The New York University Integrative Psychology Review

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Acknowledgements

The New York University Integrative Psychology Review would like to thank its administrative director, Dr. Andrew Hilford, and its faculty advisor, Dr. Lawrence Ian Reed for their contributions.

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Statement of Purpose

The New York University Integrative Psychology Review (NYU IPR) is a publication seeking to help students across all disciplines work together under the umbrella of psychology by providing a peer-reviewed platform that fosters a collaborative learning environment. Psychology is an incredibly interdisciplinary field, and we believe that it deserves a forum that exemplifies this diversity.

NYU IPR aims to empower undergraduate students of all disciplines and fields to engage in both empirical research and literature review and facilitate discussion and inquiry within the domain of psychology. We believe that creating a strong foundational framework of research literacy and collaboration across multiple disciplines and fields of study at an undergraduate level is critical to foster a truly comprehensive understanding of psychology and its applications for future generations of researchers and academics.

Preface

Welcome to the 3rd issue of the New York University Integrative Psychology Review!

It seems hard to believe that the 3rd edition of the NYU IPR is already here! Like most three-year-olds, it's found its legs and is off and running! Following on the achievements of the two previous editions, the hope is that the articles found here (the result of long hours and hard work) will inspire, educate, and challenge. A key component of the fuel that motors progress is the acquisition and exchange of new ideas and findings. As such, you can expect that the articles appearing in the pages ahead will be thought-provoking and intellectually invigorating, and, because of this, generate novel insights and prompt new questions.

So, welcome to the 3rd issue of the NYU IPR. Onwards.

Andy Hilford

Associate Director of Graduate and Undergraduate Studies, Psychology | New York University

Note from the Editors-In-Chief

Dear readers,

We are thrilled to present the first edition of the second volume of the New York University Integrative Psychology Review. This edition is the result of months of work from authors, our staff editors and faculty mentors throughout the past year.

We are delighted to have the opportunity to publish this review. This edition features twelve budding researchers who have worked to produce the featured empirical research and literature reviews.

With this new year, we are beyond excited to see what else these scholars will produce, and look forward to continuing the tradition of learning, sharing, and growing this field of study.

We hope that NYU IPR inspires undergraduate researchers to continue pursuing their passions for psychological investigation, and we look forward to producing future editions in the years to come.

Sincerely,

Sanjana Dixit   Samantha J. Gordon
Founder and Co-Editor in Chief   *Co-Editor in Chief*

Muted Affect, Amped-Up Volume: Reduced Music-Evoked Fear Responses in Psychopathy

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Abstract

It is widely observed that music can induce emotions in listeners, but little is known about the underlying mechanism. We may begin to explore relationships between personality traits and emotional responses to music by comparing subpopulations — such as those with psychopathic tendencies — to that of the general population. Psychopathy is characterized by a lack of empathy, and tends to be accompanied by diminished fear and anxiety. As such, we hypothesize a difference in emotional response between our control group and individuals who score highly on tests of psychopathic tendencies such as the Dark Triad Dirty Dozen Test (DTDD) and the Levenson Self-Report Psychopathy Scale (LSRP). In an experiment with 944 undergraduate students, where we exposed them to music and recorded the emotions they report in response, we found significant negative correlations between music-evoked anxiety and both LSRP and Dark Triad Psychopathy specifically, implying indeed reduced emotional responses and affect in individuals with psychopathic traits. We posit that this relationship could account for the differences in music preferences in individuals with psychopathic traits.

Introduction

Music evokes strong emotions (Schaefer, 2017). This pertains to both music-specific emotions such as chills (de Fleurian & Pearce, 2021), basic emotions such as joy (Juslin & Västfjäll, 2008) as well as emotions mediated by music, such as nostalgia (Barrett et al., 2010; Sedikides et al., 2022). In addition, we know much about the physiological mechanisms underlying these responses (Baltes et al., 2011) as well as the fact that music genuinely induces these emotions - listeners are not simply recognizing or perceiving the emotions inherent in the music (Scherer & Zentner, 2001). However, less is known about individual differences in response to music and their underlying mechanisms (Baltes & Miu, 2014). There are many issues when trying to link

music-evoked emotions to personality characteristics in a differential fashion. One promising avenue is to contrast emotionality in subpopulations with known differences in emotional processing with the general population. One such condition is Psychopathy.

Psychopathy is characterized by lack of empathy and shallow affect, in addition to antisocial tendencies such as pathological lying and manipulativeness (Kiehl & Hoffman, 2011). Whereas individuals with psychopathic traits exhibit particularly severe lack of social emotions, such as shame, guilt, remorse, or regret (Hare, 1998), it is also known that they tend to have diminished anxiety and fear responses (Marsh et al., 2011).

Unfortunately, the antisocial tendencies of individuals high in psychopathic traits make the diagnosis of Psychopathy challenging. For instance, instruments like the Levenson Self-Report Psychopathy Scale (LSRP, Levenson, Kiehl, & Fitzpatrick, 1995) rely heavily on the veracity of the self-reports provided by individuals. In cases of Psychopathy, we can not rely on the integrity of these reports. This problem is not contained to the LSRP. Other measures, like the Dark Triad Dirty Dozen (DTDD; Jonason & Webster, 2010) that attempt to situate Psychopathy in the context of other "dark personality" traits such as Narcissism and Machiavellianism suffer from the same problem. Of course, individuals with Psychopathy also exhibit a diminished physiological response, e.g., skin conductance response to distressing stimuli (Hare, 1978). However, eliciting such physiological responses is not a practical diagnostic path in most situations, as measuring such responses requires advanced sensory and signal processing equipment. In addition, this apparatus is rather cumbersome and prone to motion artifacts, it only works in highly artificial and contrived situations. Moreover, the kind of autonomic physiological responses measured in this way are not sufficiently specific - other conditions, such as arthritis (Geenen et al., 1996), damage to the limbic system (Lee et al., 1988) or Parkinson's Disease (Sommeraurer et al., 2015),

among others, also exhibit altered and diminished physiological responses.

Here, we wonder if Psychopathy manifests in terms of music-evoked fear. Specifically, we hypothesize and predict - in light of the known literature - that individuals high in psychopathic traits will exhibit diminished fear in response to music.

As individuals with high psychopathic traits are good at masking these traits (Cleckley, 1951) - making this condition particularly hard to understand and detect - developing behavioral probes that do not solely rely on self-report are particularly important and valuable.

Method

Participants

We recruited undergraduate students at New York University who participated in the study for course credit. To ensure sufficiently high statistical power (Wallisch, 2015), a total of 944 participants (605 female, 293 male, 46 nonbinary or not disclosed) completed the study. To ensure that this sample yields a sufficiently high power to detect effects, even if they are subtle (Wallisch, 2015), we performed a power analysis with G*Power for correlation and regression analyses, see Figure 1 (Faul et al., 2007).
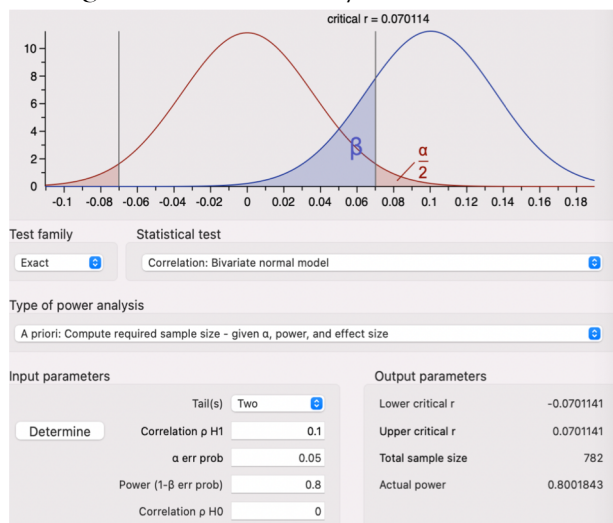
Figure 1: Power analysis with G*Power. Given that the emotions evoked by a brief stimulus can be expected to be subtle, we wanted to ensure that we are able to detect such an effect, if it should exist. Thus, we assumed a small effect size of 0.1, corresponding to a coefficient of determination of 0.01,

given commonly accepted levels of alpha (Fisher, 1925) and beta errors (Cohen, 1992). Under these assumptions, we determined that a sample size of 782 participants would yield a power of 80%. Therefore, we conclude that our sample is indeed adequately powered to detect the minimal effect size we are interested in.

Psychological Measures

In this study, we used two instruments: The Dark Triad Dirty Dozen Test (DTDD) and the Levenson Self-Report Psychopathy Scale (LSRP) to measure psychopathic tendencies. The rationale for using both is that whereas they both purport to measure the same construct and correlate highly, they do probe different facets of the condition (Bulajic et al., 2022). In addition, the DTDD yields additional metrics - Machiavellianism and Narcissism - that will allow us to determine specificity - is a diminished fear response specific to Psychopathy or a feature of Dark Triad personality traits (Furnham et al., 2013) in general? Additionally, we compute a metric of fear evoked responses by averaging the fear responses to all musical pieces across a participant.

Dark Triad Dirty Dozen Test

The DTDD is a 12-item personality inventory that consists of three subfacets: Machiavellianism, Narcissism and Psychopathy (Jonason & Webster, 2010). Participants rate each item on a 7-point Likert scale, with 1 representing strong disagreement and 7 strong agreement. Despite the brevity of the test, the DTDD is considered to be reliable and valid (Jonason & Webster, 2010).

Levenson Self-Report Psychopathy Scale

The LSRP measures psychopathic tendencies by participant responses to 26 questions on a 5-point Likert scale (Levenson et al., 1995). The LSRP supposedly consists of two underlying facets - primary and secondary Psychopathy, with primary Psychopathy referring to lifestyle choices and secondary Psychopathy to emotional responses (Vaughn et al., 2009). The

LSRP is considered a reliable and valid instrument and routinely used for assessment of psychopathic tendencies in the general population (Bowling, 2005; Brinkley et al., 2001; Falkenbach et al., 2007; Fritz & Lim, 2018; Gummelt et al., 2012; Henrich et al., 2010).

Music-Evoked Emotional Responses

Each participant listens to a set of 400 brief - 7 second long - excerpts from songs (both popular and obscure) selected to cover a wide range of musical styles, including jazz, rap, rock, pop, electronica, r&b, world music, as well as country and classical music. For each of these 400 music pieces - presented in randomized order to avoid order effects - that a given participant listens to, we asked whether their experience evoked anxiety. Participants report their experience via a check box (that is either clicked or not). When piloting this experiment, we realized that participants would readily report their emotional states with these checkboxes, but were reluctant to do so with sliders that they could adjust. Importantly, this assay promises to tap into a specific, currently present emotional state, in contrast to global assessments of mood one sees in self-report questionnaires (e.g., "sometimes I feel a little anxious"), which are hard to interpret and assess. Moreover, we want to note that we do not make a distinction between fear and anxiety here. Whereas these emotions are distinct (Rosen & Schulkin, 1998; LeDoux & Pine, 2016), it is also known that individuals with psychopathic traits would not make that semantic distinction (Hancock et al., 2013), so we use these terms synonymously here. We compute "music evoked anxiety" (MEA) as the proportion of checkboxes a given participant clicked, out of the 400.

Procedure

Once participants arrived for the experiment, they confirmed informed consent. They then were walked through the scope of the study and began the study by first answering a biodata questionnaire consistent across all

participants. Then participants completed the study by filling in the self-report measures on Psychopathy and emotional responses evoked by clips of music; questions were randomized across participants. These tests were designed by the lab and recorded using MATLAB. Afterward, they were debriefed as to the purpose of the study. For the duration of the study, participants sat alone in the testing room with the computer and the study on full screen. Participants had unlimited time to answer each question, however the study took on average two hours to complete. The IRB at New York University (UCAIHS) approved all procedures.

Data Analysis

Recorded data were analyzed using the methods above by computing Spearman correlation coefficients of music-evoked fear responses and the LSRP and each facet of the DDTD (DD Psychopathy, DD Machiavellianism, and DD Narcissism). Data were analyzed using MATLAB 2019b (Mathworks, Natick, MA).

Results

What is the relationship between Psychopathy and music-evoked fear?

The central prediction of this hypothesis was that individuals with psychopathic traits would exhibit diminished fear in response to music. In order to determine whether Psychopathy measures and music-evoked fear were correlated, we first examined the distribution of anxiety-evoking songs in the sample (See Figure 2).
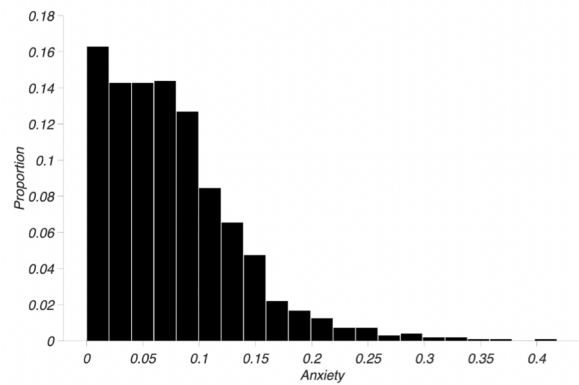
Figure 2: *Histogram of the proportion of the sample with a particular degree of music-evoked anxiety.* The x-axis indicates how much anxiety was reported by individuals in our sample. For instance, the most extreme value represents one individual who experienced anxiety in response to 40% of the clips. The y-axis denotes what proportion of the sample falls within a given bin, out of 21.

We then examined the distributions of Psychopathy scores in the sample using scores of the LSRP and the DTDD facets (DD Psychopathy, DD Machiavellianism, and DD Narcissism). Figure 3 below shows the distributions.
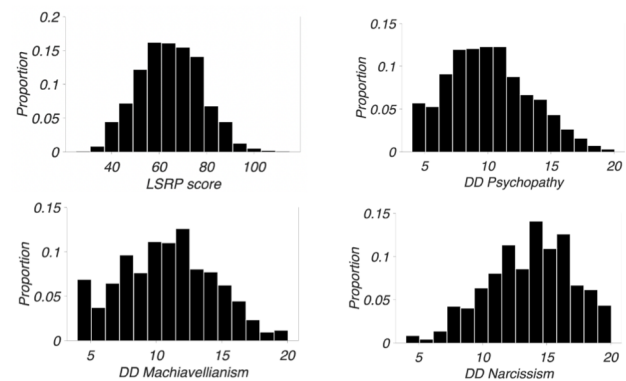
Figure 3: *Histograms of the proportion of the sample as a function of LSRP and Dirty Dozen scores.* The x-axis denotes, upper left panel: LSRP score, upper right panel: Dirty Dozen Psychopathy score, bottom left panel: Dirty Dozen Machiavellianism score and the lower right panel: Dirty Dozen narcissism score, respectively. The y-axis indicates the proportion of the sample with these scores.

Finally, we investigated four correlations between the music-evoked anxiety scores and LSRP Psychopathy, DD Psychopathy, DD Machiavellianism, and DD narcissism (see Figure 4).
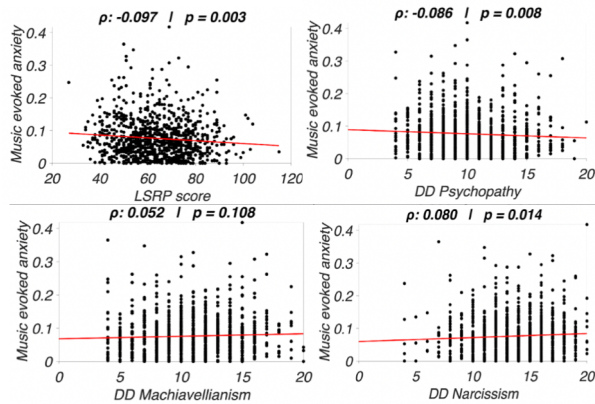
Figure 4: *Scatterplots between condition scores and music evoked anxiety.* The x-axis denotes, upper left panel: LSRP score, upper right panel: Dirty Dozen Psychopathy score, bottom left panel: Dirty Dozen Machiavellianism score and the lower right panel: Dirty Dozen narcissism score, respectively. The y-axis indicates the degree of music-evoked anxiety reported by a given participant. Each black dot represents a participant. The red lines represent the best fit lines using least squares regression.

For the sample, the scores on the LSRP (M = 64.1, SD = 13.2) and music-evoked anxiety (M = 0.076, SD = 0.0602) were negatively and significantly correlated, $\rho(942)$ = -0.097, p = 0.003. The Dirty Dozen Psychopathy scores (M = 10.2, SD = 3.09) and music-evoked anxiety (M = 0.076, SD = 0.0602) were also negatively and significantly correlated, $\rho(942)$ = -0.086, p = 0.008. The Dirty Dozen Narcissism scores (M = 13.6, SD = 3.12) and music-evoked anxiety (M = 0.076, SD = 0.0602) were significantly correlated, $\rho(942)$ = 0.08, p = 0.014. Dirty Dozen Machiavellianism (M = 10.9, SD = 3.38) and music-evoked anxiety (M = 0.076, SD = 0.0602) were not significantly correlated $\rho(942)$ = 0.052, p = 0.108.

Discussion

In this study, we found that MEA is negatively and significantly related to psychopathic traits, as measured both by LSRP and DD Psychopathy. This finding is consistent with our hypothesis that individuals with Psychopathic traits would exhibit a diminished fear response, as shown in other domains. To our knowledge, this is the first time such a pattern has been established for the response of psychopathic individuals to music. In addition, this tendency is

specific to Psychopathy - a diminished MEA is not a feature of dark triad personality in general, as there is no relationship between MEA and Machiavellianism, and a - weak but significant - positive one between MEA and Narcissism, consistent with the insecurity-based account of Narcissism provided by Kowalchyk et. al. (2021).

We note that whereas this trend is statistically significant, it is not strong on the level of the individual. However, this is not surprising, given the subtle intervention (brief excerpts) and the fact that the emotions evoked by a given music piece are determined by many factors, including nostalgia and specific experiences and preferences. Yet, we were able to detect this effect, highlighting the critical importance of well powered samples (Wallisch, 2015).

Another limitation consists in the fact that - due to the ongoing Coronavirus pandemic - we were restricted to NYU students as the sample. This immediately suggests an avenue for further exploration. First, it is important to validate these findings in a more representative sample of the community at large, in particular with respect to a broader range of age and educational background.

In addition, when doing so, it might be instructive to assess whether this pattern is specific to MEA or other emotions as well, in other words, what is the signature of music evoked emotional responses in individuals with Psychopathy more generally. We propose to do so here. Finally, we posit that these findings might shed light on the musical preferences of individuals with Psychopathy more generally. Anecdotally, we found that such individuals are prone to preferring more intense music that evokes anxiety in the general population. If psychopathic individuals do not experience this anxiety, they might prefer such music.

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The Bidirectional Relationship Between Oxytocin and Maternal Behavior: A Review on the Current Literature

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Abstract

This paper will focus on the positive feedback loop that underlies the bidirectional relationship between oxytocin and maternal behavior: engagement in maternal behavior increases serum oxytocin levels, and conversely, increased oxytocin levels correspond to increased maternal behaviors (Yoshihara et al., 2017). In some cases, it has been observed that an increase in oxytocin levels upon engagement in maternal behavior is dependent upon attachment classification styles (Strathearn et al., 2009). Additionally, studies among non-biologically related mothers and infants, along with cross-fostering studies on rats, showed that a biological connection is not necessary and generic engagement in maternal behavior is sufficient to elicit increased oxytocin levels (Bick et al., 2013; Bick et al., 2010). In addition, the modification of oxytocin levels in either direction can adjust the corresponding maternal behavior (Kendrick et al., 1987). Therefore, increased oxytocin levels lead to increased maternal behavior, and conversely, decreased level of oxytocin corresponds to decreased maternal behavior (Champagne et al., 2001).

