as well, which has more reason to prove they are not quite the same. Even the effects of memory skills would be different since EOAD has more visuospatial and language deficits while LOAD has memory deficits.

Yet, there are similarities that cannot be ignored as well, such as the similarity in the gene APP as well the same deposit materials of Amyloid Beta. This would make sense since both EOAD and LOAD have memory deficits, even non memory deficits, both would be Alzheimer's yet they still would be different types of Alzheimer's rather than stages or very similar Alzheimer's. Due to the differences listed in this paper, it has become apparent Early-onset and Late-onset shouldn't be categorized exactly the same, instead be seen as different variants with similar effects.

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Classification of Mathematic and Scientific Symbols

By Alec Situ

ABSTRACT

Mathematical Expressions Recognition (MER) has become increasingly popular in the modern world and developing better models to classify such symbols can be very useful in the world. There are many models for MER, but they aren't accurate and efficient enough or don't perform well in large datasets. Although novel approaches are not attempted, this paper attempts to enhance current models and incorporate some scientific symbols for classification. The models use deeply connected convolutional neural networks, which includes symbol segmentation and symbol recognition. The models are trained and validated on the HASyV2 dataset and have better results than most other models using similar classifying techniques. Ultimately, the accuracies were 79.16% and 80.46% for the two models.

Keywords: MER, Convolution Neural Networks

INTRODUCTION

Understanding handwritten works is indispensable in modern day society as we write everyday. However, in large batches of writing, human reading becomes dull and inefficient. Therefore, it becomes important to use computers to read mass writings. In particular, mathematical and scientific symbols are of the most unexplored areas of computer vision compared to word texts, as they are complex. As such, it is difficult to create good models to accurately classify the symbols [3]. By using computers, marking widespread math/science tests, computerizing notes, scanning work, etc, becomes significantly easier. Today, computers are becoming increasingly common in recognizing and scanning texts. However, current models don't work well enough to be able to consistently scan large amounts of math symbols in efficient manners.

Over the past decade or so, Mathematical Expressions Recognition has become increasingly popular, especially since the competition CROHME was launched. There were many attempts to classify different symbols. However, many of which were self-created datasets with few symbols and few images [5] (this one has roughly 10000 images, and not a lot of symbols). As a result, these types of datasets were relatively easily to get 95%+ accuracy with these datasets. The primary problem with these datasets is the lack of variety and complexity of the symbols. So, they aren't practical. Other attempts at classifying complex datasets, however, led to low accuracies [6, 7]. Therefore, this paper will attempt to apply machine learning algorithms to complex dataset without sacrificing high accuracies.

Method

1. Dataset

The dataset was the HASYv2 dataset from kaggle.com, which is derived from the HWRT dataset [4]. It includes 168,233 images and each image contains one symbol. There are a total of 369 distinct symbol classes in the dataset. Each symbol class contains one symbol from a pool of English alphabets, Greek alphabet, mathematical symbols, and other scientific symbols. Each image has a size of 32 pixels by 32 pixels. As such, this dataset allows for sufficient analysis of a wide range of common symbols, which contributes to the ultimate goal: to create a model applicable to real world scenarios.

Once the dataset was loaded, preprocessing was performed. The dataset included a csv file for the path of the image, symbol class, and LaTeX symbol for each image in Figure 1.

	path	symbol_id	latex
0	hasy-data/v2-00000.png	31	A
1	hasy-data/v2-00001.png	31	A
2	hasy-data/v2-00002.png	31	A
3	hasy-data/v2-00003.png	31	A
4	hasy-data/v2-00004.png	31	A
...
168228	hasy-data/v2-168228.png	1400	\guillemotleft
168229	hasy-data/v2-168229.png	1400	\guillemotleft
168230	hasy-data/v2-168230.png	1400	\guillemotleft
168231	hasy-data/v2-168231.png	1400	\guillemotleft
168232	hasy-data/v2-168232.png	1400	\guillemotleft

Figure 1: CSV file for the dataset

Firstly, the images were transformed into Numpy arrays. Noise reduction techniques were employed to remove or correct some of the faulty images/data. This includes the fixation of images from 3D Numpy arrays to 2D Numpy arrays. Then, the images were converted into simple black and white pictures (binarization) for its better contrast and high computing efficiency. In the case of Numpy arrays, the colors above a certain threshold will be black and below that threshold will be white. This method is particularly useful as the images in the dataset are relatively simple with clear background as the thresholding method could reduce the quality of images in more complicated cases.