Introduction

Oxytocin, a small yet potent neuropeptide, coordinates processes central to human reproduction and human evolution (Cardaillac et al., 2016). Oxytocin is a a cyclic neuropeptide made of nine amino acids and is produced in the brain. Oxytocin has well-characterized functions in both the peripheral reproductive tissues and the central nervous system (Churchland et al., 2012). Oxytocin has a distinguished past in the biological science field because it was the first peptide whose chemical structure was determined and produced in a lab, a feat that earned the researchers that conducted it a Nobel Prize in the process (Feldman et al., 2013).

The hypothalamus structure of the brain produces oxytocin, which is then transported directly to the posterior pituitary and released into the bloodstream, according to more recent neuroanatomical research (Evans et al., 2014).

Beginning in the late 1970s, pharmacological research demonstrated that oxytocin had a role in orchestrating several maternal behavioral modifications required for the survival of the offspring (Feldman et al., 2013). Since then, it has become clearer that not only is this the case, but also that oxytocin serves various other purposes in the brain, controlling a range of social behavior (Rilling et al., 2014).

A growing body of literature illustrates that from the early stages of infancy to the early stages of childhood, oxytocin mediates the maternal-child bond (Feldman et al., 2013). Moreover, this bond seems to not be limited to specifically just humans; aspects of similar actions that mimic maternal behavior have been observed across the animal kingdom (Bick et al., 2010). Based on the extent that the topic has been observed, and the current research regarding it, engaging in maternal behavior might not be possible without the secretion of oxytocin in

humans and animals.

This paper will explore the nature of the relationship between oxytocin and engagement in maternal behavior. It will first analyze the bidirectional relationship between oxytocin and maternal behavior and how one enables the other, and subsequently discuss the potential underlying mechanisms that facilitate this relationship. Following this, the results and conclusions of the studies presented will be discussed, leading to how this research surfaces other unanswered questions in the field and possible experiments that would provide a new framework for understanding the maternal-child bond.

The Bidirectional Relationship Between Oxytocin and Maternal Behavior

Research has shown that there is a positive correlation between levels of oxytocin and maternal behavior and has revealed more insight into the nature of this relationship (Yoshihara et al., 2017) as well as its bidirectional causal pathway. Essentially, an increase in one leads to an increase in the other (Feng et al., 2019). A study where the oxytocin level of high and lowlicking/grooming arched-back nursing behavior of mothers (LG/ABN) was measured (Champagne et al., 2001)) is a good illustration of this relationship. It highlighted its bidirectionality because it emphasized how difficult it is to analyze the order of which comes first in that relationship (e.g., the chicken versus the egg) . LG/ABN reflects mothers' maternal behavior towards their offspring, categorized as high or low, to describe the extent to which they engage in these actions. As a result of the study, they found that mothers with low LG/ABN mothers have lower oxytocin levels compared to those of mothers with highLG/ABN(Pedersen et al., 2002).

Various studies have been conducted to observe the change in oxytocin levels upon engagement in maternal behaviors. In humans, it has been observed that the mother's plasma oxytocin levels increase after a play interaction between the mother and her infant (Scatliffe et al.,

2019). Similar results have been found in rats, where a physical interaction between the mother and her pup leads to increased oxytocin levels in the rat mom (Nagasawa et al., 2012; Neumann I et al., 1996). However, in some cases, it has been observed that an increase in oxytocin levels upon engagement in maternal behavior is dependent upon attachment classification styles. To demonstrate that engaging in maternal behaviors increases oxytocin levels, one study aimed to measure the release of peripheral oxytocin levels in response to infant cues based on the mother's attachment style. The Adult Attachment Interview (AAI), a regularly cited metric which measures the mother's capacity to form secure attachment relationships, was used to assess the mother's attachment styles. After viewing infants' faces, researchers observed that the serum oxytocin levels increased in secure mothers when observing their own infant's faces compared to controls. Contrastingly, in insecure mothers, these serum oxytocin levels did not increase. Instead, insecure/dismissing mothers showed avoidance or rejection of negative infant cues. This finding suggests that infant cue-induced serum oxytocin levels in mothers are dependent on attachment style. While there is an increase in oxytocin levels upon engagement in maternal behaviors, there is some subtle nuance in the condition in which it happens (Strathearn et al., 2009).

In addition to the attachment classification styles, this increase in oxytocin levels raised the question of whether the increase in oxytocin level was due to the biological connection between the mother and her infant or whether it was purely due to engaging in any maternal behavior. In light of this, studies examining the connection between maternal behavior and oxytocin release among non-biologically related mothers and infants were conducted. They aimed to test the extent to which a biological connection is necessary for oxytocin to mediate the effect of maternal behavior. In one study, after a physical interaction between the mothers and the foster infants, scientists measured the oxytocin production and feelings of delight in those foster mothers (Bick et al., 2013). As a result,

they observed that the mothers' oxytocin production increased after the cuddle interaction with their foster infants. Furthermore, foster mothers' oxytocin production was positively associated with their feelings of commitment and behavioral delight toward their foster infants.

Likewise, a similar effect has been observed in rats; a biological connection is not necessary for oxytocin to mediate the effect of maternal behavior. A cross-fostering rat study analyzed the oxytocin production of high LG/ABN mothers when they were given a new set of pups to care for. They measured the oxytocin levels when the high LG/ABN mother and her foster infant interacted. As a result, they observed an increase in high LG/ABN mothers' oxytocin production upon engagement in maternal behavior with their foster pups (Bick et al., 2010). Therefore, this study supports the claim that a biological connection is not required to elicit increased oxytocin levels. Generic engagement in maternal behavior appears to be sufficient to do so.

Furthermore, at least in mice, it has been observed that those with higher levels of oxytocin receptors in the brain positively correlate to high LG/ABN mothering conditions, thereby establishing the positive relationship underlying the genetic predisposition to higher oxytocin levels which leads to higher maternal behavior (Champagne et al., 2001). Thus, altering oxytocin levels in either direction can also modulate the corresponding maternal behavior.

In a study, the maternal behavior of ewes was recorded after the intracerebroventricular infusions of oxytocin. As a result, the infusion of oxytocin increased the frequency of the maternal behaviors scored (i.e., sniffing, licking, low-pitch bleats, and following the lamb), and three ewes allowed suckling attempts. Additionally, aggressive (i.e., head butts) and negative (i.e., withdrawal from the lamb) behaviors significantly decreased in frequency. In fact, it was observed that ewes spent significantly more time near a lamb in a cage following the infusion of oxytocin (Kendrick et al., 1987).

Similarly, in another study, a rapid induction of maternal behavior in rats after intracerebroventricular administration of oxytocin was observed. As a result of the oxytocin administration, licking/grooming, approaching, and sniffling behaviors significantly increased in rat mothers. Also, as mothers spent more time with their pups, aggressive behaviors decreased significantly (Mogi et al., 2011). Furthermore, in another experiment, they recorded the maternal behavior of virgin rats after the infusion of oxytocin (Pedersen et al., 1979). As a result, they observed that the infusions of oxytocin-induced full maternal behavior within pup exposure, supporting the claim that an increase in oxytocin levels leads to the engagement of maternal behaviors between mothers and pups.

Another study measured mothers' engagement in maternal behaviors with their infants before and after administering oxytocin. As a result, after the infusion of oxytocin, physical interactions between the mother and her infant increased, and mothers spent more time with their infants (Gordon et al., 2010). Likewise, in humans, increased oxytocin levels lead to an increase in maternal behaviors.

Additionally, since increased oxytocin levels correspond to increased maternal behavior, it can be theorized that the reverse is true: decreased oxytocin levels correspond to decreased maternal behaviors. In humans, it has been shown that neglectful mothers have lower measures of parental warmth associated with maternal neglect (Strathearn et al., 2011). This relationship could be affiliated with oxytocin levels. However, no studies have directly tested this claim. A rat study examined the functional link between differences in oxytocin receptor levels and maternal behavior by infusion of an oxytocin receptor antagonist (ORA) into pup mothers (Francis et al., 2000). As a result, on day three postpartum, the ORA treatment significantly reduced the observed frequency of maternal licking/grooming in High, but not Low, LG-ABN mothers, suggesting that decreased oxytocin corresponds to decreased maternal behavior at least in high LG/ABN

mothers.

The studies presented in this section demonstrate a positive feedback loop that underlies the bidirectional relationship between oxytocin and maternal behavior: Engagement in maternal behavior increases serum oxytocin levels, and conversely, increased oxytocin levels correspond to increased maternal behaviors.

Dopaminergic Pathways Mediate Oxytocin-Induced Maternal Behavior

Even though the bidirectional relationship between oxytocin and maternal behavior is well characterized, the mechanisms underlying this positive feedback loop still need to be clarified. However, a growing body of evidence suggests that the facilitation of maternal behavior by oxytocin might be mediated through the dopaminergic reward pathways (Inoune et al., 1994; Hung et al., 2017; Shahrokh et al., 2010; Febo et al.,2001; Tribollet et al., 1988; Veinante et al., 1997).

Oxytocin signaling has been shown to mediate maternal behavior through the ventral tegmental area (VTA), the preoptic area (mPOA), and the nucleus accumbens (nAcc), three brain regions that have been observed to be involved in the dopaminergic reward pathway signaling (Inoune et al., 1994). A study was conducted where they provided novel evidence for the direct effect of oxytocin at the ventral tegmental area (VTA) and in the nucleus accumbens (nAcc). They used in vivo voltammetry to examine the effects of intra-VTA oxytocin infusions on dopamine signals recorded in the nAcc shell. The results revealed increased dopamine signaling in response to the oxytocin infusion (Hung et al., 2017). Also, variations in pup LG among rat moms are associated with differences in the dopamine signal in the nAcc shell. The magnitude of the increase in the dopamine signal in the nAcc is strongly correlated to the duration of the pup LG bout. High LG mothers showed increased oxytocin receptor binding in the preoptic area (mPOA), suggesting greater sensitivity to

oxytocin. Additionally, the difference between the levels of increased dopamine signaling, in the nAcc, in high LG compared with low LG mothers was abolished with an intra-VTA infusion of an oxytocin receptor antagonist, thereby showing that under normal conditions, the increased dopamine signal in the nAcc of the high LG mothers is oxytocin dependent (Shahrokh et al., 2010). Therefore, these findings show that individual differences in maternal behaviors are associated with variations in the mesolimbic dopamine system's activity during mother-pup interactions (Shahrokh et al., 2010).

Likewise, Febo *et al.* used functional magnetic resonance imaging of the rat moms to determine whether oxytocin modulates brain activity upon postpartum dams receiving suckling stimulation. As a result, suckling from pups increased the BOLD signal in the VTA and nAcc, suggesting the association between engaging in maternal behaviors and activating dopamine-sensitive pathways. Also, the blockage of the oxytocin receptors with OTA led to attenuated positive BOLD responses to suckling at the VTA and accumbens compared to the response before the antagonist. They also observed that the administration of oxytocin-activated accumbens suggests that this neuropeptide induces the release of dopamine within this region. However, the evidence of oxytocin receptor density in the accumbens has been inconsistent. Thus, it is highly possible that suckling may be mediated indirectly through the VTA and/or mPOA (Tribollet et al., 1988; Veinante et al., 1997).

Furthermore, since dopaminergic pathways mediate oxytocin's effect on maternal behavior, there may be a direct relationship between maternal behavior and dopamine signaling. To test this claim, a study was conducted where females were continuously infused with dopamine antagonists at the VTA throughout the peri parturitional period and afterward given either a brief interaction period with pups or no interaction with pups. Eighter the D1-like antagonist or the D2-like antagonist was given to the females. The dose of both dopamine

antagonists resulted in a significant attenuation of maternal care immediately postpartum. Also, seven days later, when retention of the maternal behavior was tested, only females who were exposed to the D2 antagonist showed a delayed response to show complete maternal behavior towards donor pups; therefore, both dopamine receptor subtypes were crucial for the rapid and complete expression of maternal behavior. Only the D2 receptor subtype seems to be involved in the retention of this behavior during the early postpartum period (Byrnes et al., 2002).

Although various mechanistic studies in rodents demonstrated that maternal bonding is dependent upon dopamine transmission, the mechanisms of this relationship in humans have not been described so far. Therefore, to garner more insight into the relationship between maternal behavior and reward circuitry in humans, a study tested the role of central dopamine in human bonding. They applied a combined functional MRI-PET scanner to probe mothers' dopamine responses to their infants. As a result, the dopamine signaling of the mothers increased upon engagement in maternal behavior (Atzil et al., 2017). Therefore, these data indicate that dopamine could be involved in mother-infant bonding. The complexity of human bonding patterns cannot be fully captured in nonhuman animal models. Therefore, by providing the initial evidence of the neurochemistry of social bonding in humans, this study is a good platform for future investigations on human bonding.

Conclusions/Future Directions

To reveal the mechanisms underlying the positive feedback loop between oxytocin and maternal behavior, it has been shown that the facilitation of maternal behavior by oxytocin is mediated through the dopaminergic reward pathways (Inoune et al., 1994; Hung et al., 2017; Shahrokh et al., 2010; Tribollet et al., 1988; Veinante et al., 1997). It has been shown that oxytocin signaling mediates maternal behavior through the ventral tegmental area (VTA), the preoptic area (mPOA), and the nucleus accumbens (nAcc), which are the brain regions that are involved in the dopaminergic reward pathway signaling. Moreover, studies show a direct relationship between maternal behavior and dopamine signaling (Atzil et al., 2017). Therefore, dopamine signaling of the mothers increases upon engagement in maternal behavior, suggesting that dopamine is involved in mother-infant bonding (Gordon et al., 2010).

However, there are still many unanswered questions regarding the relationship between oxytocin and maternal behavior. Therefore, this section will elaborate on the unexplained aspects of this relationship and discusses some proposed experiments which can provide a new framework for understanding this phenomenon.

In human mothers, engaging in maternal behaviors causes an attachment style-dependent increase in oxytocin. However, it is still being investigated as to why there is an attachment style dependency. It has been known that there are neglectful mothers, but there is a critical lack of literature studying the reasons why they are neglectful. This raises two important questions. Firstly, does having low basal oxytocin levels in neglectful mothers lead them to be less maternal towards their children? Secondly, does having low levels of basal oxytocin in neglectful mothers decrease the amount of oxytocin that they will secrete upon engagement in maternal behaviors?

It is known that, at least in mice, there is a correlation between oxytocin levels and the magnitude of nurturing behaviors. In a study where they garnered blood samples from high and low LG/ABN rat mothers and measured the differences in oxytocin levels, they found that low LG/ABN mothers have lower oxytocin levels compared with high LG/ABN mothers (Pedersen et al., 2002). Therefore, in the administration of ORA, decreased levels of oxytocin did not affect low LG/ABN mothers because these mothers had low levels of oxytocin. If this information is extrapolated to humans, human mothers with insecure attachment classification styles have low levels of oxytocin.

Therefore, engagement in maternal behavior may not have led to a significant increase in oxytocin levels. To test this claim, a study where the serum oxytocin levels of females are measured at the early stages of life and compared to those measured after motherhood could be proposed. In this study, the serum oxytocin levels of the females at the early stages of adulthood can be collected to see if they have low levels of oxytocin to begin with, and their attachment classification styles can be measured using the Adult Attachment Interview (AAI). Then, if the participants choose to have children, the same process can be repeated after motherhood. This experiment's findings may help explain the low maternal behaviors in neglectful mothers by determining if neglectful mothers already have low levels of oxytocin, explaining their low maternal behavior.

If low oxytocin levels contribute to neglectful maternal behaviors in adulthood, then this neglectful maternal behavior is not only directed towards their offspring, but generally towards any maternal behavior. If the reverse were true, where having high levels of oxytocin pre-motherhood predisposes someone to becoming a more nurturing mother, then this is not specific to the biological infant. However, it could be adapted to infant children as well.

Moreover, to test whether there is a lower decrease in neglectful mothers' oxytocin levels compared to secure mothers upon engagement in maternal behavior, a comparison between neglectful and non-neglectful mothers based on this attachment classification style as well as a measurement of their child-carrying behavior — to measure how maternal they are —can be performed. In this experiment, after making neglectful and non-neglectful mothers engage in maternal behaviors, the rapid change in oxytocin before and after the interaction can be measured. There are two possible theoretical findings for this experiment. The first finding could be that there will be no difference in oxytocin levels, which will argue that low levels of oxytocin predisposing them make them want to engage in maternal behaviors less, even though it increased the same amount afterward. However, if the oxytocin levels

in neglectful mothers' decrease is limited, making them enjoy this process less and would provide helpful insight into neglectful mothers' biochemistry. Also, the observed less secretion of oxytocin in neglectful mothers may help to explain why they are less maternal. Either way, this experiment's findings will be novel for the field, as they will answer various unanswered questions.

Furthermore, the idea is that low levels of oxytocin in the early stages of adulthood predispose someone to become a more neglectful mother in the future. In that case, this raises the question of if and how the administration of oxytocin prior to becoming a mother will affect how neglectful of a mother that person will be in the future. To test this claim, oxytocin levels of female participants at the early stages of adulthood can be measured, and those with low levels can be administered with oxytocin. Then, if the participants have a child, their neglect patterns can be observed after birth. Likewise, parallel experiments can be performed on mice to get more causation. High LG/ABN mothers have increased levels of oxytocin signaling, and perhaps even before motherhood, their oxytocin levels can be observed. Similarly, low LG/ABN mothers will have low oxytocin levels prior to becoming mothers. Then, prior to motherhood, ORA's can be applied to high LG/ABN mothers, and its effect on LG/ABN behavior can be observed upon engagement in maternal behavior. A mouse study of this will provide more explanation to the maternal behavior observed in humans, as it shows changes in both directions of oxytocin. The potential results can be adapted into a preventative measure that can be used as a treatment to increase maternal behaviors.

Furthermore, it has been observed that there is an intergenerational transmission of maternal behavior: High LG/ABN mothers have higher levels of oxytocin receptors, and this causes them to be more maternal towards their pups. Since the way a high LG/ABN mother treats their rat pup affects the pup's neurodevelopment, the rat pup will more likely become a high LG/ABN mother in the future. Therefore, if a mother is maternal, their child is more inclined to

become a similar type of mother in the future because of how the mother cared for and raised the pup in the early stages of life. This raises an interesting question of the extent to which oxytocin mediates this transmission; perhaps behavior and culture play a larger role than we understand.

A possible observation can be made by measuring how high an LG/ABN mother is on a spectrum. If the mother is 100 on this LG/ABN scale, and the rat's pups on average are 70, this will present a clear connection between the score of how high or low the LG/ABN mother is compared to their young. This will provide an obvious first observational data set. Then upon the birth of the rats, their blood samples can be collected to measure the amount of oxytocin circulation in their blood, and when they become mothers, their oxytocin levels can be connected to how high or low LG/ABN mothers had become. On average, high LG/ABN mothers will have a greater number of high LG/ABN pups than those of low LG/ABN mothers, but that does not mean that all of their pups will be high LG/ABN. Statistically, a high LG/ABN mother will not have all high LG/ABN pups. Therefore, some of the high LG/ABN mothers' rat pups will become low LG/ABN mothers in the future. This can happen because they had lower levels of oxytocin than other rat pups with higher levels of oxytocin. This raises the question of whether this apparent correlation between the rat pups having lower levels of oxytocin compared to those with higher levels of oxytocin is a potential causative effect on explaining why one became a high LG/ABN mother and one became low. To determine whether this is administered behaviorally or biochemically, the number of interactions of grooming arched-back behaviors between the mothers and the pups can be observed via video monitors. With these monitors, one possible observation could be that the pup who got half of the interactions with its mother as the other pup did became a low LG/ABN mother while the other pup became a high LG/ABN. Therefore, using this method, the number of interactions can

be quantified between the mother and the pup, and the oxytocin levels can be observed as well. Also, as a comparison, the oxytocin levels can be altered to observe what happens in the future. Since oxytocin levels can be directly altered, this observation will give a comprehensive answer on how intergenerational transmission works and to what extent oxytocin mediates this transmission.