2. Models

The preprocessed images were split so that 80% is used for training the model and the rest is used for testing. This allows for the model to test in separate, random data like in the real world. All of the models tested were Convolution Neural Network (CNN) models, as analyzing previous models shown that CNN gave the best results for deep learning [1, 2]. In particular, the models are drawn from the TensorFlow Keras package, using four of the layers from the package: Conv2D, MaxPool2D, Flatten, and Dense. The number of Conv2D and MaxPool2d layers varied with different models, but the number of Conv2D always equals the number of MaxPool2D. For

most models in general, including the model I chose, there was 1 Flatten layer. Finally, I decided to use only 1 Dense layer.

However, for the Dense layer, the activation function was Softmax. For each of the Conv2D layers, the padding was always "same" for the Conv2D layers. The loss was calculated through categorical cross entropy and the optimizer was Adam, a stochastic gradient descent method. Finally, the models were trained on 7 epochs, as any more didn't increase the accuracy. Occasionally, if there is overfitting, the training would end early by employing the EarlyStop function from Tensorflow Keras.

The first of the models tested was focused mainly on the efficiency and the simplicity of the model. There were only 2 Conv2D and 2 MaxPool2D layers, and the layers weren't particularly complex. For this model, the sigmoid function was used as the activation function:

$$S(x) = \frac{1}{1 + e^{-x}}$$

The sigmoid function.

The architecture of the first model is illustrated in table 1:

Table 1: Model 1 and its construction. Includes layer type, output shape, and parameters of each layer.

Layer Type	Output Shape (None, 32, 32, 32)	P
	(None, 16, 16, 32) (None, 16, 16, 32)	a
Conv2D	(None, 8, 5, 32) (None, 8, 5, 64)	r
	(None, 4, 2, 64) (None, 512)	a
MaxPool2D	(None, 369)	m
Conv2D		6
		4
MaxPool2D		0
Conv2D		9
		2
MaxPool2D		4
		8
Flatten		
Dense		0 Accuracy: 79.16%
		18496
		0
		0
		189297

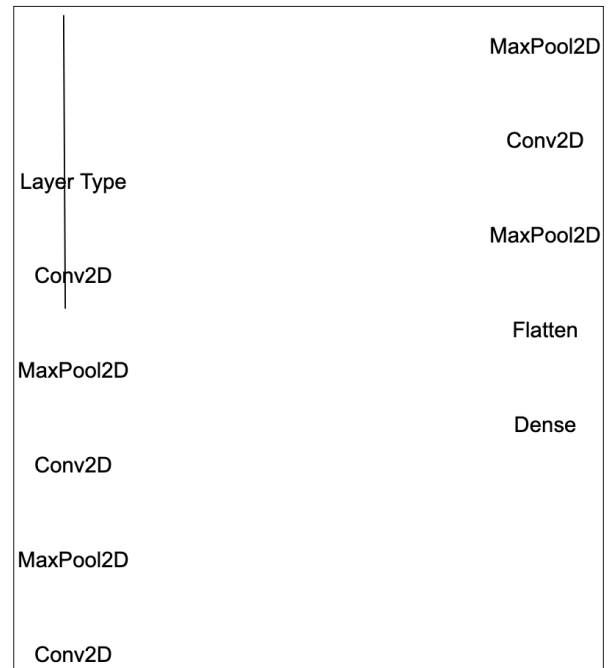
Another model used was a more complex one, which had a total of 4 Conv2D and 4 MaxPool2D layers. This time, the activation function was ReLU, but as said previously, the activation functions don't make too much of a difference.

$$R(x) = \max(0, x) \tag{2}$$

The ReLU function.

The architecture of this model is in table 2:

Table 2: Model 2 and its construction. Includes layer type, output shape, and parameters of each layer.



Output Shape	Param
(None, 32, 32, 32)	3
	2
	0
(None, 16, 16, 32)	0
(None, 16, 16, 64)	1
	8
	4
	9
	6
(None, 8, 8, 64)	0

(None, 8, 8, 64)	36928 Accuracy: 80.46%
(None, 4, 4, 64)	0
(None, 4, 4, 128)	7
	3
	8
	5
	6
(None, 2, 2, 128)	0
(None, 512)	0
(None, 369)	1
	8
	9
	2
	9
	7

Obviously, the models were measured by accuracy, but time was also considered.

RESULT

The models performed as follows on the testing data:

Table 3: Results for the two models.

Table 3: Results for the two models.			
	Training Accuracy	Valida	Time
Model 1			190s
Model 2	82.12%		
	84.37%		350s

Although there are often one or two more Dense layers in other models, my testing showed that including the extra Dense layers led to significantly worse accuracies. This is mainly due to the existence of 369 categories, making it difficult to add more Dense layers. Moreover, many different activation functions were tested, but the results remained similar between different activation functions. Although the 2 proposed models have different activation functions, the change is unnoticeable. From Table 3, also note that the training accuracy was higher than the validation accuracy in both models. This means that although there is a little bit overfitting, it wouldn't cause too many problems.

DISCUSSION

Considering there were 369 different categories with over 160,000 images, the results were good. Moreover, the low image resolution (Figure 2) in conjunction with the fact that many symbols were similar (Figure 3) made the classification even harder. Although there was a difference in the accuracy between, it was only 1.3%. Despite being 1.3% less accurate, model 1 took almost half the time of model 2, which is very significant because one of the primary focuses of this paper is to discover more efficient models. Compared to previous studies [3], model C improved the accuracy by 4%. While it doesn't sound like a lot, 4% of 160,000 images is 6400 images. In the case of real exams, this would be a huge increase in correctness.

While the results are promising and better than before, it is far from useful. 80%, despite being a good accuracy for this type of test, is not nearly accurate enough for the real world.



Figure 2: An image of the letter C from the dataset



Figure 3: Two sample images of the letter E and

There are also many limitations of this study which should be addressed. For instance, because not all of the dataset (160,000 images) were checked, there might have been errors in some of the images, such as a symbol on a wrinkled paper. Although some error checking was performed, it is not enough to guarantee the dataset is flawless. Therefore, in future works, eliminating all these errors would be ideal. Furthermore, testing different architecture types for the models would be useful because the two models presented in the paper are very similar in construction. Finally, as the CSV file already includes the LaTeX for each symbol/image (Figure 1), it would be useful to translate the results into LaTeX as it becomes more readable.

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Artificial Intelligence in Fashion

By Qingxi Rui

ABSTRACT

From conception through manufacturing and consumption, innovation and machine intelligence have a tremendous effect on the fashion industry. Fashion has often been a forward-thinking industry, eager to evolve and adapt as they become available. Artificial Intelligence is no exception, as it evolves at a breakneck pace. For more than a decade, artificial intelligence has been utilized to analyze fashion trends and customer necessities. Its influence on fashion and the growth of concepts such as Fast Fashion is undeniable. The apparel industry's digital revolution is becoming increasingly reliant on technological advancements, with the utilization of Artificial Intelligence in a wider spectrum of activity becoming increasingly common. Nevertheless, a research of AI's brief career in the fashion industry clearly demonstrates that AI has a massive effect on this trend and the allied sectors, which is a substantial player in the international economy. The present crisis generates a slew of questions about one of the most important cultural trends. Certain fashion specialists are concerned about the present unpredictably social, cultural, and economic conditions that is shaping the industry's future. Many are discussing the issues brought up by the development of artificial intelligence, in addition to the issue of sustainable development. As a result, examining potential directions and forecasting their effect is critical to the growth of creative arts. This article aims to examine how AI is currently being used in the fashion industry and business environment.

INTRODUCTION

Since humans began wearing clothes, people have liked to show their personality and uniqueness; fashion is the way to help them achieve this desire. According to Schmelzer (2021), the fashion industry plays an essential role globally, estimated to be worth around \$300 billion in 2018 and occupying 2% of the global GDP. Many traditional outline shops and online businesses are dedicated to selling fashionable products (Purswani, P. (2021). For example, Zappos, the big shoe outline retailer, joined Amazon in 2020; other major retailers aim to achieve significant business success for fashion retail by creating a private brand (Schmelzer, 2021).