However, this raises a question on how to observe this relationship in humans. It is difficult to propose a human experiment because there is no universal metric to assess human maternal behavior. The major challenge is the cultural variance in defining maternal behavior. To overcome this problem simply, there should be a universal metric to assess maternal behavior. Theoretically though, and with the metrics and methodology currently available, the best way to approach this problem would be to perform experiments where twins are reared apart, and twins are reared together. This would allow us to observe if their oxytocin levels differ based on the environment in which they are raised. This experiment will likely assert that the intergenerational transmission of maternal behavior is likely due to behavioral influences from the foster mothers. The field needs to recognize its limitations. Therefore, future studies should focus more on the intergenerational transmission of humans.

Furthermore, it is already known that there is somewhat of a reliance upon the dopaminergic reward pathways on the relationship between oxytocin and maternal behaviors. This paper analyzed the mechanistic underpinnings of the bidirectional relationship. However, the only results it elaborated on are in one direction, which is how increased oxytocin levels lead to increased maternal behavior. This emphasizes how, there is very little literature about the opposite direction, where engaging in maternal behavior leads to increased oxytocin levels.

In rats, when a rat mom hears the rat pups call, it causes them to engage in maternal behaviors, leading to increased oxytocin levels.

The argument can be that upon hearing its rat pups call, the rat mom had already increased oxytocin levels. Therefore, engaging in maternal behavior is an artifact of the increase in oxytocin before even engaging in maternal behavior. The only way to test this in humans is to make them engage in various acts of maternal behaviors toward their offspring. However, the act of engaging in maternal behavior should be unprompted. Therefore, it should not be in response to infant cues but to their own will.

It has been known that oxytocin is secreted through the anterior pituitary gland, which receives input from the hypothalamus. Therefore, this experiment requires working backward, so engaging in maternal behavior needs to converge on to the hypothalamus and then to the pituitary gland. Therefore, there should be a convergence between the physical action of maternal behavior and the social centers in the brain that determines the intentionality of acting, because if an action is performed but is not directed maternally, there will not be an elucidation of oxytocin.

It has been known that oxytocin levels increase upon engagement in physical acts with infants. However, if the participants were asked to perform the same physical task on an anonymous object, there would presumably be a disconnection between their motor cortex performing these actions and the social centers in the brain that interpret this as a maternal context. To verify this, there should be a difference in the fMRI signaling because, on one, the motor cortex will light up since they are performing a physical task. On the other, the other brain regions will respond to the specific context that they are in. This observation will provide the critical answer because it will display the brain regions that are responsible for recognizing what counts as maternal behavior, and this will coordinate with other brain regions that are involved in the action to converge onto the hypothalamus to send signals to the anterior pituitary to secrete oxytocin. Additionally, to thoroughly test this mechanism, we can find the analogous brain region in mice that is conserved in mice and humans. Then, we can inhibit that brain region and observe their oxytocin levels upon engagement in maternal behaviors, particularly in high LG/ABN mothers.

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The Social Psychology of Police Brutality: An Analysis of the George Floyd Murder

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Abstract

Police brutality is an omnipresent, pervasive force in U.S. society. The George Floyd murder of May 2020 spiked widespread outrage and protests against the violence that police have historically targeted toward people of color. The Floyd murder was particularly violent, as it was a slow and torturous suffocation in front of many bystanders. This paper reviews key psychological phenomena that play a significant role in race-motivated interpersonal violence, especially between people of authority and minorities, such as implicit and explicit biases, mental heuristics, stereotype threat, and self-fulfilling prophecies. In order to combat police brutality, it is necessary to understand the psychological mechanisms behind it.

Situational Analysis

Situational Setting

It is a Monday evening on May 25, 2020, in Minneapolis, Minnesota. The city's Police Department receives a call about a man who allegedly used a counterfeit $20 bill to purchase cigarettes at a convenience store. Shortly after, George Floyd is aggressively forced to the sidewalk by two police officers. They then attempt to forcefully put him in the backseat of a squad car. Floyd resists, as he has entered a state of panic, saying he is claustrophobic, not comfortable getting in the back, and having trouble breathing. Another squad car pulls up, and officers Derek Chauvin and Tou Thao step out. Upon entering the scene, Chauvin immediately forces Floyd face down onto the pavement. Three of the officers pin him down, kneeling on his legs, abdomen, and neck. Pedestrians gather as Floyd begins to cry out in protest that he is unable to breathe. He begins to beg and call out for his mother. Two officers back away, but Chauvin remains, kneeling on Floyd's neck, a move that's against police procedure unless a suspect is actively resisting with violence (Hauck & Wagner, 2020). Despite outcries and protests from onlookers, many of

whom are recording the scene on their cell phones, Chauvin continues to press his knee into Floyd's neck, threatening anyone who steps forward with mace. Floyd begins to bleed from the mouth at minute seven and a code three EMT is called in. He lies still, and people begin to yell that he's dead and urge the officers to check his pulse. They don't.

George Floyd was brutally and mercilessly murdered over the course of 17 minutes, by people whose purpose is to serve and protect. Floyd is one of thousands of black men who are murdered, abused, and beaten by police officers throughout the U.S. His murder was entirely preventable. Chauvin could have removed his knee from the neck of a man who lay helpless on the pavement below him. Why didn't he respond to Floyd's pleas that he was suffocating? Why did Breonna Taylor get shot in her bed in the middle of the night? Why did 17-year-old Elijah Brown get beaten to death in the street amidst soft cries of "I love you"? Why did Tamir Born (12 years old) get shot immediately, just because he was carrying a toy gun (Dewan & Oppel, 2015)?

Police brutality is a dangerous and powerful force in the U.S. today because of the powerful dynamics the title "police officer" connotes. Additionally, it is difficult for many

white police officers to resist being biased/prejudiced, whether consciously or unconsciously. Implicit bias, stereotype threat, and mental shortcuts are only a few ways in which "unbiased" and "nonracist" police officers are two to five times more likely to kill black men than white men (GBD 2019 Police Violence US Subnational Collaborators, 2021).

The Power of Authority

The primary source of Chauvin's authority is the power dynamics between civilians and law enforcement. This dynamic upholds the influence of police officers over others within the U.S.

Derek Chauvin was well-known for complaints (17 of them) against him for racially biased policing. He was also involved in three police shootings, one was fatal. His partner, Tou Thao, also had many complaints against him, six in total (Hauck & Wagner, 2020). As described in power dynamic theory in the textbook *Social Psychology*, these two officers exhibited direct power over Floyd because of their a) legitimized authority label and b) coercive ability to implement punishment because of that label (Aronson et al., 2019). From the beginning, both men already held higher social positions than Floyd, because of their races (white and Asian relative to Black American) and because of their legitimized authority label. The badge and occupation that police officers hold symbolize an authority figure that is a legalized influencing agent of power for enforcing the law.

Floyd was abused by someone he viewed as having the *right* to exert power over him. Police officers are influencing agents over civilians because of the direct control they have over potential life-altering punishment. Floyd's obedience was a way of avoiding possible legal and/or physical punishment. He was compliant throughout the altercation, only resisting when he began to experience panic. He allowed himself to be pushed and pulled around, protesting only when he was being forced into a space in which he could not mentally manage at the time. Floyd

obeyed the officers because civilians are socialized to obey legitimate authority figures. Most people obey authority even when authority figures aren't present; it is an embedded behavior to avoid punishment, such as stopping at a red light even with no police cars in sight.

In the study "Racism and Police Brutality in America" (2013), Cassandra Chaney and Ray Robertson collected opinions about police support in America. One woman described police as "the backbone that keeps sanity and security in our homes, neighborhoods, and the world at large" (p. 486). The study revealed that many Americans share this belief, with immutable confidence, further adding to police officer's powerful influence over society. Whether or not one supports the police, compliance with this type of authority is the social norm. Floyd obeyed Chauvin to the point of death, given these prevalent beliefs.

It is evident that Chauvin is keenly aware of these power dynamics. He exhibits this through his behavior, captured on the videos taken by the bystanders. He shows his authoritarian personality through the use of direct, hostile aggression. In one video, Chauvin is seen threatening to mace a woman who is standing on the sidewalk videotaping the scene (Hauck & Wagner, 2020). Pictures from police bodysuit cameras show approximately 10 people standing on the sidewalk, watching. Multiple times, protests from bystanders are heard, but no one steps forward, as the cost of helping Floyd outweighed the reward. Anyone who directly tried to intervene might have found themselves in a similar, lethal situation. Through the officer's body cam pictures of the onlookers, it is clear that everyone present understood the danger of the situation (Treisman, 2021).

The video taken by Darnella Frazier went viral and initially exposed the murder, igniting outrage in Minneapolis and eventually nationwide. The report released by the Minneapolis Police Department the next day was titled "Man Dies After Medical Incident During Police Interaction" and had no mention of any

kind of restraint (Treisman, 2021). If the video had not been recorded and released, it is likely this case would have gone uninvestigated like many other incidences of police brutality.

The Race-Crime Stereotype, Bias, and Heuristics

Chauvin's implicit and explicit biases/attitudes toward black people, as well as the mental heuristics he exhibited that day, greatly contributed to his capacity to murder George Floyd. Implicit bias and stereotype heuristics are two primary sources of racial bias in policing. Implicit bias is the unconscious and immediate evaluation people make about others, and stereotype heuristics are when people call to mind generalized traits of a certain group of people when confronted with a member of that group (Aronson et al., 2019). Together, they create the gut reaction a person feels toward others upon first encounter. Although they are unconscious, these attitudes affect behaviors, and their outcomes. Unintentionally, implicit bias has the ability to affect many decisions one makes consciously. Biases exist from ingroup to outgroup. People discriminate against and make hasty generalizations about those who are not part of their own communities (black vs. white, police vs. citizen).

Race-crime implicit association is defined as the stereotype that pairs blackness with criminality. This association is a type of implicit bias that has been shown to impact visual processing in police officers, such as the speed and accuracy of police's perception of weapons, and the use of excessive and immediate force (Kahn & Martin, 2020). Studies show that officers are quicker to mistakenly shoot unarmed black men than white men who are carrying blurred, unthreatening objects such as a cell phone (Kahn & Martin, 2020). Race-crime association, paired with intergroup bias, results in dehumanization perception, in which a white police officer, such as Chauvin, may view a black suspect, Floyd, as less than human. Dehumanization stems from stereotypes of black people as property or "apes."

This leads to more extreme uses of force and discounting black people's physical pain. An example is Freddie Gray, whose spine was broken during police transport (Kahn & Martin, 2020). Chauvin never showed any signs of remorse for his actions, as his self-justification for the murder was most likely that he didn't murder someone whom he perceived as entirely human. During his trial, he briefly stated to the Floyd family, "There's going to be some other information in the future that will be of interest" (Hernandez, 2021). Chauvin remains in denial of the fault he holds in his hate crime.

With racialized stereotypes and innate biases, Chauvin's availability and representative heuristics led to his crime. An availability heuristic is a mental shortcut whereby people base their judgments on the ease with which something is readily available in their mind. A representative heuristic is a mental shortcut where one classifies something according to how similar it is to a typical scenario (Aronson et al., 2019). Upon first entering the scene, Chauvin immediately inserted himself into the altercation and pinned Floyd to the ground within two minutes of his arrival. Chauvin was likely making his decisions based on information that was readily available in his mind, using his unconscious availability heuristic formed around his implicit biases and stereotypes: this black man, who is resisting arrest, must be a criminal due to his blackness and phenotypic appearance. A repeated offender of racist policing, Chauvin likely also used a representative heuristic, comparing this situation to others in which he abused black people and got away with it, leading to repeated behavior. Why would this situation be any different in his mind? Chauvin exhibited implicit, immediate bias and deadly mental shortcuts in the way he reacted so quickly and aggressively toward Floyd. He then proceeded to exhibit *explicit bias* as the situation de-escalated, which involves controlled processing of effortful, conscious, and deliberate thought (Kahn & Martin, 2020). He slowly killed Floyd and had seven minutes to stop, more than enough time to consciously make the decision to remove his knee.

He killed Floyd among cries of protest from the victim and bystanders, begging him to stop. He portrayed his conscious beliefs about Floyd through his actions and was able to self-justify killing him because of his implicit and explicit racist attitudes.

Social Implications

Police Brutality: The Stereotype Threat

There has never been a time in America when black people and police were at peace with one another (Graham, Haner, et al., 2020). Within many black families, children are raised to fear, distrust, and comply with police, through the infamous "talk" black parents have with their children (Graham, Haner, et al., 2020). Black people are generally raised to avoid contact with police, yet black youths consistently come into more contact with police officers than white youths, with outcomes that tend to be negative (Graham, Haner, et al., 2020). If a black child has a direct negative experience with a police officer, or has a family member or friend who has a bad experience, this first impression will serve as a lens and reference point through which future contacts will be viewed. A recent poll found that 49 percent of blacks, as compared to 12 percent of whites, were most worried about themselves or someone they know falling victim to police brutality. This racial divide hypothesis states that blacks fear police brutality at a significantly higher level than white communities. White people were more concerned with other crimes, such as break ins at their homes (Graham, Haner, et al., 2020). At the same time, due to centuries of discrimination and segregation, black people reside mostly in inner city neighborhoods that are economically disadvantaged and over policed. Over policing results from the race-crime stereotype, discussed earlier, which is not only strong and widespread within police officers but also among white people in general. This is evident through Implicit Association Tests (IAT), which test random samples of white people who

are asked to pair guns and/or negative words with either black people or white people; they are much faster at pairing these ideas with black people (Kahn & Martin, 2020). The stereotype is so widespread that many black people learn to fear it and associate it with members of outgroup communities, especially white police officers.

Stereotype threat is the learned fear of being judged based on negative, widely held group stereotypes against one's community (Kahn & Martin, 2020). Victims of this threat, under the power and scrutiny of police, experience mental anxiety, physical arousal, and impaired cognitive processing and decision making. People who fall under the race-crime perception do not want to be perceived as dangerous or violent, especially when faced with a powerful authority figure. Actively attempting to avoid being seen as dangerous results in distracted thinking and impaired behavior. Police officers also fall victim to this threat, as they (usually) don't want to be perceived as racist cops. This results in police officers' increased anxiety, impaired interactions, and, ironically, use of excessive force. Through lower perceptions of self-legitimacy, such as the cop consciously knowing he is in a position of authority deemed biased against black people, he obtains a higher endorsement of using excessive force while simultaneously feeling less support for fair policing. This results in an overall increased support for and use of forceful policing... a positive feedback loop that enhances direct police aggression (Kahn & Martin, 2020).

Symptoms of stereotype threat are similar to pre-attack indicators that are taught to police throughout the U.S., leading officers to potentially misinterpret the actions and cues of harmless citizens as threatening (Kahn, McMahon, et al., 2017). To reiterate, the symptoms of stereotype threat in a victim are increased anxiety, physical arousal, and reduced cognitive capacity. Increased physiological arousal due to stereotype threat includes an increase in skin conductive response (sweating), increased heart rate and blood pressure, lowered skin temperature, and increased systemic vascular resistance. This can eventually

result in asthma, autoimmune disorders, cardiovascular disease, and more. Higher heart rate and sweating contributes to high anxiety, which has its own physiological responses such as fidgeting, stiff posture, nervous smiling, averted eyes, rocking back and forth, and rapid eye blinking (Kahn, McMahon, et al., 2017). Police officers are trained to perceive these symptoms as common pre-attack or escape-attempt indicators, leading to more forceful and aggressive interrogation techniques and defensive posturing and behavior as a way to exhibit dominance and power.

In addition, reduced cognitive capacity in the victim impairs their social ability and behavior. Working memory, which is the system that is necessary to keep things in mind when performing complex tasks like reasoning, learning, and comprehension, is impaired, which reduces a person's processing and retention of incoming information, leading one to act in a manner out of character (Baddeley, 2010; Kahn, McMahon, et al., 2017). It may cause someone to act in the only way they know how in certain situations, which is conforming to the stereotype. Reduction in cognitive capacity paired with increased anxiety causes victims to align their behavior with that of the race-crime stereotype, and resist police compliance or act in such a way that confirms the presumed beliefs of the officer. This interpersonal phenomenon is known as the Pygmalion Effect. Relatedly, the officer, when experiencing anxiety and high arousal while worrying about being perceived as racist, may also experience this effect. This would cause the officer to act in such a way that confirms the victims presumed beliefs, by increasing force and acting more aggressively than he normally would. This threat is independent of implicit or explicit bias and can result from any situation in which stereotype threat is merely present, causing people's behaviors to change and conform to the widespread stereotype they face. The officer does not need to have racist attitudes to be affected, and the victim does not need to have negative explicit beliefs against policing either. Furthermore, reduced cognitive capacity

leads to a reduction in the ability to regulate speech, including increased speech impairment, changes in dialogue, use of repetitive phrases ("I can't breathe." "I can't breathe."), and hesitant and slow responses. Based on the suspect's body and speech cues, the officers may assume suspicious behavior, while at the same time adhering unconsciously to the prejudiced police officer stereotype, resulting in escalated situations. Implicit and explicit racism/bias aside, *any person in a position of authority is susceptible to falling victim to this threat*, a possible explanation behind the movement of "All Cops Are Bad" (ACAB).

A study researching police training used a sample of 15 sources of training that were analyzed by three independent coders who measured the code and language used to describe pre-threat indicators and specific behaviors that police are trained to detect in suspects. In 93.3 percent of trainings evaluated, inter-rater reliability pertaining to physiological arousal code such as "…rapid blinking, rigid posture, clenching the fists, dilated pupils, face flushing, trembling in extremities, gaze aversion, rolling the shoulders, scanning the scene, [and] sweating…" were mentioned as pre-attack indicators (Kahn, McMahon, et al., 2017, p. 50). Anxiety behaviors were found in 73 percent of trainings: "…fidgeting, pacing, a high vocal pitch, clenching the jaw, rocking on feet, shifting weight, touching face or neck, removing clothing, scratching…" (Kahn, McMahon, et al., 2017, p. 51). Eighty percent of sources mentioned symptoms of reduced cognitive capacity: "…changes in the cadence of dialogue, hesitant/short/slow responses, averting the eyes, repetitive responses, and the thousand-yard stare" (Kahn, McMahon, et al., 2017, p. 51). Taken together, 60 percent of police trainings studied included symptoms and behaviors of physiological arousal, anxiety, and reduced cognitive capacity as indicators of physical danger and attack indicators in suspects (Kahn, McMahon, et al., 2017). None of the trainings mentioned stereotype threat.