The adoption of artificial intelligence has gradually influenced the fashion industry. Most fashion companies have focused on production processes and prioritizing on quality. According to Luce (2019), the internet and technology has provided innovative ideas that fashion brands should consider when determining the standards of design and quality of fashion items. The rapid adoption of artificial intelligence implicates an extended approach to other business sectors. According to Purswani (2021), world fashion and retail capitalization on artificial intelligence may reach \$7.3 billion annually by 2040.

Artificial intelligence is changing multiple elements of the fashion industry's value chain, including design, sales, marketing, logistics, and manufacturing. For example, fashion brands are reshaping their product design and development methods by anticipating what consumers want to wear next. A.I. consultation gradually is replacing humans because consumers can also directly benefit from A.I. in their online browsing experience; they could get the suitable suggestion for size or resolve other questions from A.I. quickly (Purswani, 2021). Not only can virtual models help designers showcase their latest creations around the world, even at a time when big fashion shows are banned due to COVID-19 restrictions, they can also cut down on waste by showcasing unproduced clothes (Marr, 2021).

AI also assists fashion houses and law enforcement by identifying illegal recreations or "fakes". Artificial intelligence structures can keep a continuous watch on fake products that increasingly appear like the real thing. In this region, Customs and Border Enforcement is applying artificial intelligence technology to help pinpoint the effectiveness of

advanced products that are often counterfeited, like wallets or sunglasses (Luce, 2019). Designers and brands that use the latest technologies to drive design, manufacturing and production will stand out in a rapidly changing fashion world. The first section of this paper describes how artificial intelligence works for the fashion industry then the benefits of artificial intelligence for the fashion industry are discussed, finally a section dedicated to the discussion and summarization of important aspects on artificial intelligence and the fashion industry.

How A.I. Works for the Fashion Industry

1. Fashion Trending Forecasting

Most textile companies seek to monopolize the market; hence, some have focused on regular production of new and trending fashion items. Due to this, brands should incorporate new, distinct, and attractive clothing designs to catalyze the production process, which implies designers and producers should work faster and under short production timelines (Ma & Sun, 2020). Since there is a great evolution of fashion products, this makes it problematic to predict fashion trends. A lot of time is also wasted due to difficulty in making fashion predictions. Analyzing past trends, social media trends, and customer preferences by hand, analysts are expected to spot trends to come (Laaziz, 2020). Traditionally, retailers' estimates of this year's sales are based on data produced last year. However, this might not provide a clear justification, since sales are affected through factors that are hard to confirm. In addition to the hassle of manual work for planners, spotting trends creates cost problems for fashion brands if forecasts are not correct (Bisen, 2021). If brands invest in leveraging A.I., they can solve all problems quickly.

The design and pattern of clothing matching the right color combination is the key to attracting customers. AI-based demand forecasting methods can reduce prediction errors by up to 50% (Schmelzer, 2021). A.I. tools trained with quality and massive data will analyze past fashion data, examine customers' needs and preferences, evaluate competitors' moves, and identify market trends. After crunching the data, the A.I. tool provides accurate fashion styles and designs within minutes (Laaziz, 2020). For example, by leveraging users' data directly, brands like Finery and Stitch Fix have quick and easy access to information that helps them plan what styles people like and know how much to produce (Marr, 2021).

Meanwhile, trends in the fashion industry change quickly and there are new designs or patterns on the market every day. Designers need to keep up with new styles. According to Bisen (2021), artificial intelligence algorithms can replicate popular styles through image analysis and design.

2. Modelling Design

In the past, design modelling was a very complicated process. There was less technology and connectivity; hence, access to fashion information was problematic to participants and people depended on rudimentary ways of obtaining information. The latter considers gravity and collision to calculate the remaining shape of the garment, with enough pleats and folds. A.I. provides a more intuitive approach to virtual clothing design (Ma & Sun, 2020). Virtual fitting uses artificial intelligence to generate non-existent, lifelike digital human bodies. Designers could start with a 2D sketching system that allows them to draw silhouettes and stitches of clothing directly on a virtual mannequin (Purswani, 2021). According to Decaudin et al. (2021), the A.I. system converts the sketch into an initial 3D surface using existing methods based on a precomputed distance field around the mannequin.