A final, important point about this threat is that it is heightened with higher phenotypically racial stereo typicality (e.g., darker skin, wide nose,

large lips). Racial minorities with these features are at risk of increased explicit and implicit racialized stereotyping and profiling than those with lower stereo typicality from the same race. Police officers are more likely to perceive black people in higher stereo typicality as criminals. Many high-profile fatal police shootings involve victims who fall into this category (Kahn & Martin, 2020). People are somewhat aware of biases but are less aware of how phenotypic specific characteristics heighten these biases. In one policing study, even white subjects who exhibited more stereotypically white features received less force during arrest than those who deviated from typical white features (Kahn & Martin, 2020). Studies like this portray the prevalence of pro-white police attitudes, and how this bias causes preferential treatment to those included within the ingroup of white people ... even specifically *white* white. In additional studies, the more phenotypical stereotypic black subjects were, the more they expressed concerns with identity threat during police interaction. Not only does immediate implicit ingroup bias affect the behavior of police officers, but a layer of threat vigilance is added when the victim's physical characteristics align with more Afrocentric facial features (Chaney & Robertson, 2013).

Preventative Measures

George Floyd was a victim of stereotype threat. He was immediately anxious, which is captured on video in the ways he willingly and yet disgruntledly lets the officers abuse him. Floyd grimaced and cried out, and experienced physiological arousal and anxiety. He voiced concern about entering the back of a vehicle and his ability to breathe freely. The aggressive actions of the officers resulted in higher physiological arousal causing panic. Floyd exhibited reduced cognitive capacity and his behaviors portrayed unclear thinking and inhibited behavior regulation, evident through his resistance. On the ground, he cried, "I can't breathe," "please," and "mama!" over and over again. These repeated

pleas were likely caused by reduced cognitive capacity and high anxiety affect.

Reducing police brutality is a daunting and seemingly impossible task but must be proactively addressed to decrease and eliminate brutal and aggressive racist murders. More effective police training can reduce implicit bias in police officers. Awareness and further education on how implicit bias affects behavior at a psychological and behavioral level needs to be a *significant* requirement in becoming a police officer.

However, reducing racial implicit bias is not enough to eliminate police brutality. Education about stereotype threat within officer training is essential, as this can occur outside of any type of conscious or unconscious prejudice. The fact that a vast amount of current training for police mentions extremely similar, if not identical, symptoms of stereotype threat as signs indicating dangerous behavior while never mentioning stereotype threat is a complete failure of thorough bodily and psychological cue training. Instruction focusing specifically on stereotype threat would help educate police further on how to consciously notice this learned instinct in others and themselves. Knowing the symptoms of stereotype threat in others may deter police from making incorrect assumptions about a civilian's manner, leading them to be more thoughtful and intuitive about a person's actions. Education on this issue would better equip police to notice it within themselves and understand that civilians are just as nervous as police of being wrongly perceived. This would strengthen communication and understanding between both parties, improving interactions. Training on stereotype threat may help bridge the gap between racial minorities and the police, leading to more empathic, respectful, and productive interaction within future encounters (Kahn, McMahon, et al., 2017).

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Attentional Boost Effect in Divided Attention

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Abstract

This study focuses on the alternative effect of divided attention; specifically, how divided attention is able to boost memory encoding in some situations. The purpose of the study is to address previous studies' limitations; lacking a demonstration of significant numerical boost of memory due to divided attention. This experiment used a mixed-subject design to investigate the limitations of the attentional boost effect, which is divided attention's ability to enhance memory encoding. 118 participants were split into group A (divided attention DA) and group B (full attention FA). Both groups were given a word memorization task, words paired with red dots were target words while words paired with green dots were non-target words. After the memorization task, both groups were given a recognition task with selected target and non-target words. The results support the hypothesis as it demonstrated a significant numerical boost of memory resulting from the attentional boost effect when comparing target words encoded in divided attention (DA) and full attention condition (FA). Other findings concerning comparisons of recognition of non-target and target words in DA and FA conditions were consistent with previous research findings. In sum, the results support the initial hypothesis and the purpose of the experiment.

Introduction

Divided attention may affect people in many memory-related tasks such as reading or studying. With countless established research linking divided attention and reduction in memory performance, divided attention is deemed a negative influence on memory encoding. However, new studies show otherwise. In Spataro et al (2013), two groups of participants were given words to memorize; of which, most were non-target words with green circles below and some target words with red circles below. The group of participants who divided attention in DA condition to detect the red circles were found to experience an attentional boost when recognizing words paired with red circle in later memory test; attentional boost meaning despite divided attention, these participants recognized red circle paired words just as well as participants who were told to ignore the circles in FA condition. Similarly, in Zheng et al 2021, the attentional boost effect was also found to enhance semantic information memory encoded in divided attention condition to the level of the full attention condition in a series of memory tests. However, previous attentional boost research was limited in demonstrating a significant numerical boost of

memory and only demonstrated a relative boost where target recognition is similar in DA and FA condition. This current study will determine the limits of attentional boost and address the limitations of (Spataro et al 2013) by demonstrating a significant numerical boost of memory resulting from the attentional boost. A word memorization task paired with green or red dots followed by a recognition task was used in the study. It is hypothesized that recognition of target words will be significantly better when encoded in DA condition compared to when encoded in FA condition.

Methods

Participant Demographics

The participants of this study are 118 students from the University of Toronto. Of all the participants, 89 were female, 26 were male, and 2 were nonbinary. These participants were divided into two groups based on the alphabet of the last names; group A consisted of all individuals with last names A-L, and group B consisted of all individuals with last names M-Z.

Stimuli and Apparatus

This study uses a mixed-subject design where two separate groups of participants are tested on the same list of words but with different instructions. The independent variables are the amount of attention available and the colour of the dots under each word. The dependent variable is the number of correctly recognized words. The experiment took place on *TopHat* where participants could complete it on their own digital devices. In phase 1 of the experiment, 60 words are shown to both groups with 500ms intervals in the same order; 50 words had a green dot underneath as non-target words while 10 words had a red dot underneath as the target words. In phase 2, the same multiple-choice memory recall task was given to both groups where all 10 target words were tested while 10 random non-target words were tested for a total of 20 questions.

Design and Procedure

In phase 1, both groups were shown the same list of 60 words with colour dots below. Participants in group A is the divided attention group (DA); they were instructed they will see a list of 60 words presented individually with a short period, and they should try to remember the words by reading it out loud as they will be given a memory test at the end. They will see either a red or green dot appear below each of the words; each time a red dot is detected, they should make a checkmark on a sheet of paper. Group B is the full attention group (FA); they were instructed that they were going to see a list of 60 words presented individually within a short period, and they should try to memorize by reading them out loud as they will be given a memory test at the end. Group B participants were also told to ignore the dots to ensure full attention in the task. When phase 1 of the experiment was completed by the two groups, all participants engaged in the phase 2 recognition test where 10 target words paired with red dots and 10 non-target words paired with green dots were tested.

Results

The purpose of the experiment was to demonstrate a significant numerical boost of memory resulting from the attentional boost. A paired samples T-test was conducted for the FA group (group B). Of the 47 participants, an average of 6.06/10 words were recognized paired with red dots with an SD of 2.11, and an average of 6.23/10 words were recognized paired with green dots with an SD of 1.86, the difference was not significant suggesting colour of dots did not affect recognition, $T(46)=0.56$, $p>0.05$. A paired samples T-test was conducted for the DA group (Group A). Of the 71 participants, an average of 6.89/10 words paired with red dots were recognized with an SD of 1.74, and an average of 5.24/10 words were recognized paired with green

dots with an SD of 1.67, the difference was significant suggesting colour of dots affected recognition, $T_{(70)} = 5.75$, $P < 0.05$ An independent T-test was conducted for the recognition of words paired with green dots (non-target recognition). The difference between correct recognition of words with green dots in DA ($M = 5.24$, $SD = 1.67$) and FA ($M = 6.23$, $SD = 1.86$) was significant, $T_{(116)} = 3.03$, $p < 0.05$, suggesting attention affected recognition. An independent T-test was conducted for red dot (target recognition). The difference between correct recognition of words with red dots in DA ($M = 6.89$, $SD = 1.74$) and FA($M = 6.06$, $SD = 2.11$) was significant, $T_{(116)} = 2.31$, $P < 0.05$, suggesting attention affected number of words recognized.

Discussion

The results of the study supported the hypothesis that recognition of target words will be significantly better for DA condition compared to FA condition. This study replicated the effects of attentional boost found in previous studies and demonstrated a significant numerical effect of the attentional boost to support the hypothesis. Whereas Sparato's study found that attentional boost was relative as it enhances memory for target words in DA condition to the same level of the FA condition, the current study demonstrated a stronger attentional boost effect as target words encoded in DA condition were recognized significantly better than encoded in FA condition. This is likely due to the extra attention given to identifying the red dots resulting in the target words paired with red dots also receiving more attention in encoding. Thus, this extra attention in DA condition is suggested to enhance the encoding of target words into short-term memory, leading to superior recognition over encoding in FA condition where no extra attentional resource was present.

Difference between recognition of non-target words encoded in FA and DA condition is consistent with findings by Spataro et al (2013) where non-target words in DA condition had

significantly worse recognition than in FA condition. The decrease in recognition is likely due to humans having a limit to their attention load. In the DA condition, the extra attention given to detecting the red dots likely took attentional resources away from encoding the non-target words. In turn, this decreased attention for encoding non-target words results in fewer words being captured into short-term memory compared to the more equal amount of attention received by non-target words encoded in FA condition.

Results from comparing the recognition of target and non-target words in DA condition contradicts findings from an early study by Jeffrey and Mulligan (2006). Similar to the target scenes in (Swallow and Jiang), target words in DA condition of this study were recognized significantly more than non-target words and non-target words saw a significant decrease compared to FA condition. This is likely due to more attentional resources expanded toward the target words, enabling more target words to be captured into short-term memory, resulting in better recognition compared to non-target words that did not receive extra attentional resources.

The nonsignificant difference between the recognition of target words and non-target words in FA condition is in line with findings by Swallow and Jiang (2010). This result is consistent as target and non-target words in FA should have the similar attention; thus, they have similar attentional resources to be captured into short-term memory resulting in a nonsignificant difference in recognition.

A limitation of the study would be that it lacks diversity as most of the participants are females; as such, most of the participants were also university students. With most of the participants being female university students, the study lacks to reflect the true diversity in the real world. By having a more diverse participant pool, the study results may have better generalizability to the general population. A future direction of the study would be to investigate what types of memory are affected by attentional boost as the current study only investigated implicit memories,

such as memorization of words. In summary, the main finding is that the attentional boost resulting from DA is effective in providing a significant boost of memory for target words encoded in DA condition. This finding supports the hypothesis and implies that attentional boost in DA condition is not limited to enhancing the memory of target words to the level of FA condition but is also capable of surpassing it.

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A Comparison of Reward Processing in Bipolar I Disorder and Schizophrenia

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Abstract

With a shift in the psychiatric field towards the NIMH Research Domain Criteria (RDoC) framework and the transdiagnostic approach being applied to the diagnosis and treatment of psychiatric disorders, there is a need to understand the parallels that exist between disorders to improve the accuracy of diagnosis and care for those suffering from these disorders. This review aims to take a closer look at the intersection between two clinically different psychiatric disorders in an attempt to observe any similarities in reward function in SCZ and BD-I, including anatomical, neurological, and psychological impact of aberrant reward processing pathways. Comparisons can be drawn from disorder-specific neuronal responses, discrepancies in the affected brain regions and neuronal structures, and other applicable nuances in reward processing. As advancements continue to flourish in psychiatry due to increases in the precision of psychiatric research due to medical technology advancements, comparisons can be drawn that account for the detailed neurological complexities between SCZ and BD-I. An understanding of these parallels could serve as a tool to increase the effectiveness of clinician medical intervention of shared reward-processing psychopathology, guide researchers towards optimal drug and therapy developments, and inform clinicians of how to better diagnose and care for those who suffer from SCZ and BD-I.

Introduction

Bipolar I disorder (BD-I) and schizophrenia (SCZ) are two chronic, and oftentimes lifelong brain disorders with severe neuropsychological impairments. BD-I disorder has been arranged into two major subtypes, bipolar type I and type II (Kapadia et al., 2020). BD-I will be discussed in this review. BD-I is associated with having the highest levels of severity in terms of life outcomes and everyday function. It is associated with alternating cyclical episodes of mania and depression, including mood instability. Mania is a symptom commonly linked to substantial increases in cognitive and emotional reward responsiveness (Simon et al., 2010). The DSM-IV classifies the main symptoms of the manic affective state as abnormally high levels of optimism and cheerful mood, energy, decreased need for sleep, accelerated speech and thought, a lack of concern for consequences, and delusions of grandeur. The depressive affective state of BD-I includes depressed mood, anhedonia, decreased interest in activities, fatigue, abnormalities in sleep habits and appetite, cognitive impairment, decreased libido and increased suicidal thoughts. BD-I also includes delusions, hallucinations, and neurocognitive impairment during both affective states (Aldinger & Schulze, 2017). A diagnosis of BD-I is given after the occurrence of a singular manic episode (Guzman-Parra et al., 2021). BD-I negatively impacts the overall quality of life of an individual, including social capabilities that can lead to social ostracization and decreases in socioeconomic status (Aldinger & Schulze, 2017; Guzman-Parra et al., 2021). In general, the age of onset falls between late adolescence and early adulthood (Aldinger & Schulze, 2017). Etiology and disorder prognosis have been observed to be impacted by both genetic and environmental

factors. There is a high level of genetic heritability in BD-I, with a genetic risk factor in twin studies of 80–85% and overall heritability of 59%. BP affects 1-2% of the population (Barnett & Smoller, 2009; Lichtenstein et al., 2009), emphasizing the need for accuracy in the clinical diagnosis and treatment of BD-I (Guzman-Parra et al., 2021).

Schizophrenia (SCZ) is a severe mental disorder where an individual experiences abnormal interpretations of reality of the world around them (McCutcheon et al., 2020). Those diagnosed with SCZ will experience at least two of the following for greater than a month: Positive symptoms such as delusions, hallucinations, disorganized speech, grossly disorganized or catatonic behavior, and negative symptoms such as diminished emotional expression (American Psychiatric Association, 2022). Positive symptoms are classified as changes in thought and behaviors, whereas negative symptoms occur due to an individual withdrawing from society, leading to blunted/flat behavior and emotional expression and a lack of interest in social interaction (Abplanalp et al., 2022). For a substantial period of time after the onset of the disturbance, symptoms must cause impairment to areas of major functioning (self-care, work, interpersonal relationships), and some symptoms of SCZ must continue for at least six months (American Psychiatric Association, 2022). Similarly to BD-I, SCZ is impacted by both genetic and environmental factors. SCZ affects roughly 1% of the population and is known to be around 64% heritable, and 81% heritability in twin studies, however, it is found to be on average that more cases are sporadic, having no known genetic cause (Gejman et al., 2010; Lichtenstein et al., 2009). Environmental risk factors such as psychosocial factors, birth complications, adverse childhood experiences, socioeconomic status and urbanicity, infection, cannabis, and immigration can also increase the risk of developing SCZ (Vilain et al., 2013). Typically the onset of SCZ occurs in early adulthood, however, pathogenesis is believed to start in early childhood during neurodevelopment (McCutcheon et al., 2020).

Many psychiatric disorders, including SCZ and BD-I, have been observed to be connected to deviancy in reward circuitry, which highlights the importance of these pathways on disorder prognosis and treatment outcomes (Chau et al., 2004). Neural reward system pathways are crucial to behavior and memory, connecting certain activities to feelings of pleasure, reinforcing certain behavioral responses. It has been observed that those with SCZ have atypical subjective reward experiences due to abnormalities in decision making in reward planning and reward obtainment outcomes. This is thought to be because of the impaired ability to fully represent the value of plans and outcomes of presented stimuli. Gold et al. (2008) found that in SCZ there is a reduced correlation between personal evaluation of stimuli, action planning, action selection and outcomes. There are also impairments in the ability to fully comprehend the value of presented choices and response options, causing compromised decision making. Rapid learning is severely impaired (Gold et al., 2008). In negative symptoms of SCZ, overexpression of dopamine (DA) is thought to lead to diminished reward acquisition and motivation impairment (Gold et al., 2008). In BD-I, there is an increase in reward seeking behavior, impacting goal-driven reward seeking behaviors and motivation (Singh et al., 2013). In both disorders, atypical interactions in the cortical-striatal networks are thought to vastly impact reward processing (Phillips and Swartz 2014; Caseras et al. 2013).

Some of the main regions of interest involved in reward processing in BD-I and SCZ include the nucleus accumbens (NAc), the frontal lobe, the mesocorticolimbic dopamine system, and the amygdala (Chau et al., 2004). One main area of the reward pathway is the mesolimbic pathway, also referred to as the dopaminergic pathway, which coordinates the release of dopamine (DA). DA is the main neurotransmitter involved with the psychopharmacology of reward, as it strengthens synapses involved with memory and learning and enhances memories associated with reward and overall feelings of pleasure. The

mesolimbic pathway is activated by the ventral tegmental area (VTA) of the midbrain and projects onto the NAc of the ventral striatum (VS) in the basal ganglia (BG) in the forebrain, leading to the feeling of pleasure and reward. Though by all means not an exhaustive list of reward processing regions of BD-I and SCZ, there are a few major regions of interest that have been found to play a critical role in the development and trajectory of the disorders. One such region is the ventral striatum (VS) of the basal ganglia (BG), which receives input from the cingulate, insular, and prefrontal cortices, allowing for the conscious prediction of outcomes of reward, expectation, presence, and tracking of reward stimuli (Eldar et al., 2016). The VS is considered to be the heart of the reward-processing system and consists of the rostroventral putamen, nucleus accumbens (NAc), and ventromedial caudate nucleus (Nusslock & Alloy, 2017). Abnormalities in the striatal function have been observed to be associated with some of the reward system pathology commonly associated with BD-I and SCZ (Whitton et al., 2015). Disconnectivity of the corticostriatal network, the connection between the striatum and the cortex, have also been observed to lead to reward-related abnormalities in BD-I and SCZ. A more specific region of interest in reward processing in the VS is the ventromedial striatum (VMS), which is supplied by the ventral tegmental area of the brain (VTA), which is a part of the mesolimbic pathway. The VMS uses phasic striatal DA signaling to guide associative learning and is a crucial facet of learning, motivation, and attention to reward-predictive cues (Whitton et al., 2015; Popescu et al., 2016). The medial prefrontal cortex (mPFC) and orbitofrontal cortex (OFC) are two other significant regions involved in reward pathways in BD-I and SCZ. During learning, phasic DA has been found to enhance behaviorally relevant stimuli discrimination (Popescu et al., 2016). Abnormalities in phasic dopamine signaling in the striatum have been shown to impact effort to obtain a reward, reinforcement learning and attention to cues of reward-prediction (Whitton et al. 2015).

With the regions of interest discussed above, along with the large impact that reward pathways have on SCZ and BD-I, correlations can be drawn from shared reward pathways to account for shared disorder symptomatology and psychopathology. As advancements continue to flourish in psychiatry due to research and medical technology, such utilization of neuroimaging in research and clinical settings, the classification of identifiable biomarkers for measuring disease progression, diagnosis and treatment response, and increased understandings of the genetic architectures of BD-I and SCZ, reward system pathways can be studied through a system-specific cross comparison (Legge et al., 2021; Lin et al., 2022; Phillips et al., 2013; Swartz, 2014;). Using a transdiagnostic and RDoC approach, which emphasizes the limitations of rigid classification of psychiatric disorders and focuses instead on disorder interconnection, clinically distinct disorders can be analyzed in a manner that accounts for disorder complexity, disorder comorbidity, and heterogeneity (Kapadia et al., 2020; Nusslock & Alloy, 2017). Viewing disorders through this perspective can lead to alternative diagnosis and treatment methods that align with current technology such as neuroimaging, genetics, and artificial intelligence, leading to increased efficiency and effectiveness in treatment (Kapadia et al., 2020).

Similarities in Neurological Reward Responses

Deficits of Reward Processing: Blunted Neuronal Reward Responses

Blunted and/or exaggerated neuronal responses are core neurological features that lead to SCZ and BD-I psychopathology (Sharma et al., 2017; Smucny et al., 2021; Whitton et al., 2015). BD-I and SCZ both experience neuronal deficits in reward processing, which is thought to be due to the disorder-shared symptom of anhedonia. Anhedonia is connected to the reward processing pathway through the NAc and the VS of the

mesolimbic pathway (Smucny et al., 2021). It is believed that there is a strong association between the onset of anhedonia in BD-I and SCZ and abnormalities in reward anticipation (Simon et al., 2010). Because of the inhibition of reward anticipation, feelings of pleasure that arise due to reward consumption are inhibited in tandem. The decreased anticipation of rewards leads to both the negative symptom of anhedonia in SCZ and depression observed in BD-I (Sharma et al., 2017). Neuroimaging studies have also captured the decreased anticipation of rewards due to anhedonia and blunted neuronal responses in those diagnosed with BD-I and SCZ (Sharma et al., 2017; Smucny et al., 2021; Whitton et al., 2015). These reward-processing deficits have been observed in the frontostriatal neural circuit and increased connectivity between the cingulo-opercular network, which includes reward-processing areas such as the insular cortex and dorsomedial frontal cortex, and NAc. Disconnectivity in the NAc was also observed at resting. Both the increased cingulo-opercular network connectivity and dysconnectivity in the NAc showed decreases in reward processing hyperconnectivity and decreased connectivity between default mode network and cingulo-opercular network regions are associated with reward processing and anticipation deficits in BD-I and SCZ. Reward deficits in both disorders have also been linked to an increase in connectivity between the cingulo-opercular network and the NAc, with an observed decreased connectivity in the default mode network and the NAc. Reward responsiveness impairment may be due to this decrease in connectivity within the default mode network to the cingulo-opercular network, and hyperconnectivity with the default mode network. This highlights the NAc as a potential core aspect of reward deficits in cortical networks (Sharma et al., 2017).

Decreases in ventral striatal-hippocampus (vST-hippocampus) coupling have been detected in both BD-I and SCZ, along with a blunted affect in this region during reward anticipation (Schwarz et al., 2022). This reduction in the vST-

hippocampus coupling is hypothesized to be an endophenotype correlated with the positive and cognitive symptoms that arise with the emergence of psychosis in SCZ (Schwarz et al., 2022). Endophenotypes are a specialized categorization of biomarkers that can be used to measure the genetic heritability of observable psychopathy symptoms, serving as a bridge between the potential biological origins of a disorder, and the medical diagnosis for the observable symptoms (Beauchaine, 2009). Endophenotypes in BD-I and SCZ are categorized within their respective disorders and are specific to that disorder . They are genetically derived and are independent of symptomatology present at a given time in an individual. Given the heritability of endophenotypes, biological relatives will also share the endophenotype for a given disorder (Beauchaine, 2009). The vST-hippocampal coupling is connected to the polygenic scores observed in SCZ, which serves as a familial genetic link for SCZ. VST-hippocampal coupling is an endophenotype for BD-I and other psychotic disorders (Schwarz et al., 2022). Similarities in these endophenotypes are believed to lead to the more generalized similarities between biomarkers in these disorders and indicate that there may be strong similarities in reward processing between BD-I and SZ.

Increases in Reward Processing: Exaggerated Neuronal Reward Response

Along with negative symptoms of psychotic disorders such as anhedonia, positive symptoms can also have an impact on reward processing abnormalities in BD-I and SCZ. Previous studies have observed alterations in reward anticipation in those with illnesses that have irregular increases in reward processing, such as SCZ and BD-I (Smucny et al., 2021). Whitton et al. (2015) remarks on the exaggerated neuronal reward responses in BD-I and SCZ, which in SCZ may lead to the positive symptoms of psychosis. This has been found to be related to a hyper-release of striatal DA. This increase in DA

release may occur in response to nonsensical or inconsequential stimuli, leading to psychotic symptoms. In BD-I, heightened activation can be observed in areas of the brain with high DA receptor density during manic and hypomanic symptoms. This increased activation has been observed for anticipatory reward systems in the VS, reward-predictive cues, and reward receipt. Prefrontal brain regions have also been observed to affect the VS by the lack of inhibition of the over-activation of the VS (Whitton et al., 2015). Similarities in exaggerated neuronal reward responses have been found to lead to symptoms of mania and psychosis in BD-I and SCZ, respectively. In the corticostriatal network, striatum and cortex connections have been observed to lead to decreases in drive to obtain reward and goals and a reduction in pleasure seeking behaviors, and in both negative symptoms of SCZ and depression in BD-I (Sharma et al., 2017; Strauss et al., 2014).

Differences in Neurological Reward Responses

Although new findings suggest a number of similarities between SCZ and BD-I in reward processing, there continue to be reward processing differences between the two disorders. One study found that the specific patterns of brain activity during reward anticipation in SCZ and BD-I are distinguishable (Smucny et al., 2021). This particular study focused on the regions of the anterior cingulate cortex, anterior insula cortex, and VS, which make up the foundation of the corticostriatal reward network . Hypoactivation was also observed in the anterior insula in those with SCZ compare to those with BD-I. In the dorsal anterior cingulate cortex hyperactivation was observed in those with BD-I when compared to those with SCZ when presented reward-based stimuli (Smucny et al., 2021; Whitton et al., 2015). Simon et al. (2010) observed that in SCZ, hypoactivation of the VS has been observed to be correlated with apathy, decreased reward motivation, and an increase in depressive symptomatology. These findings suggest a

significant relationship between negative symptoms in reward anticipation and apathy for those with SCZ. One proposed explanation for deficits in VS activation and increased apathy is that those with SCZ may experience dysfunction in BG activation, given that deficits in striatal DA D2 receptors have been observed to have a direct relationship to apathy symptoms in people with SCZ. This study highlights the importance of reward processing in the VS, given that apathy may be a key factor in the reward processing abnormalities and dysfunction observed in those with SCZ. In BD-I, there is a decreased ability to delay the reward response, observed through symptoms of mania. There was found to be no difference in neural activation during reward receipt of monetary loss during either reward outcome or anticipation in the VS. However, there was greater VS activation during monetary reward anticipation. The findings suggest that during manic episodes in BD-I, there is a decrease in the ability to differentiate between the relevance and actual value of rewards (Simon et al., 2010). In BD-I, the PFC fails to decrease activity and responses of the VS, and the ventromedial prefrontal cortex (vmPFC), integrates limbic and prefrontal areas with reward information inputs, show a heightened favoritism of the inputs of the VS (Mason et al., 2014). In SCZ, the BG and DA reinforce learning and prediction of outcomes of reward (doi: 10.1093/schbul/sbn068). In BD-I , there are abnormally high levels of activity in VS during reward-anticipatory cues, consumption and anticipation of rewards have been observed (Caseras et al., 2013; Mason et al., 2014; Trost et al., 2014). In BD-I, symptoms of mania have recently been associated with elevated reward-related activation in regions with high concentrations of DA receptors, and DA agonists have been observed to aggravate atypical reward learning leading to high reward and high risk decision making (Whitton et al., 2015). In BD-I, elevation of the striatum is associated with mania (Whitton et al., 2015). Alterations in the mPFC have been found to impact initiation of curiosity when it comes to uncertainty in reward outcomes

in SCZ (Strauss et al., 2014). In SCZ, deficits in connectivity of the OFC, involved with memory and learning, lead to a decrease in maintaining and generating an accurate understanding of rewards and outcomes. In SCZ, DA functioning and the deviancy of the anterior cingulate cortex and midbrain is thought to impact effort-value calculation in reward seeking and acquisition behavior. (Strauss et al., 2014). Alternatively, in BD-I, there is an increase in reward seeking behavior due to aberrant subcortical and PFC activations, impacting goal-drive reward seeking behaviors and motivation (Singh et al., 2013).

Discussion

Analyzing the reward processing factors in BD-I and SCZ to cross compare neurobiological reward pathways and neurological dysregulation shows promise for increasing the effectiveness in targeted intervention and treatment methods of these disorders (Whitton et al. 2015). Both BD-I and SCZ share many similarities regarding reward processing deficits and abnormalities and potential phenotypic linkage. With the nuance and complexity of these disorders, research regarding reward processing similarities in BD-I and SCZ is important for understanding of how to better treat and care for those suffering from these chronic, and oftentimes lifelong, disorders. With aberrant reward processing being a core component of psychopathology in BD-I and SCZ, current research indicates that there is disorder-shared selective attention to cues of reward prediction, goal-driven reward behaviors, atypical cross-diagnostic functionality during learning reinforcement and reward based decision making (Whitton et al. 2015). All of this points towards the benefit of using a transdiagnostic perspective, which allows for SCZ and BD-I, two distinctive disorders, to be studied through and treated as an interconnected and complex map of shared symptomatology (Whitton et al. 2015). Blunted VS reward based signaling in negative symptoms of SCZ and depressive state of BD-I, and elevated VS signaling in BD-I mania and the positive

symptoms of psychosis in SCZ, and atypical phasic DA signaling in both disorders indicate reward processing commonality. Studying the shared reward processing abnormalities in SCZ and BD-I has also led to a greater understanding of anhedonia, providing evidence of the benefit of studying other common symptomatology through a transdiagnostic and RDoC perspective. There continues to be improvement in the identification of shared biological and neurological mechanisms and symptom commonality between these disorders (Whitton et al. 2015; Beauchaine 2009; Sharma et al., 2017; Strauss et al., 2014). This emerging evidence is paving the way towards the development and improvement of disorder prevention and treatments methods in SCZ and BD-I, in the hopes of alleviating the individual and societal burden of severe and persistent mental illness.

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Constructing A Brighter Future for Transgender College Students By Analyzing Their Negative Experiences

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Introduction

Have you ever used an all-gender bathroom in college? Perhaps it felt strange at first, but all-gender facilities are extremely important to transgender students. More research is being done on transgender students' college life. Some research focuses on negative experience that transgender students have, which includes faculties lack of knowledge about transgender issues, inadequate health care, and the fact that LGBTQQ (L: lesbian, G: gay, B: bisexual, T: transgender, Q: queer, Q: questioning) groups tend to focus more on LGB than other members of the LGBTQQ. A lack of appropriate counseling, being refused access to bathrooms and school dormitories, and micro-aggressions are transgender issues as well. Responses of transgender students in previous surveys indicated that they want to experience better treatment. The negative experiences that LGBTQ groups are facing are mainly divided into two aspects, one is being marginalized, which will make them lack a sense of engagement and belonging to the university, and the other is being discriminated against, which will reduce their sense of well-being. The difference between these two aspects is that discrimination may be a conscious prejudice and stereotype, while marginalization may be a habitual barrier formed by the campus climate for a long time. Based on a literature preview of some previous research, this paper also includes an interview with Colleen Raimond who is the LGBTQ coordinator at the University of Rochester to explore in depth the marginalization and discrimination faced by LGBTQ in college.

Section 1: The Marginalized Experience of Transgender Students in College

The marginalization of transgender college students is evident in the lack of organizations that speak for transgender students, the lack of knowledge of campus employees, the lack of psychological counseling, and the lack of effective services that include transgender students. It is worth noting that although transgender students are often included in LGBTQ organizations, compared to the attention that LGB students receive and the degree to which their needs are met, the issues of transgender students are often overlooked. For example, there are not many campuses with LGBT centers, let alone departments dedicated to addressing the concerns of transgender students (McKinney 68).

In a study by McKinney - which questioned students from 61 different colleges and universities - no students reported having a university policy on gender identity or

discrimination, and only 33 percent of transgender students reported having an LGBT office or center on campus (McKinney 67). Transgender undergraduate students feel that staff have not received the necessary education on transgender issues, and this thought was echoed by transgender graduate students. They feel annoyed with the ignorance of the staff (McKinney 68). Both transgender undergraduate and graduate students feel that there is a lack of organization for transgender issues in schools (McKinney 70), and expressed frustration and sadness with the fact that they themselves seem to be the only group who cares about transgender students (McKinney 69).

Compared to the lack of attention for transgender students, the attention placed on LGB students is much more developed. Limiting transgender issues to identity issues alone will not solve the problem, because their sexual orientation and gender identity are more complex things, as "gender identity may not determine sexual orientation" (Dugan et al. 720). Especially when there are facilities like gender-specific bathrooms and dormitories on campus that distinguish between transgender students and other students, LGBTQ groups may feel targeted and segregated (Dugan et al. 721).

For undergraduates, a lack of organization has become a major complaint. Campuses lack the resources to address transgender and gender identity issues. In dealing with LGBT issues, schools seem to favor LGB over T. Transgendered undergraduates who participated in the survey generally said they did not get appropriate counseling at school. The people they consult are less helpful, less knowledgeable, and less inspiring than transgendered students themselves (McKinney 70). At the same time, because they have been marginalized for a long time, transgender students may not feel inclined to contribute much to the common good of society, because their perception of their individual values are negatively influenced, so they may feel that such a society that makes their value damaged is not worth their dedication (Dugan et al. 733).

Graduate students were especially disappointed in the health services offered to transgender students (McKinney 71). Graduate transgendered students often need to pay extra money for counseling or health checks because their health insurance does not cover the treatment they need. They reported feeling lonely in LGBT organizations, because as a small group of students, LGB students seemed to overlook their feelings, making it difficult to find a sense of belonging. At the same time, their identity is diminished by the fact that, without a formal organization or institution, it is hard to find a community of students who are transgender like themselves (McKinney 72).

Colleges ought to develop educational programs about transgender issues to staff, and then open an official transgender organization (Seelman 29) for the protection of the rights of transgender students and ensure enough attention for their psychological counseling and health-insurance. However, when providing appropriate psychological counseling to transgender college students, it is worth noticing that, transgender students are like everyone, do not make any difference in mental health, and they should not be mistaken for having special psychological problems just because they are transgender students unless they point out that their struggles are coming from their identity (Raimond).

Section 2 The Discriminated Experience of Transgender Students in College

Transgender college students are often harassed by unfriendly questions about their gender, refused entry into bathrooms and dormitories, or feel embarrassed when they see the gender classification sign in the bathroom door and avoid using it themselves, because such a gender-specific sign will make them feel that they are not included. Due to the discrimination they face, their overall health is put at risk. Discrimination also differs by race and social class, as transgender students of color and of lower socioeconomic status (SES) have more negative

experiences. For instance, transgender students of color and low SES are more likely to be refused entry into bathrooms and school apartments (Seelman 8), and such discrimination does even lead to an increased suicide rate (Seelman 18).

Institutions of higher education are expected to be prepared to meet the needs of many diverse groups. The health and happiness of transgender college students is strongly negatively correlated with prejudice, harassment, discrimination and violence. They are more likely than non-transgender students to commit suicide or self-harm, and this has been linked to unfair treatment (Seelman 3).

In fact, the use of bathrooms and dorms has a significant impact on the happiness of transgender college students (Seelman 7, Raimond). Transgender college students who experienced a negative bathroom experience said they were asked which bathroom their gender should go into or even told to leave (Seelman 7). In addition, male-to-female transgender students were more likely to be denied access to school infrastructure than students who are unable to be distinguished by others as to what gender they are "trans" from (Seelman 8). At the same time, those transgender students who "were people of color, had a disability, lived in a rural area, or were more often perceived by others as transgender" were more likely to be denied access to bathrooms and dormitory accommodation (Seelman 8). Some transgender students try to avoid harassment because they are afraid others will not perceive them as the sex indicated on the bathroom door. They feel unsafe and try to avoid using the school bathroom altogether by, for example, not drinking water (Seelman 9).

Transgender students receive little academic and social support or praise in college that contributes to academic success and self-healing (Seelman 5). In fact, they have a weaker sense of belonging in college than non-transgender students because of the climate of discrimination and harassment that they exist in. Transgender college students are more likely to consider dropping out because of concerns about their safety (Seelman 6). After experiencing discrimination and neglect, the transgender college student is more likely to experience a multitude of issues, from loss of employment, criminal charges, or even drug abuse, engaging in sex work to support themselves, homelessness, and committing suicide (Seelman 7). Transgender individuals have a higher rate of suicidality after being denied access to bathrooms and dormitories, according to a study which analyzed responses from the National Transgender Discrimination Survey (Seelman 16). Therefore, it is urgent to create a campus atmosphere that is friendly to transgender students, so as to help them integrate into college life, and regain their confidence.

Schools can establish formal institutions to maintain a non-discriminatory environment. When building an infrastructure, it is important to have an all-gender bathroom in each building (Seelman 28), and to educate school staff and students about discrimination. At the same time, the creation of more co-ed dorms so that transgender students can live equally is important. It is wrong to set up a special type of dormitory for them, and they should instead be allowed to live with other students normally. Sustainable policies and regular speeches on campus to let people know more about transgender students are also a way to reverse the negative situation (McKinney 74). For instance, gender mixed dorms, single private bathrooms, and campus clubs like LGBTQ are necessary to be popularized in college.

Conclusion

There are many aspects of the transgender experience worth further exploration. Colleges can try to break some traditions. For instance, according to the fund of the school and the size of the campus, colleges can consider changing the two gender-independent dormitory buildings into the same dormitory building with students of different genders on the same floor, and integrate the dormitory into a gender-mixed dormitory.

Future research is also necessary to study the possibility and forms by which transgender folks self-regulate to live positively, which can better help transgender students to heal their inner trauma and get out of the bad shadow.

While it is necessary to include transgender students in LGBTQ to discuss, it is not effective enough for transgender students themselves. Since transgender students are actually quite different from LGB, there should be special mechanisms to meet their unique needs. In addition to educating school staff, transgender students need to be provided with the necessary counseling. Schools can also adopt formal policies to address discrimination against transgender students.

Future research could investigate the lives of transgender students themselves, and set open-ended questionnaires for them, so as to provide them with more targeted help. As long as more people pay attention to the transgender issues in college, a bright future for transgender students is within sight.

Appendix: Interview Questions & Report

This interview was conducted on the questions of transgender students at the University of Rochester. By discussing the positive and negative experiences of transgender students at the University of Rochester and the university's policies and facilities, this interview is intended to supplement the accounts of marginalization and discrimination that transgender college students are experiencing. The interviewee, Colleen Raimond, who is the coordinator of LGBTQ at the University of Rochester, shared her thoughts and analysis on the situation of transgender students at the institution. This interview took the form of a face-to-face interview. The following is a paraphrased account of the live recording. The interview lasted 26 minutes and 50 seconds.

Ms. Raimond comments that all students talk about mental health in different ways, which depend on a variety of factors such as family background and education about mental health. She has not found that trans people talk about mental health differently than other students. She means that trans students do not have any sort of higher rate in mental health issues. She thinks that the conversations around mental health are consistent and worth being discussed in every group of people. Trans students remark that some people believe that being transgender is a mental illness, which is not true, and so trans folks talk about such stigmatization. There are different rules about transitioning in different states, and in some states trans people have to speak to a therapist before they are able to do transitioning, and thus, sometimes trans folks will talk about the barriers that are put in place in the context, which is one way they talked about mental health in the community, but that is not sort of to the question of long term issues. All in all, she thinks that trans folks talk about long term stuff in the same way that everybody else talks about it in society.

When people talk about trans people, or really any people, they kind of try to look at the intersections between their identities: where their identities cross over each other. For trans folks, a lot of pressure sometimes comes from their religious or cultural identity, which is at odds with their gender identity. If a trans person's family belongs to a religion that is not inclusive of trans people, that can add some extra pressure. The same way that if a trans person's culture is at odds with trans people, that can cause additional pressure, too. All of those things, all these different identities and where maybe they might be at odds with each other is where some of these things can come into play that may lead in a direction of suicidal ideation.