Recognizing the potential of A.I. in design, many tech giants are already making significant moves to integrate technology into their design practice. For example, Amazon has developed an A.I. tool that analyzes and learns from incoming images and then generates entirely new fashion designs on its own. Amazon has also developed another A.I. application that analyzes and processes the images fed to determine whether a particular style looks fashionable (Bisen, 2021). It's not only Amazon, but dozens of other tech giants have begun their A.I. journey, fully streamlining their design creation process (Ma & Sun, 2020). In partnership with Tommy Hilfiger and FIT, IBM is using A.I. to support designers to increase the pace of the product development life cycle. In addition, Tommy Hilfiger has teamed up with IBM to create Reimagine Retail, a program that equips design skills with A.I. (Shi & Lewis, 2021). Thus, designers can learn about Natural Language Processing (NLP) techniques and vision skills to provide personalized clothes. By using A.I., teachers could provide the platform that students could learn from images with fashion factors, which students could enhance creativity and save more time on the search. (Purswani, 2021).

3. Customer Experience

When customers have higher expectations about a particular fashion brand, their demand will rise; thus, producers are faced with the pressure of meeting the instant demands of customers. Several industry giants have come up with the latest technology-driven apps that can enhance the customer experience (Shi & Lewis, 2021). Companies can provide information about what customers want, such as personalized ads or markdown alerts with A.I. Meanwhile, with A.I., fashion brands strive to put customization at the forefront of their customers' buying process; for example, Fashion Box, provided by Stitch Fix23, uses a similar technique. After completing a style test, customers receive a box of recommended clothes, offering a different shopping experience than before (Decaudin et al., 2021). A.I. technologies provide personalized stylist apps with an image utility, which makes users pick products efficiently. Using these images as input, the app will recommend the best style based on the user's body type, skin tone, and preferences while keeping in mind fashion trends. Thus, algorithms can make stylish suggestions to achieve a complete look. Alibaba, for example, focuses on clothing generation and recommendation, showing clothing combinations on checkout pages and cross-selling (Xingxing & waikeung, 2021). Cross-selling involves actions and practices of merchandising more products and services to the prevailing consumers. Using cross-selling can be directed to improve the incomes obtained from consumers and sustain the relationships with consumers. The approach to the procedure of cross-selling can be varied. MACTY with A.I. can help inspire users to consider what to wear and how to match them by automatically creating the perfect look.

Benefits of A.I. for Fashion Industry

1. Increased Sales

The artificial intelligence model is used to detect the results of clothing attributes.

Figure 1: Fashion attributes of 16 clothes of Dolce and Gabbana

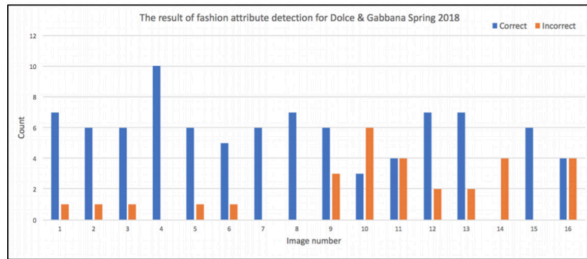


Image sourced from Shi, M., & Lewis, V. (2021).

Using Artificial Intelligence to Analyze Fashion Trends. Retrieved June 17 2021, from <https://arxiv.org/abs/2005.00986>

This figure shows the fashion attributes of 16 designs of Dolce & Gabbana that were analyzed statistically. The statistical examination of the fashion attributes generated from the 16 designs in Dolce & Gabbana implies that 75% of the projection performed by the AI model is correct, and 25% projection is not correct (Shi & Lewis, 2021). The results partially support the hypothesis that the proposed A.I. model can create correct fashion attribute designation from explored regions in the displays. A.I. can identify the detailed attributes of fashion products and know-how to find similar products based on simple words provided by customers (Kellet, 2018). In addition, it can accurately recommend fashion products based on the observation of customers and trends. Whether it is the streaming of videos or fashion, personalization is the fundamental to commercial success (Shi & Lewis, 2021). The level of personalization contributes to increased sales. Thanks to the significant data revolution, a huge amount of user information is waiting to be mined and scrutinized (Xingxing & waikeung, 2021). Zara is a good example. As the famous short sell brand, following fashion contributes to the selling volume and success of ZARA. There are numerous variables that have led to Zara's prosperity, but one of its most important traits, which has helped it become the worldwide fashion giant it is currently, is its capacity to put consumers first. Consumers are infatuated with Zara, and they have shaped the corporation's and brand's ethos from its inception