There is a concept called "passing", which is when a trans person is perceived to look like their gender identity, rather than the gender they were assigned at birth. Some people are passing, and others are not. Such phenomena can cause a lot of anxiety and depression. There is a lot of violence and fear against trans people. There is a lot of stigma around trans people. On the other side of it, if their body is experiencing transition, it

can cause more fear but they are unable to relieve pressure because of cultural constraints or financial constraints. For example, not all trans people want to have surgeries, not all trans people want to do non medical modifications or take hormones. However, if they do want to do that, but they are not able to, it can lead to a lot of feelings of hopelessness and depression.

Same with the previous researchers by some specialists, she agreed that bathrooms and dormitories are two places that are difficult for transgender folks to access. The reason is that trans students do not feel comfortable using a restroom, which can cause a lot of medical issues and a lot of anxiety, and the same issue remains with housing. Another place where discrimination and marginalization can be present is the world of athletics. In the US, there are rules from the NCWA (the National Collegiate Wrestling Association) which determines when somebody can play on a women's or men's team, with consideration to hormones. If a person begins to take hormones that change what team he/she can play on, this creates another sphere in which there can be a lot of discomfort. Additionally, Greek life fraternities and sororities do not all have trans inclusive policies for students. There is the question of what happens if a student is a member of a Greek organization and then transitions - what does that mean for his/her membership to that organization? Ms. Raimond also thinks that for some trans students, existing sororities on campus can cause discomfort because there are people who are transphobic in such groups. There are also other people who are unfamiliar with seeing gender presented in different ways. In fact, U of R is a very international campus that has a lot of international students, so the way that gender is expressed in different countries can be very different. For people from one culture, perhaps they look transgender students normally because in their culture that is acceptable, but someone from a different culture might feel uncomfortable.

Ms. Raimond thinks that there is a lack of understanding of trans culture, which is difficult to deal with. She thinks that avoiding micro-aggressions can be difficult and understanding gendered language can be difficult. She thinks lack of understanding about the community is a big issue. Cultural differences can be difficult to solve.

There are quite a few things like rules, for example, for U of R's first year dorms, the individual dorm rooms are gendered, but males and females are allowed to live together if they are upper class students or transfer and if they apply for mixed dorm, which can be embarrassing for transgender students due to the fact that if a student is trying to transition and be admitted by society, it depends on whether he/she changed his/her gender marker legally. Some transgender students may not have completed this legal transition, so it is difficult for them to follow their hearts when choosing a gender. These are other barriers that the trans people have: for example, in New York State, to get their gender marker changed on their identification, their gender markers need to either have an "F" for female or "M" for male on their driver's licenses or other places. After they get their legal name changed, they have to have a note from their doctor to get their gender marker changed, which is another thing which causes difficulty for trans students because the way that they appear in the system will be different depending on that.

On the other hand, there are many positive experiences for trans students, among them being finding a community in college. Members of the trans community in the LGBTQ community are becoming more common. In all classes, students start to talk about trans people, and have opportunities to interact in spaces that are safer, and they have a lot of rules at U of R that help to create safe spaces. One of the rules is that there is no need for people to use the bathroom that matches their gender at birth, which means that a student who, for example, is gender fluid, can use whichever bathroom they want. Rules like that give more freedom and safety for trans students. Inclusive policies and visibility indeed make a big difference as well. U of R has big events that are for the LGBTQ community. Ms. Raimond thinks

that learning about LGBTQ culture can help create a trans-friendly community. Whether in their classes or through the medallion program (a social leadership program in U of R) and extracurriculars, they are able to make a safer space for trans students. If a trans student is beginning to explore how they might want to express their gender, they have a safe space to do it. Having a LGBTQ coordinator position, like Ms. Raimond, helps create a good community for trans people, because people can talk to her when they are struggling with transgender specific issues. Ms. Raimond often gets emails from people with inquiries like this: "Hey, my friend just came out as trans. Can I come talk to you? Because I don't want to ask them weird questions, but I just want to understand so I can be a good friend." Thus, having Ms. Raimond at U of R is helpful because people have a safe place to go to ask those questions. She also popularized education about transgender students on campus so that her hopes of creating an inclusive environment can come true. U of R also has many trans-friendly structures and space so that trans students are included in the school's culture.

U of R thinks that it is necessary to have appropriate counseling and health services, so it has a counseling center. A complaint that Ms. Raimond heard from trans students is that there are not any counselors that are transgender, and that there is nobody who really focuses on that identity. Although she thinks that some of the trans students would say that they do not feel that it is sufficient to meet their needs, she thinks that they have a good counseling center in general. As far as health services are concerned, their student health insurance covers gender affirmation surgery, as well as hormone therapy, which is rare in other colleges.

As for attitudes towards trans students on campus, Ms. Raimond thinks that in the LGBTQ community, the environment is changing over time. She knows that there was a time that with transgender students in U of R did not feel included in "pride network", which is their student group, but now they are very much included

in pride networks, which make efforts to ensure that trans people are included. There are people on the executive board who are members of the transgender community, so she is hopeful that those changes will help students feel less lonely. They have also made an effort to have a discussion group that addresses the trans community. Ms. Raimond acknowledges that coming out as trans is oftentimes not accepted by people as well as coming out as lesbian, gay, or bisexual is. She thinks that there is some tension there, but she is hopeful that they are moving in the right direction. At least in their student groups they were creating a more inclusive space so that there are some places for students to go. The safe space they created allows LGBTQ students to feel comfortable talking about their struggles, and invites those who want to know more about the group to get knowledge of how to get along well with LGBTQ groups.

Ms. Raimond is hopeful, but she has no way of knowing if the knowledge of transgender issues of staff and faculties has improved, since getting safe space trained from human resources is optional for faculty and staff. She does not get asked to speak to members of the faculty. She said that there are a lot more staff members now that know more about things like pronouns and general trans issues because she was invited by their department to go talk to them. She said that if she had to guess, there are more staff members now that have transgender knowledge, but she does not know if there are more faculty who have enriched their knowledge too.

Ms. Raimond thinks like any community, there are some trans people that really want to be accepted in society. She compared ignoring trans identities to "racial blindness". Different races exist, and this shouldn't be ignored, because if people say that they do not see race, it means that they believe that everybody has the same identity and the same experiences. Some trans people say that they just want to integrate and not have their trans identity be over emphasized. Ms. Raimond thinks that like any other culture, this preference depends on the person. For example, she thinks

that some Chinese international students who want to assimilate: "I just want to assimilate to America and not really stand out." Other Chinese students might feel differently, and are more proud of their Chinese identity. This same dichotomy exists in the trans community.

Ms. Raimond thinks that when they create safer spaces and more inclusive spaces, they emphasize the importance of people being true to themselves. She thinks that those actions help combat a variety of issues. She thinks that education is really important. Reliable information and education can assist trans people in finding safe ways to obtain non surgical body modifications, such as breast binding. In an environment where there is education about reliable resources, trans-males can learn how to bind their breasts safely. Ms. Raimond has found that lots of people practice breast binding in an unsafe way, just because they do not have access to such resources. Depending on what surgeries trans students get or if they do not get surgeries at all, they might still need to have gynecological visits. If campuses do not ensure that gynecological visits are safe for transgender people, health issues can arise because they are not getting themselves checked out because of fears of discrimination.

As for personal resilience, Ms. Raimond thinks that finding community is important, which means finding other trans people to talk to, watching videos and blogs where they can learn about other people's experiences, and taking classes that talk about LGBTQ history or the psychology of gender. She also thinks that everybody should talk to a therapist, which, like talking to their friends, helps in building a supportive structure around themselves. She said that it is not like a personal resilience concern but like any other common culture. Having somebody who you can express ideas and feelings to is one of the solutions for preventing isolation.

Generally, the future of transgender students is bright. At the University of Rochester at least, health services for transgender students are much better than those at other places. Some campus policies also aim to create a friendly atmosphere for transgender students. The gradual formation and promotion of transgender culture also provides a place for transgender college students to belong to. They are firmly moving in the direction they want.

Questions Asked in the Interview:

1. How do transgender people speak about mental health struggles that may result over the long term?

2. What are the situations over time that create risks for transgender student's suicidality as a consequence of discrimination and stress?

3. Are being denied patterns seen in bathrooms and housing similar to those that might be seen in other education settings?

4. I see that U of R has an all-gender bathroom in the library. Is this one of the efforts that be considerate for transgender students?

5. Can I inquire about what measures are taken at U of R to support transgender students?

6. Are there many gender-inclusive facilities at U of R?

7. Are there enough appropriate counseling and health services on campus?

8. Except for suicide attempts, what are other psychological and physical health outcomes?

9. What are the protective factors and forms of resilience—both at an individual and an institutional level—that can help buffer transgender people against negative health outcome?

10. I read some papers about transgender students which said in their transgender students felt lonely and ignored even though they are a part of the

LGBT community, but those studies are from a few years ago. At the U of R, do you think this situation has improved?

11. Is the staff and faculty at U of R more knowledgeable about transgender now than they were a few years ago?

12.May I guess that there may be transgender students who don't want to be either marginalized or over emphasized?

13.Whether are they want to be treated just like normal people so that they can integrate into society more comfortable?

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Social Status' Influence on Diffusion of Responsibility

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Abstract

Diffusion of responsibility occurs when people are less likely to act in a situation that requires help when they are not the only people involved. The more bystanders, the more likely one is to assume others will respond, thus failing to act themselves. The present study proposes a study to investigate the effect of perceived bystanders' social status on diffusion of responsibility. Male and female participants (N = 90) are each randomly assigned to spend 20 minutes in a room with five actor bystanders of one of the three conditions while two actors in an adjacent room scream for help for 90 trials. The three conditions are classified by the actor bystanders' perceived social status (high, medium, low) by clothing, cleanliness, and accessories. The participants' reaction to the screams next room is recorded and measured. The proposed result demonstrates that participants in the condition where actor bystanders appeared of high-status have the lowest rate of reaction due to obedience to perceived authority and a feeling of lowered self-efficacy. The participants in the condition where actor bystanders appeared of low status helped the most, likely due to the boosted feeling of self-efficacy to help.

Diffusion of responsibility is a phenomenon where an awareness of other bystanders diffuses a witness' feeling of responsibility to take action. The diffusion of responsibility is exceptionally important for humans as we are social animals, and we depend on each other for survival, motivation, confirmation, and security. Therefore, when a phenomenon, such as diffusion of responsibility, that is very capable of diminishing human cooperation, it is important to rigorously study the phenomenon so methodologies may be devised to enhance social bonds and responsibilities. On the other hand, bystander effect is where the presence of other bystanders discourages an individual to provide help. Diffusion of responsibility in turn leads to the bystander effect as the presence of others diffuses one's responsibility to help. Then, as participants look for informative information from others on whether they should help, other bystanders effectively affected by the same diffusion of responsibility fail to provide assistance, leading to confirmation of action between bystanders; thus, fulfilling the bystander effect. Diffusion of responsibility was originally investigated by Darley & Latané (1968), where subjects were found to be less helpful to someone with a seizure when the subject is aware of the existence of other bystanders. A more recent replication demonstrated the application of this concept: Weisenthal, Austrom & Silverman (2010) found that subjects are more likely to donate more

money to charity individually than in groups. However, like Darley & Latané (1968), this study omitted the possible effects of bystanders' characteristics and social status on the diffusion of responsibility. According to the Milgram shock experiment (Milgram 1963), humans are prone to conform to those who appear authoritative and esteemed. The purpose of this study is to investigate whether the status of other bystanders will affect the diffusion of responsibility as there is little to no previous research on this topic. It is hypothesized that bystanders who appear to be of high status will worsen the diffusion of responsibility and inhibit an individual to help, as humans have the natural tendency to follow the steps of authority and those who appear prestigious.

Methodology

Participants

Subjects of this study come from diverse backgrounds and are randomly selected through multiple mediums to avoid sampling bias, and external confounders and increase the generalizability of the study outcome. They will be selected from social media ads, emails, and flyers handed out on the streets; and an equal number of people are selected from the three sources. Participants will be compensated with either a coupon to McDonalds or 20 dollars cash. There is no specific age or gender focus as the study is directed to the general population; therefore, the recruitment participants from different sources will provide a good representation of the general population. Ideally, the sample size should be around 90 individuals for a reasonable representation and also still be accessible to study.

Materials

The study requires the participation of 17 confederate actors. There will be three experimental conditions, and participants are randomly assigned to one of the three conditions.

Condition A is characterized by high-status bystanders; five actors in this condition are well-dressed. Condition B is the median-status appearance of bystanders, with five actors will dress casually. Condition C refers to low-status appearance bystanders; five actors in this condition will be poorly dressed and groomed. Two actors play the recruiters. The research will take place in a small, enclosed room next to a vacant room; the two rooms must not be soundproof of each other. A 24 hour nutrition recall test is given.. The two recruiters in the adjacent room must act out a scripted argument with one actor screaming "help me" to get the attention of the participants. All of the actors in conditions A, B, and C are not allowed to communicate with the participant during the trial and do not respond to screams from the adjacent room. 30 participants total are assigned to each of the three conditions for a total of 90 trials.

Procedure

Five confederates in each condition will wait for the subject in the waiting area. When everyone arrives, actor recruiters take the five confederates and the subject into the experiment space. Each of the six people in the room receives a memory test that lasts for 10 minutes from the recruiters. The recruiters explain that the task is designed to test each participant's memory capacity and conversation is forbidden to reduce distractions. After giving instructions, recruiters announce the beginning of the test and move to the adjacent room. Five minutes into the memory test, recruiters in the adjacent room start acting out the staged dispute. Despite hearing the screams, the five confederates in each given condition do not react to the screams. The recruiter screams for help for 10 minutes, during which the study records whether the subject observes other bystanders' behaviors by turning their heads or leaves the room to assist the actor in the adjacent room. If the participant does not leave to assist by the end of 10 minutes, their behaviors are ignored and recruiters return to the

test room to debrief. If the participant arrives to assist, the recruiter returns the participant to the test room to debrief. From the time the recruiters leave the room, the study should be at around 20 minutes.

Predicted Results

We hypothesized there could be a negative correlation between the perceived status of other bystanders and the likelihood of the participant leaving the room to help, while the rates of turning their heads and looking for confederates' reaction remain similar across three conditions. It is expected that the smallest number of subjects will leave the room in condition A, where confederates are of high observable status.. For condition B, it is expected that some participants will volunteer to assist despite observing no reaction from the confederates. Of the three conditions, condition C is expected to have the most participants actively helping and leaving the room.

Discussion

The predicted results support the hypothesis. Participants were least inclined to assist bystanders in high-status settings; when the perceived status of onlookers decreased, participants became more willing to assist. When a person in condition A is unsure what to do in an ambiguous circumstance, they eagerly seek guidance from high-status bystanders. Participants may assume that because there are other high-status and presumably trustworthy individuals in the room, other individuals' actions are more credible and they are more suited to assist; this relates to social conformity and worsens the distribution of responsibility.

In condition B, when a subject is unsure of what to do in an ambiguous scenario, they can seek advice from middle-status confederates. Participants are likely to see a more equal dynamic of competence and dependability dispersed between all people in the room since a middle-status appearance does not transmit a feeling of

trustworthiness and authority as powerfully as a high-status appearance. Those with high perceived social status convey a stronger sense of authority and conformance, as demonstrated by Edward and Gregory (1982), and people are more willing to follow and conform with those with high social status. Responsibility is less likely to be dispersed with this perspective since participants are more likely to think they are equipped to help and will take greater responsibility to act. Subjects who feel more equipped are more likely to help since their higher ability decreases the diffusion of responsibility; when an individual feels more competent, their responsibility in the subject of their competence increases as their failure to help will induce a strong sense of cognitive dissonance.

In condition C, when participants are trying to determine what to do in an uncertain scenario, they can only get useful information from a low-status bystander. Participants are expected to negatively view the low-status bystanders' ability and qualification to aid because low status transmits a low feeling of reliability and credibility and participants may have a stronger sense of self-efficacy and confidence to help comparatively. According to a study conducted by Cramer et al (1988), subjects' competency affects their decisions to help when other bystanders are present. Additionally, the subjects may feel a heightened sense of responsibility as they may feel like leaders of the cohort. As a result, dispersion of responsibility is the least common as the participants believe they have a higher level of qualification and dependability than others in the room and are thus more inclined to assist.

One flaw of the study is that participants' age is not taken into account when their actions are altered by the status of bystanders. In future studies, individuals of different ages should be investigated independently to obtain more generalizable and reliable results. Future research on this issue may look at how the status of different locations (for example, high-status resorts versus low-status inexpensive motels) affects the diffusion of responsibility.

The projected results may have an impact

on present scientific research by further investigating smaller aspects of diffusion of responsibility; this, in turn, may drive new studies into strategies for reducing the effect of perceived status on the dispersion of responsibility. The findings may be utilized in the real world to lessen responsibility dissemination. For example, ads and electronic posters can be put up in public and on social media to educate people on the effect of bystanders' observable social status and dispersion of responsibility. As the public becomes more aware of the issue, campaign ads should call for action so people would disregard other bystanders' appearance and be more alert and helpful to lend their helping hands in emergent situations.

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Multiple Personality Disorder Explained in The Scope of Conscious Relativity Equation

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Abstract

Humans seek relativity in perceptions in order to socialize, in regards to who humans choose to interact with is defined by how much one human feels they are able to relate to another, which is accomplished through a nuanced process of perception and comprehension of who they are themselves and how others define themselves. As Aftab (2019) mentions, mental disorders are psychological disorders created by information processing feedback loops gone awry in biologically intact brains. This indicates that interactive feedback in socializing, the relativity of understanding one another, is absent in dissociative disorder patients. This is implied in Cudzik, Soroka, and Olajossy (2019) where their article pinpoints why children create another self within themselves: to protect themselves from harm from traumatic events which could correlate with the result that having abuses are related with feedback errors in socializing just as Aftab (2019) mentions above. That very mindset of likeability in terms of relativity from one another in perceiving and understanding who they are themselves and who others are is what makes us humans, just as Simone Reidners et al. (2012) state in their article where dissociative disorder or multiple personality disorder comes from disrupted attachment. Multiple personality disorder patients lack those as they are inflicted by sexual, emotional, or physical abuse in childhood. And, that very post traumatic stress effect keeps them in constant search of that post traumatic stress. They seek to find relativity within themselves as they were never taught it could be done by socializing with others in childhood. That is what theoretically provokes them to split personalities within themselves. The equation of conscious relativity can explain both in predevelopment state (as in children who are still in neuroplasticity state) of multiple personality disorder in childhood and matured state of development of multiple personality disorder in adulthood who are no longer capable of neuroplasticity. The conscious relativity equation postulates that when more than two individuals perceive one another, cognitive processing slows down and interactions based on this processing define how likable a person can become.

Introduction

Multiple personality disorder, or dissociative identity disorder, is characterized by the DSM-V the experience of a disconnection and lack of continuity between thoughts, memories, surroundings, actions and identity. People with dissociative disorders escape reality in ways that are involuntary and unhealthy and cause problems with functioning in everyday life. (Reinders and Veltman, 2020). Dissociative disorders often develop as a reaction to trauma and help keep difficult memories at bay. Symptoms — ranging from amnesia to alternate identities — depend in part on the type of dissociative disorder individuals have (Reinders and Veltman, 2020). The conscious relativity equation theorizes why and the process by which multiple personality disorder could be developed. Based on the rules of post traumatic stress disorder (PTSD) patients seeking risky environments as Weiss et al. (2015) state in their article, that sensation of seeking

PTSD could be the reason why types of dissociative disorders, specifically multiple personality disorder, manifests as a result of exposure to trauma in certain individuals. Either in the causality state of such disorders or its matured state in its development, the conscious relativity equation provides information that could explain both state and hypothesize a static relativity effect, which creates a splitting personality on an individual to create relativity by force. Thus, it can be concluded humans crave to seek relativity in perceptions, as Aftab (2019) states in his article.