(Shi & Lewis, 2021). Zara sells apparel for males and females, as well as children's clothing, footwear, and extras. Zara TRF is a sub-brand for young ones and teens that provides swankier and occasionally edgier goods.

2. Enhanced Service Quality

Looking for technologically advanced solutions can help fashion companies solve more fashion problems quickly. A.I. based solutions such as A.I. intelligent assistant or image search are playing a role in companies such as ASOS, Nike, and Sephora to enhance outline customer service (Boyd, 2017). Besides, a personal virtual A.I. stylist can combine multiple artificial intelligences, including natural language processing and understanding, A.I. vision skills, and machine learning to provide services like Style Check with personalized clothing suggestions based on what is provided in the user's clothing (Decaudin et al., 2021). Meanwhile, customers could gain help anytime. In addition, the A.I. powered Chatbot can help provide a direct connection with a live human agent. Due to direct contact, customers can experience personalized services.

3. Improved Inventory Management

A.I. can make inventory predictions based on past data. Through this prediction, A.I. could tell the customer stories, and then retailers could use identity what products fit their customers. A.I. could even create a filter for their products targeting different customers. Retailers would learn about the majority of customers' behaviors, thus helping them manage inventory further (Intelligence Node, 2017). Firms can manage costs more accurately than before by understanding the inventory flow. The use of A.I. tools for demand predicting permits retailers to decrease prediction faults by up to 50% while reducing stock by 20% to 50% (Standish et al., 2018). Retailers use artificial intelligence to increase inventory turnover and work together to optimize experiences and business forecasting.

4. Reduce Workforce Through Automation

According to the World Economic Forum projection, in a change likely to exacerbate disparity, half of all manual tasks will be operated by machines by 2025 ((The Economist, 2017). A distinct report from the Massachusetts Institute of Technology projects indicates that AI can replace more than two

million laborers in the manufacturing sector by 2025 (Shi & Lewis, 2021). Farfetch, for example, the world's top virtual marketplace for luxury goods, is supporting A.I. among Farfetch's associates (1,500 beauty shops and more than 200 brands) to achieve automation in its supply chain by linking its online inventory to in-store inventory and offering services such as click-and-collect, and in-store returns (Intelligence Node, 2017).

5. Reduced Return Cost

According to Kellet (2018), returns are a challenge for the fashion industry and add to operating costs. A.I. provides personalized service in terms of selling products; thus, customers have less probability of buying clothing they are unsatisfied with. In turn, A.I. reduces returns and increases consumer satisfaction. Otto, Germany's biggest virtual merchant of end-consumer fashion and routine products uses a profound knowledge algorithm to forecast with 90 per cent correctness what consumers will purchase before placing an order (The Economist, 2017). In general, the application of A.I. in the supply chain can also help reduce click-to-ship cycle times and dropout rates (Weiß, 2016).

A.I. inventions could also play a part in textile production once the clothes are designed. Fashion producers are revolutionizing artificial intelligence to aid develop the efficiency of the production process and increase human fabric staff. Artificial intelligence structures are utilized to identify imperfections in the fabric and guarantee that the color of the completed fabric matches the basic design. Artificial intelligence developments such as computer vision make the value assurance procedure simpler.

DISCUSSION

In the past only giant e-commerce companies like Amazon had the capacity to utilize AI, however as AI has evolved it has become available to small traders who are using the advanced technology to comprehend the complex fashion market (Intelligence Node, 2017). This data may give small businesses improved sustainability. Smart, AI-powered systems can further help offer more utility to fashion products by detecting configurations and extrapolative analytics that can guide fashion trends, purchasing designs and inventory-associated issues to (Kellet, 2018). One business at the front of A.I. modernization in fashion is

a virtual private fashion service. The business practices machine-learning algorithms to offer a better consumer experience and improve supply chain efficiency. Machine learning developments are also being used to speed up logistics and improve the efficiency of supply chains. A.I. is being utilized to regulate and improve supply chains and decrease transportation expenses and times.

According to Kellet (2018), computer vision, achieved through machine learning, is also utilized to aid identify fashion replicas and counterfeits. Previously, recognizing fake goods needed eyes trained by specified customs or other law enforcing agencies. Today, A.I. structures can constantly watch fake products that increasingly look like the real thing. In this area, Customs and Border Enforcement is applying artificial intelligence technology to help pinpoint the effectiveness of high-end products that are often fabricated, such as wallets and sunspecs.

Due to A.I., the fashion industry has changed its working style in terms of selling, design, customer service, and supply chain. A.I. shifted the workforce to automation, improving product efficiency, inventory management, and reducing costs (Kellet, 2018). In addition, virtual technology can help the designer see the end result of their work before it has been created. Therefore, the designer could track the fashion trend based on the A.I. prediction. Based on these changes, A.I. creates significant profits in the fashion industry (Laaziz, 2020).

Although A.I. is a powerful technology, it still has some drawbacks as it applies to the fashion industry. At present, A.I. is not very mature in segmentation technology. The A.I. structure can only detect basic clothing classifications, such as ties, bags, and umbrellas (Fashionpedia, 2019). A better artificial intelligence algorithm is required to detect fashion elements with greater precision. At present, from the perspective of the research frontier, the improvement of artificial intelligence algorithms is still very promising (Shi & Lewis, 2021). Furthermore, because of the deficient geographic and ecological data images, the recommended A.I. approach cannot explore unexpected or interesting trends (Shi & Lewis, 2021).

CONCLUSION

From providing personalized advertising notifications to customers, reminding them of cut prices, eliminating their questions or queries via chatbots, and becoming personal stylists and offering instant clothing advice, fashion brands can leverage A.I. to enhance customer experience (Kellet, 2018). Based on the results of this investigative study, the recommended A.I. structure is considered capable of detecting fashion elements from images with a certain level of precision (about 75%) (Weiß, 2016). In conclusion, A.I. has some benefits in the fashion industry; first, it can ease professional fashion's commercial and ecological burden on corporations and establishments. In addition, artificial intelligence can benefit trend-forecasting corporations and fashion entities to function more efficiently (Fashionpedia, 2019).

Since A.I. can act as both a designer's design assistant and a consumer's personal stylist, the technology's impact changed the fashion industry and brought a significant profit (Luce, 2019). However, the use of A.I. in fashion design and creation also raises specific copyright issues: who owns the copyright to the work made by the machine? In the United States, fashion designs created using artificial intelligence have no explicit copyright protection under U.S. law. Other countries outside the U.S., such as the UK, India, Hong Kong, Ireland, and New Zealand, are more flexible, with rules that grant copyright to people who write A.I. programs (Ford et al., 2018). This discussion shows that there are still many issues to be solved, but integrating artificial intelligence and human expertise in the fashion industry seems promising. However, taking this path also requires supporting A.I. approaches that properly manage the diffusion of A.I. technologies to ensure that A.I. systems will be people-centered, to improve personal and social well-being, and worthy of our trust.

Although the A.I. model is not perfect in the fashion industry, it should still be developed to improve accuracy prediction, segmentation technology and diversity. The advent of trendsetting technology, A.I., has changed the way companies execute their processes and the discussion we had proved that the clothing industry is no exception (Fashionpedia, 2019). The application of artificial intelligence to the fashion industry suggests that we should not see the future of work replaced or superseded by technology, but rather the complementarity of man and machine

(The Economist, 2017). With most prominent fashion brands already taking advantage of the benefits and applications of A.I., there is no denying that A.I. technology will soon become mainstream for midsize companies and startups. So today is the right time for apparel companies that have not yet planned to adopt A.I. to plan and start their digital transformation journey. After all, no organization wants to be left behind in the digital race. Smarter machines and smarter people can complement each other, creating masses of bespoke products and services: a world of new craftsmen (Shi & Lewis, 2021). The fashion industry can play a leading role in this process.

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