Theory of the Conscious Relativity Equation Aligning with Multiple Personality Disorder:

The Conscious Relativity Equation theorizes Multiple Personality Disorder is derived from having a single patient with psychopathology not being perceived by anyone, or in other words, hypothesized to have multiple personality disorders caused by isolation from the society (by being cut off from any social contacts or socializing of any sorts), which will be defined as isolation theory. It is hypothesized that the equation for conscious relativity is:

Figure 1. $P^B/C = D$

P is the number of subjects' perceptions with B as in opposing subjects perceiving the number of P. C is the mean of common knowledge with an average from rate of 1 to 10 of likeability, with likeability defined as the main source of how perception is shaped (10 being the most likable and 1 being least likable, according to Simone Reidners AAT, Willemsen ATM, Vos HPJ, den Boer JA, Nijenhuis ERS (2012). In other words, common knowledge, as defined by Reuell (2015), is an awareness of people knowing that others know what they know themselves as individuals as common knowledge. D is the individualistic knowledge of belief without awareness that others know what individuals know about themselves. To address multiple

personality disorder in this specific conscious relativity equation, replace P with:

Figure 2. p^b

where p is the number of personalities of the patient within one subject perception; this will lead to p to be a number of more than 1 with b hypothesized as 0 if the patient is isolated or cut off from the world, as it has been stated in the beginning of the hypothesis that potential patient who would develop multiple personality disorder is hypothesized to be cut off from the world to develop such psychopathology; And, that factor is "b" in Figure 3. Judging by having:

Figure 3. $p^b = 1 = p^0$,

No matter how much B is amplified D will get static as numerical value 1 as B increases and C gets closer to 1 which indicates D becomes static in relativity, hence, no relativity in the perception of consciousness or personality, as Figure 1. states above. This suggests that the public does not comprehend or understand multiple personality disorder patients. Based on this isolation theory, or disordered attachment issues as Gillig (2009) mentions in his article in which he derives multiple personality disorder, it is further hypothesized or implied that the patients garner little to no sympathy from the public. In other words, from childhood, theoretically in order to develop multiple personality disorder, one must be neglected by either third parties or parents for being perceived as an unpleasant individual to society—that is what static relativity means. In other words, the more relativity occurs the more individual or individuals are understood by the public and empathized with, thus, conscious relativity theory, which is a theory of Conscious Relativity Equation: an equation that postulates that when more than two individuals perceive one another, processing slows down in mind, and interactions based on slowed-down-processing defines how likable you would become. Based on how the hypothesis of isolation creating multiple

personality disorder aligns with the outcome of the trend of unpleasantness from the public against those patients in the real life. It is therefore imperative that the hypothesis is confirmed by the equation and what this equation implies as messages.

According to the Mayo clinic paper (2017), multiple personality disorder or dissociative identity disorder can be caused by trauma from sexual, emotional, or physical abuse in childhood from parents or someone who is close to the kids. Though it may sound contradictory to the theory presented in this paper that outer perceptions or isolated environment cause such disorders, such statement is a hypothesis that is based on isolation as a deriving force for causing multiple personality disorders, based on Aftab (2019) and Cudzik, Soroka, and Olajossy (2019) state om their articles. If one is abused by one person or two (judging by the fact the papers imply trauma based on harm-inflicting closely related abusers) that relativity effect will remain as 1 as in

Figure 4. $1^b = 1$

equation. Such PB equalizing 1 from Figure 1. will bring down C as 1 based on the abuser's likeability against the child, creating static relativity like I had mentioned previously. With this condition, it can, therefore, come to a conclusion that Post Traumatic Stress Disorder (PTSD) is sought after as the paper in "Post-traumatic stress disorder (PTSD)" (2021) claims traumatized patients seek for sensation of anxiety and traumatic stress after inflicted by it. Hence the initial theory presented of having b being as an isolation theory is a matured version of potential multiple personality disorder which is an outcome of patient seeking for harmful environment based on their addiction to PTSD while their efforts keep them separated from normal healthy socializing world. Hence, Figure 4. is the premise of Figure 3.

Therefore, it is possible to theorize that people crave to understand and shape perceptions of others to socialize, which could be defined as "constantly changing relativity effects." For those patients with multiple personality disorders, they do not have the privilege of creating relativity by socializing due to a pervasive fear and the childhood trauma they have experienced, so theoretically in order to combat this detriment to their methods of socialization, they create fluency in the relativity effect by splitting personalities within themselves. This very factor can cause the public to fear these patients, which in turn creates more static relativity that isolates them further from society.

Discussion

This paper postulates only a small scope of how psychological pathology works according to the equation of conscious relativity. Will this explain other psychopathology? It will depend on what variables are swapped to represent. As for an example, schizophrenia which can be theorized as:

Figure 1. $P^B/C = D$

Where P stands for perceptions of schizophrenia patient, whereas, B stands for perception of third party assessing schizophrenia patient with a measurement of likeability reflected on C. from scale of 1 to 10. If we were to separate P as

Figure 3. $p^b = 1 = p^o$,

which equals to P with

Figure 4. $1^b = 1$

applied in same fashion in multiple personality disorder, it can be hypothesized that schizophrenia is caused by isolation theory based on static relativity relationship. This could provide a possible explanation for other psychopathologies that are affiliated with the development of psychiatric traits. As multiple personality disorder causation hypothesis states above, every psychiatric conditions are derived from diminished

interactions of socializing factors. As the second example of schizophrenia suggests, such an equation explains multiple personality disorder in a similar fashion: isolation theory (by having *Figure 4.* being the premise of *Figure 3*; and, *Figure 3* being the premise of *Figure 1*). If one is cut off from the world, there is, therefore, a high chance of developing psychiatric conditions that are not limited only to multiple personality disorders or schizophrenia. Based on the equation, if a static relativity relationship is found, those who are susceptible should be warned of it. This is the purpose of the Conscious Relativity Equation.

Conclusion:

This paper went over a theory for the causation of multiple personality disorder. The Conscious Relativity theory also hypothesizes that static relativity is not only limited to multiple personality disorder but also other types of dissociative disorders. And, they all may have one common ground or root cause: isolation theory. Thus, Conscious Relativity Equation is a measurement scale that provides a possible answer to the question of whether isolation theory is justifiable as the root of multiple personality disorder or any other dissociative disorders.

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Primary Caregivers' Barriers to Research

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Abstract

Presently, researchers aim to recruit the most unbiased and representative populations for research studies. In light of the COVID-19 and the rapid societal change affecting study practices in different aspects, this study takes into consideration for conducting remote research as well as filling research gaps in the setting of the pandemic. In addition to focusing on primary caregivers common logistical, demographic, and circumstantial barriers were reviewed and identified (Perrino, T. et al., 2001). Although this is not an exhaustive review, it is a starting point for implementing fundamental changes into how research can be conducted to mitigate barriers to research for primary caregivers.

Keywords: Research, Barriers, Caregivers, Participation

Introduction & Background

In developmental cognitive neuroscience research, studies are often designed to understand disparities of, and differences in, childhood outcomes across different socioeconomic classes, as well as different economic, cultural, and structural experiences. To conduct these studies, researchers must successfully recruit subjects from diverse backgrounds to produce results most representative of target populations. However, a common challenge faced by researchers is recruiting and retaining participants from lower-resourced and racial/ethnic minority populations. This results in research to be heavily dominated by western, educated, industrialized, rich and democratic (WEIRD) populations. There are several barriers preventing people from diverse backgrounds from participating in research studies, which remain poorly studied. Examples of these barriers include lack of financial support, childcare, transportation, lack of trust in science and knowledge regarding the study, and therefore, a hesitance to participate (McElfish, P. et al., 2019). Additionally, the COVID-19 pandemic has disproportionately affected minority communities, presenting new challenges to participating in remote research studies which have not been studied over the past 2 years (Mersha, A. et al., 2021).

To address these knowledge gaps, this study is designed and implements a mixed-methods study to explore the most prevalent barriers, exacerbated by COVID-19, that primary caregivers face when participating in research. COVID-19 has overturned the lives of many populations, and it is now more crucial than ever that researchers take time to truly understand what is happening behind the numbers and data in research. Ultimately, listening to vivid experiences and overseeing a finer investigation into people's thoughts and feelings is vital to broaden research goals and direct awareness to what is important. In the era of pandemics such as COVID-19, it is necessary to conduct research in a safe and accessible manner. Thus, researchers aligned studies with remotely-conducted methodology to improve ease of participation, enhance generalizability of findings, and increase speed of publication of study findings in parallel to viral transmission prevention to either participants or researcher (Saberi, P., 2020). Due to the many limitations that are not addressed by previous

studies, this project is designed to uncover the multitude of barriers that primary caregivers of infants or young children encounter when engaging in research studies. It is anticipated that generating data regarding the most prevalent barriers caregivers encounter will help uncover efficient solutions to promote inclusivity and accessibility in research among New York City residents.

Literature Review

In order to understand previous research involving the barriers to participation, past literature was reviewed to investigate previously conducted studies around this topic. It is notable that following the COVID-19 pandemic, there are many remote research studies that are yet to be published.

Common barriers that prevent people from participating in research include misconceptions of what research studies actually entail, and underlying factors stemming from an individual's socioeconomic status, such as chronic stress. For example, a study which investigated the best practices for participant engagement concluded that the best practices were to "increase participants' trust in research, science, academic/research institutions, improve public perception of research, and implement positive changes in health equity in the conduct of research" (Khodyakov, 2018).

Similarly, another paper addressed changes in participant engagement in a family-based preventive intervention with time and tension. Findings indicated that "higher chronic family tension was related to lower initial levels of engagement but not rates of change. Sessions when families displayed more session-specific tension were characterized by different levels of engagement for parents, depending on their level of chronic tension" (Bamberger, 2014). Previous studies have found that barriers to participating in research include lack of knowledge on the research topic, and stressors that they experience in their home environment, resulting in reduced engagement. However, understanding how factors such as socioeconomic status may hinder participant engagement in research remains understudied. This is a major gap in the literature, because there is no reasoning as to why these factors (such as increased stress, or a lack of knowledge) are caused in the first place.

Parents, especially those of lower SES, could experience higher levels of stress if they have to work multiple jobs to provide for their family, are experiencing food insecurity, or have limited access to childcare. There are also many fundamental barriers in improving public perception about research, including income inequality and level of education. For example, many studies involve using electroencephalogram (EEG) caps and heart rate monitors on children and adults, however some families are apprehensive in participating because they may assume it is invasive and potentially harmful. Because people might be unfamiliar with methods like EEG, they might not participate in these studies, which is a primary barrier. Thus, this project is designed to understand knowledge gaps to design interventions for primary caregivers in the future.

The study seeks to explore barriers on an individual level by studying an individual's income, familial environment, child care accommodations, food security, language barriers, and perceptions of devices such as EEG caps and heart rate monitors. The literature review underscores that the biggest similarity between all of the research is confined to participants that were generally well-educated, industrialized, and to individuals who belonged to a higher SES. The aim is to break this barrier, and study caregivers of all different backgrounds.

Lastly, previous research on this topic studied adults, whereas the project seeks to study primary caregivers with infants and young children. This specific population has not been studied as often, which makes the proposed project unique and generalizable. Studies should be made to be more accessible to parents of all different backgrounds, with hope to expand the

research of infants and young children, and advance knowledge on the impact of the social and language environment on early neurocognitive development.

The aim for this research is to be widely inclusive, especially to underrepresented communities, to realize a comprehensive understanding of how to increase accessibility and inclusivity in science and psychology.

Materials and Methods

First, we conducted a literature review on research barriers in previous studies to understand the current and commonalities of existing research. We interviewed 40 participants through Zoom, all of whom were living in any of the five NYC boroughs, with a child/children 10 years or younger. The interview consisted of survey questions asking them about their comfort level with various lab tasks, experiences related to research, and general life difficulties. We also introduced certain survey themes that pertain to lab research participation, like comfort, comprehension of lab procedures, ease of traveling and transportation, etc.

In terms of demographics, participants identified as African American (80%), White (15.0%), Asian (2.5%), and Multiracial (2.5%). Roughly half of the sample reported obtaining a Bachelor's degree (52.5%), 42.5% obtained a Master's/Professional degree, 2.5% of our participants obtained an Associate Degree, and 2.5% have less than a college degree. Finally, 30% of our participants had an annual household income of less than $75,000 while 65.0% of our sample had an annual household income greater than $75,000.

Results

Most participants preferred remote interviews pre-COVID (67.5%), during COVID (85%), and post-COVID (65%). Prior to data analysis, it was hypothesized that there would be an association between any given barrier to participating in research, and participant income level. No association was found between any specific barrier to participating in research (p = 0.12) or reason for participating in research (p=0.25) and income level through performing a Chi Square Analysis. This suggests that caregivers across all income levels face similar barriers and have similar reasons for participating in research. Of all the survey themes, participants had the highest median response, on a scale of 1-5 (where 1 is extremely uncomfortable and 5 is fully comfortable), "comprehension of research staff's instructions" had the highest median of 4.69, and "comfort with using EEG caps" had the lowest median of 3.55. The top three barriers amongst the sample were "hours of participating don't work with my schedule" (65%), "lab safety concerns" (47.5%), and "not provided with enough information about the study" (32.5%).

Conclusion & Discussion

Based on the data, it can be concluded that the issue is not a family's lack of interest in research, policy, and understanding of children, but that there are barriers they experience which prevent their participation, like inconvenient lab hours, safety concerns, and a lack of information regarding the study. Researchers do not need to convince possible participants that research is important. Instead, research teams should focus on the logistical barriers that impact primary caregivers, such as the ones mentioned above, as well as knowledge about scientific apparatuses and tests. This can be done through extensive information sessions, offering more travel accommodations/compensation, and developing a more educational curriculum centered around educating primary caregivers on unfamiliar scientific topics such as experimental procedure and unfamiliar apparatuses. These are the changes that should be implemented to truly advance research, so that research conducted in New York City produces results that more accurately portray the diversity of its populations.

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Physical Activity and the Onset of Alzheimer's Disease

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Background

Alzheimer's disease (AD) is a neurodegenerative illness affecting more than 50 million patients worldwide. Alzheimer's has been identified as the most frequent cause of dementia; roughly 5.3 million Americans are impacted by the disease, leading to a major need for an effective, yet economical, treatment in the medical field (Morris et al., 2017). Patients with severe AD require constant living care which is currently not accessible in terms of availability as well as financial means. Although the cause of AD is unknown, research has identified a number of risk factors. Examples of which include substance intake, old age, high fat diet, and more (Jia et al., 2019). There is no cure for AD, and it is considered a fatal disease– with death occurring between 3-9 years after diagnosis (Jia et al., 2019). Current researchers are exploring whether physical activity decreases AD-related symptoms, as well as delays the onset of AD altogether. This paper explores the neurobiology behind AD, and how exercise affects neuronal networks. Moreover, this paper will discuss the prospect of the utilization of exercise as a standardized treatment for AD; implications regarding the combination of intensity and frequency for optimal results for patients will be touched upon as well.

Symptoms of AD vary between patient to patient, however they are classically divided into three categories: memory, motor, and behavioral symptoms (Jia et al., 2019). Memory symptoms go beyond forgetting a colleague's name or where one parked their car; they are more closely demonstrated by forgetting larger chunks of information like an entire experience or person (Toda et al., 2022). Symptoms concerning the impairment of memory affect the patients entorhinal cortex and hippocampal formations first (Jahn, 2022). The entorhinal cortex is the liaison between sensory information and the hippocampus, which is responsible for retrieving the brain's memories. Thus, severe AD limits the patient's ability to retrieve memories as well as forming new ones. AD affects the patient's motor system in terms of dexterity and speed of movements (de Paula et al., 2016). The motor complications from AD are likely a result of the impairments of the patient's cognition as well as neural communication (de Paula et al., 2016). In order to perform meticulous actions well, it is imperative that the different regions of the brain must communicate reliably and efficiently. Toda et al. explore the correlation between behavioral symptoms and the severity of cognitive function. Symptoms such as agitation, irritability, anxiety, depression, emotional distress, and more are all common behavioral symptoms and were identified to increase alongside the severity of cognitive deficits (Mega et al., 1996).

The treatments administered for memory-associated symptoms are medications called "cholinesterase inhibitors" or vitamin E supplements (Karceski, 2012). Medications for memory symptoms are only administered to those with mild to moderate cases and have shown varied success in slowing down the progression of memory loss (Karceski, 2012). Motor symptoms affect the patient's ability to talk, control facial expressions, body rigidity, body posture, bradykinesia, and tremor (Wirths & Bayer, 2008). The current treatment for the loss of motor function in AD patients is treadmill exercise (Lee

et al., 2014). Consistent but short duration treadmill walking increases coordination and balance of the subjects (Lee et al., 2014). The behavioral symptoms involve changes in mental and emotional capacities and they notably progress along with the disease. Treatments for behavioral symptoms can be prescribed anti-anxiety medications, antidepressants, and sometimes antipsychotics (Corbett, 2012). Patients with late-stage AD often lose control of many basic motor functions; this symptom has few viable treatment options outside of assisted care (Wirths & Bayer, 2008). With limited treatments for AD, it is crucial for researchers to discover and implement new treatments in order to slow the progression and severity of the disease.

Aducanumab is the newest FDA approved treatment for Alzhiemers as of December 2022 (Alia, 2022). The new drug is a monoclonal antibody that attacks the Aβ plaque buildup in the patient's brain(Alia, 2022). Although new treatments are arising, there are no drugs available for prospective patients to take as a preventative measure.

Exercise: Resilience against Alzheimer's Disease

Liang et al. spearheaded research involving exercise and tracking AD biomarkers (2010); in this research, participants who exercised regularly had lower levels of tau. Among various other compounds, tau is a naturally occurring protein found in the nervous system that exhibits uncharacteristic qualities when a patient is suffering from AD (Liang et al., 2010). The typical function of tau is to secure and stabilize microtubules in the brain. However, in a patient with AD, the unusual shifts in chemicals lead to the separation of the tau protein and microtubules; consequently, the excess tau becomes entangled with itself, forming neurofibrillary tangles (NFT), which ultimately blocks many synapses and disrupts neuronal connections (Vasilevskaya et al., 2020). Liang et al. tracked the relationship between levels of tau and exercise; elevated tau levels (and various other AD

biomarkers called PIB and ptau181) correlated with participants who participated less in exercise and vice versa (2010). The relationship between exercise and a reduction of tau levels indicates that with added physical activity the cognitive functioning of patients with AD will be improved.

Besides entangles of neurofibrillary tau, there are other neurobiological indicators involved in diagnosing AD (Chen et al., 2016). An important protein associated with AD is the beta-amyloid protein (amyloid-β or Aβ). Aβ is formed from the breaking down of the amyloid precursor protein (APP) (Zhang, 2011). APP is a transmembrane protein found on neurons in the brain. Normally, APP can be cleaved by α-secretase. The products of this cleavage result in soluble fragments of APP (Zhang, 2011). When APP is cleaved by β-secretase and then sequentially cleaved by γ-secretase, the insoluble Aβ protein is the product (Zhang, 2011). The Aβ is naturally self-adherent in nature and will agglomerate when an excess amount is present. When Aβ protein is found in surplus in AD brains and is prone to cluster together causing what is called Aβ plaque (Zhang, 2011). The Aβ plaque build-up and tau proteins work in conjunction with each other, especially in memory-related areas of the brain like the hippocampus and the entorhinal cortex, to disrupt normal cell function (Chen et al., 2016). Neurons with Aβ plaque build-up and abnormal tau levels experience synaptic dysfunction that disrupts neuronal communication (Zhang, 2011). Additionally, the formation of intraneuronal fibrillary tangles leads to neuron loss (Zhang, 2011). Symptoms arise because of "neuron degeneration, low neurotransmitter levels, and loss of synapses in the brain" which disrupts normal brain function (Alia, 2022).

Further research by Liang et al. explored if there was a potential correlation between increased physical activity and a decrease of Aβ plaques– as seen with tau tangles (2010). However, a nonsignificant correlation of Aβ reduction was recorded in the case of increased exercise (Liang et al., 2010). Research from Chen

et al. explored how exercise affects the brain of AD patients through a meta-analysis of various studies (2016). The information from Chen, W. et al. contradicts the Liang et al., 2010 study findings. Chen et al., identified that both tau and Aβ plaque levels in the brain were reduced with consistent and extensive exercise through a meta analysis of various studies (2016). One of the experiments considered by Chen et al. was a study conducted by Yuede et al. in 2009 about the effect both voluntary and forced exercise had on plaque deposition in mice. The data collected by Yuede et al. suggests that voluntary exercise reduces hippocampal degeneration (2009). These results imply that there is a correlation between exercise and an increase in neuroplasticity which would be beneficial for patients with AD. Additionally, they describe exercise to have a "neuroprotective" effect on the brain because of the beneficial enzymes and growth factors that are produced when exercising (Chen et al., 2016).

The specific type of exercise which slows the progression of AD has yet to be determined; however, aerobic exercises with a middle to high intensity are considered ideal when taking into account the limited information we have on AD. Aerobic activity has been shown to improve the quantity of cortical region's gray matter over time indicating strong neural connections and communication (Chen, et al., 2016). Aerobic exercise promotes increased neurogenesis and synaptogenesis by increasing blood flow in the brain and strengthening the capillary system. (Kaliman et al., 2011). Neurogenesis and synaptogenesis activity is increased when blood flow is higher (Chen et al., 2016). With AD, a common symptom is the loss of neurons. Neurogenesis is the growth of neurons from stem and progenitor cells. Similarly, synaptogenesis is the formation of connections between neurons. Losing synapses is another symptom of AD because of the excess neurofibrillary tangles created from excess tau. Improving neurogenesis and synaptogenesis in patients with AD would be beneficial for cognitive function.

Patients wanting to regain or maintain cognitive function rely on their neurons and synapses functioning and remaining healthy, something that exercise naturally encourages. Results reported by Morris et al. (2017) further support the previous research. Morris et al. conducted a 26 week random trial with adults who were diagnosed with early-stage AD. The effects of both aerobic and anaerobic exercise on cognitive functioning were examined. The first group was instructed to do a minimum of 150 minutes of aerobic exercise per week, while the other group was instructed to engage in an anaerobic stretching routine (Morris et al. 2017). The participants' caregivers monitored their neuropsychological symptoms of AD– using the Disability Assessment for Dementia– and reported them in the beginning of the study, halfway through it, and at the endpoint. According to Morris et al., patients with AD and no exercise regimen normally drop about 1 point per month (100 being a perfect score) on the cognition test (2017). In this experiment, participants with the aerobic exercise regimen gained an average of 1.5 points throughout the 26 weeks. Alternatively, the anaerobic group decreased with a mean of 4.5 points over the course of the study. This suggests that consistent aerobic exercise has a beneficial impact on those with early stages of AD. Moreover, despite the anaerobic group performing worse on the cognition test, they performed better than projected. Morris et al. expected them to lose 6 points on average–one point per month– but they only lost 4.5 (2017). The data showing the average loss of only 4.5 points may indicate that the anaerobic exercises don't improve cognition but suggest that they may be effective in slowing down cognitive decline in patients with AD. The results of this study correspond to and affirm the cognitive benefits of exercise mentioned by Chen et al. in their review (2016). Chen et al. suggests that exercise is beneficial for patients with AD because of the increased probability of neurogenesis and synaptogenesis that results in enhanced patient cognition (2016). The Morris et al. study provides data that supports the

relationship between anaerobic and aerobic exercise and levels of cognition (2017). More specifically, anaerobic exercise was shown to slow down neurodegeneration and aerobic activities improves patient cognition scores (Morris et al. 2017).

Research on aerobic and anaerobic exercise on Alzheimer's has further explored their effects on cognitive ability and the onset of AD. Past research conducted by Paillard et al. demonstrated that a possible method of exercising is a "multicomponent" approach (2015). A meta-analysis of multiple studies with different exercise regimens and intensities found that physical activity reduces "the risk of developing AD by 45%" which further supports the idea of a multicomponent approach (Paillard et al., 2015). Additionally, physical activity has been shown to delay the onset of AD, as well as reduce its mortality (Chen et al., 2016). Other research suggests that the social aspect of exercising is an important factor for improving cognitive functions (Paillard et al., 2015). Results from research performed with patients with AD have shown the "socialization effect" (Paillard et al., 2015). Exercise, specifically walking, with another person resulted in stronger preventative effects than those who exercised alone. Lastly, this kind of disease calls for intense and time-consuming care which burdens the patients economically (Jia et al., 2019). One of the fantastic parts about viewing exercise as a component of treatment, is that walking or practicing yoga is relatively cost-free and will not add to the tremendous cost of living with AD.

Discussion

The reviewed research sparks compelling questions about the efficacy of exercise in delaying the onset of and improving the symptoms of AD. A baseline level of agreement among all sources was clear; exercise has beneficial outcomes for patients with AD. An aspect of this treatment which is still debated between researchers is which exercise methods prove to be the most effective in increasing cognitive ability in AD

patients. One confounding variable of this research is the difficulty in testing the effects of exercise on AD patients; these patients may not be easy to work with and, when suffering from severe AD, struggle with high level comprehension. Furthermore, behavioral symptoms that may arise, like depression or irritability, may make it harder for patients to meaningfully participate in exercise. It is very difficult to, in real-time, track someone's AD progression. AD affects a small but significant portion of the population, thus tracking its onset is very difficult as no patient's timeline is the same. The research findings unanimously suggest that the best course of action to delay the onset of AD is a combined approach of aerobic exercises and strength/balance training. For maximum cognitive benefits, connecting the different aspects of exercise would produce the most consistent and desired result. Some practical further research would involve studies comparing frequency, intensity, and duration of exercise, as well as which combinations elicit the most favorable results.

A benefit of understanding how exercise interacts with the brain is that obtaining an understanding of how the neural connections remain intact has important implications for the creation of medications and treatments. Exercise seems to be a promising component for future AD treatment. Studies have shown that cognition and motor abilities are improved in patients with AD with an implemented exercise regimen. Although some specific aspects of this treatment are yet to be solidified, the data supports the future of exercise treating aspects of AD. Current research into drugs for treating AD builds off the same benefits as exercising. Much like exercising, *Aducanumab* is designed to lower Aβ plaque build up. This drug is a monoclonal antibody that will attach to the Aβ proteins themselves and break them down. In trials, the drug has shown to be effective in lowering levels of Aβ build up and improving cognitive function (Alia et al., 2022). The results of treating a patient with *Aducanumab* is similar to the results produced from experiments treating patients with exercise

regimens.

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Group Therapy As A Way to Increase Resilience in LGBTQ+ Patients

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LGBTQ+ individuals are 2.5 times more likely to experience depression, anxiety, and substance abuse compared with heterosexual individuals (Kates, et al., 2016). Many queer patients have reported that they have experienced discrimination from both medical and mental healthcare providers, often causing them to delay or forgo necessary treatments (Safer, et al., 2016). To prevent this, healthcare providers must be educated on and qualified to treat the specific needs of LGBTQ patients. Research done at The Rainbow Heights Club in Brooklyn suggests that peer-led, community-run group therapy is a highly effective way to address these needs, as it focuses on strengthening resilience factors such as community support, which LGBTQ individuals often lack.

Resilience-Based Therapy (RBT) is a branch of Cognitive-Behavioral Therapy (CBT) that focuses on building resilience factors (Joyce et al., 2018). Sadhbh Joyce defines resilience as the "process of bouncing back from difficult experiences and adapting well in the face of adversity, trauma, tragedy, threats or significant sources of stress" (Joyce et al., 2018). There are many factors in someone's life that boost or improve resilience and these are called resilience factors (Kwon, 2013). There are a number of different resilience factors but not all are equally important. The most important factors are a supportive environment, high self-esteem, wealth, and interpersonal connections (Kwon, 2013). While all of these factors are of great interest, the focus here will be on interpersonal connections as this is likely the factor most directly and successfully addressed in RBT.

Resilience-based therapy is often used to treat victims of traumatic events and it has, for instance, been particularly successful in the treatment of women in abusive relationships (Anderson, et al., 2012). This success is promising for queer populations because they often lack the same resilience factors the women in these situations lack such as self-worth and community support. Abusers will make attempts to isolate their victims, chip away at their self-esteem, and even gain control of their finances. They create an environment designed to trap these women (Anderson, et al., 2012). This same study found that treatment of these women is most effective when it builds up the specific resilience factors the abuser deliberately tore down. They found that the most important resilience factor was that of interpersonal support. The women in the study consistently stated that their recoveries would not have been possible without the support of the other members of the program (Anderson, et al., 2012). Targeting interpersonal resilience factors creates a domino effect of positive changes to one's resilience. Each interpersonal connection provided an additional resilience factor to the patient (money, self-esteem, supportive environments, etc.) and catalyzed their recovery (Anderson, et al., 2012). The same results were found in children suffering from sexual abuse (Flett, Flett, and Wekerle, 2015), homeless populations suffering from substance abuse (Lewis, Hopper, Healion, 2012), and interestingly, in children with severe Generalized Anxiety Disorder (Watson et al., 2013). Study after study found that interpersonal support systems and relationships helped patients recover in ways they could not have without these connections.

So where do queer people fit into this

equation? This directs one's attention toward Ilan Meyer's groundbreaking study on stress in the LGB community and the minority stress model. The Minority Stress Model describes different kinds of stressors experienced by sexual identity minorities and how they interact with each other as a system (Meyer, 2003). The initial stressor comes from firsthand experiences with bigotry and exposure to hate. These experiences cause persistent states of anxiety in queer populations as they then fear they will experience bigotry again in their day to day lives. They then incorporate these experiences with bigotry and negative expectations into their idea of self-worth (Meyer, 2003). In this way a bigoted society acts as a trauma or stressor that has the ability to exacerbate or trigger mental illnesses. This situation is only made worse by the fact that LGBTQ+ people generally have fewer resilience factors than cisgender and heterosexual populations. This discrepancy in resilience is influenced by their social isolation in heteronormative groups which influences interpersonal connection, internalized shame which affects self-esteem, and economic disadvantages through biased hiring practices which is a determining factor in wealth and socioeconomic status (SES) (Kertzner, et al., 2009). As such, queer people are not only under more stress than heterosexual populations, but they also have fewer defenses against the stressors.

Parallels between victims of domestic abuse and queer people include unsafe home lives, a reduced sense of self-worth, social isolation, and a tendency toward maladaptive coping mechanisms like substance abuse along with their increased rates of depression, anxiety, and post traumatic stress disorder (PTSD) (Klien, 2017). Both groups lack the same resilience factors. The stressors are different but the handicaps are the same, so when a domestic abuse patient and a queer patient are met with significant trauma, as they are likely to experience, they will likely exhibit and develop the same conditions and maladaptive coping mechanisms[7] .It would be reasonable to suggest that treatments that worked for victims of domestic abuse might also be effective in treating queer patients.

So what worked and what does this treatment look like? As previously stated, resilience-based therapy that focuses on developing interpersonal relationships has been shown to be successful in treating trauma. Therapists will often encourage women leaving abusive relationships to reconnect with their families and old friends who can support them in this difficult, and often dangerous, transitional period (Anderson, et al., 2012). This can be more difficult for queer patients who often cannot rely on their families for any form of support and have to build their own network of support through members of the LGBTQ+ community (McCann, Brown, 2019). Queer communities are often communities of transplants, people who have left their hometowns and home states in favor of typically more open-minded cities. Many LGBTQ+ individuals experience a vulnerable period of time wherein they are new to a city and do not have any close interpersonal connections. Group therapy serves to substitute their lack of family ties and provide another form of social support. This is the basis for a program called the Rainbow Heights Club (RHC) studied by Eileen Klein.

As social animals, humans need social relationships. Queer people growing up in hetero-normative environments especially flourish once they find LGBTQ+ connections, though his often does not happen until adulthood. "Perceived social support was found to correlate moderately to highly with greater life satisfaction, less depression, and less loneliness in samples of these lesbian individuals [who had a close friendship with at least two other LGB individuals] from both university and community samples" (Kwon, 2013). Findings like these encouraged the formation of the Rainbow Heights Club. The club combined the mental healthcare of therapy with the community-based activities of an adult summer camp. The main appeal of the club is its peer-run group therapy sessions that help patients form social connections

with other patients. Klein's research on the efficacy of the organization "concluded that in a peer-run and supportive culture, clients can feel they have authentic relationships based on honesty and mutual accountability." (Klein, 2017). This mutual concern and accountability is not only between peer leaders and their patients but also between the patients themselves. Research has consistently shown that social support is a vital factor in resilience, and it is the factor most targeted by this type of therapy.

In peer-led group therapy (PLGT), mental health professionals who "have experienced mental illness themselves and share the lived experience of the clients in the agency" facilitate sessions (Klien, 2017). If the session is about dealing with anxiety in healthy ways, patients can be assured that the therapist leading the discussion at the Rainbow Heights Club is a queer person with an anxiety disorder. Patients are able to better connect with these providers and regard them as positive role models because of their similarities.

Traditional individualized therapy has limitations, as all treatments do. It may give patients knowledge of the basic tools to improve their resilience, but this does not necessarily translate to any skill at using these tools. Whereas, PLGT practices in RHC are focused not only on providing knowledge of these tools, but also active development of them. It helps instill individual resilience but cannot, by itself, bring about community or interpersonal resilience. This type of therapy helps people develop healthy coping mechanisms and manage their stress but it is only one gear in the immense clockwork of psychological well-being. A person's mental health is directly tied to their environment, and it is difficult to make lasting change without addressing these underlying problems. Individualized therapy doesn't actively change someone's environment but it does help them deal with problems in their environment. As mentioned earlier, group therapy can create social connections for its patients. If a patient's presenting problem is that they feel alone but don't know how to talk to people and form

relationships, individualized therapy can teach them how to improve their social skills and alleviate social anxiety. In group therapy, however, that same patient has the opportunity to talk to similar people in an accepting and supportive environment.

Discussion

The use of resilience-based therapy within LGBTQ+ populations has the ability to bridge the gap between providers and the community, allowing a therapeutic experience that is more tailored to LGBTQ needs. The peer-led group therapy approach pioneered at the Rainbow Heights Club seeks to address the prominent feelings of isolation in the queer community as well as the widespread distrust in mental and medical health practitioners. This approach allows the clinic to change a patient's environment into one more supportive to their needs by placing isolated people into communities rife with proof that their situations can improve.

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The Role of Dopaminergic Pathways in the Neuromodulation of Synaptic Plasticity in Motor Learning

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Introduction

What does one need to do to learn a new skill associated with motor movements, such as in the case of riding a bicycle which requires pedaling, involving the execution of sequential motor movements? Based on present scientific studies, the most obvious answer might be procedural memory. However, there are more players who come into play if we explore what happens within our brains as we learn new motor skills.

Dopaminergic pathways are known to play a crucial role in learning and memory mainly as a rewarding mechanism that provides reinforcement for certain behaviors and controls motivation for the execution of action (Wickens, et al., 2003). They also play an important role in synaptic plasticity, which is associated with the learning and acquisition of acquiring new motor skills (Beeler, et al., 2010). However, the role of the dopaminergic pathways in synaptic plasticity in motor learning still remains unclear, being subjected to a debate in the scientific community. What are the molecular and cellular mechanisms of synaptic plasticity in motor learning in the primary motor cortex? How can dopaminergic projections and localized receptors regulate synaptic plasticity in M1? Which neural pathways are involved in this process? This paper will explore dopaminergic neuromodulation on molecular, cellular, and organ levels in order to investigate the role of dopamine in synaptic plasticity associated with motor learning assessed in different contexts. (behavioral, disease, artificially induced learning deficits, etc.) to answer these questions.

The Molecular Effects of Dopamine

Dopamine (DA) is one of the main neurotransmitters which are important for the execution of physiological functions in an organism, referring to motor control, mediation of emotional states and mood, motivation, and reward, behavioral reinforcement, and control of high-order cognitive processes.

Dopamine or 3,4-dihydroxytyramine, is produced by dopaminergic neurons in the brain. It is synthesized from a precursor amino acid called levodopa (L-DOPA) (also serves as a precursor in catecholamines), which is transformed into dopamine afterwards as the carboxyl group is removed. DA vesicles are released into the synaptic cleft upon the increase in the intracellular $Ca2+$ ions, then dopamine binds 2 main types of receptors in the postsynaptic cell - DA1 and DA2. These receptors refer to the G protein-coupled metabotropic type of receptors (GPCR), which activate adenylate cyclase and use cAMP pathway for signal transduction. DA1 is known to be an excitatory receptor that produces EPSPs upon activation, whereas DA2 is an inhibitory receptor that facilitates IPSPs (Bear, et al., 2020). These 2 antagonistic receptor types are involved in long-term potentiation (LTP) processes and long-term depression processes (LTD) as part of the Hebbian plasticity mechanism which will be described later. Therefore, they can either facilitate or depress synaptic plasticity. LTP is the process

by which the existing connections between synapses become stronger as the AMPA receptors' sufficient depolarization causes the subsequent activation of NMDA receptors which release the block of Mg2+ ion, so that the active Ca2+ influx causes the addition of new glutamate-sensitive AMPA receptors into the cellular membrane. These additional receptors allow more positively charged ions to enter the cell and make the postsynaptic cells more sensitive to glutamate, making the synapse stronger, as it becomes more likely to be activated in the future. LTD is the opposite process of LTP and leads to synapse weakening through the reduction of available AMPA receptors, spanning the membrane (Missale, et al., 1998). Recent research showed that low concentrations of dopamine lead to the enhancement of NMDA-mediated currents and inhibitory transmission through the activation of D1 excitatory receptors (favors LTP), whereas high DA concentrations weaken NMDA-mediated currents, producing an effect mediated by D2 inhibitory receptors (favors LTD). These findings illustrate the potential role of DA in LTP and LTD formation. Through the regulation of NMDA-mediated currents, DA can modulate the sign ((+) potentiation vs. (-) depression) and amplitude of synaptic plasticity by having an impact on the LTD/LTP threshold (Sheynikhovich, et al., 2013).

The influence of molecular DA on key synaptic plasticity on the molecular level can be projected to the main neural circuits associated with dopaminergic modulation in our brain to explore the role of dopamine in reward and motor control important for motor learning.

Dopaminergic Pathways

The highest density of dopaminergic neurons (up to about 75%) can be found in the ventral midbrain, where 3 distinct nuclei are located that give a rise to 3 major dopaminergic pathways within the mammalian brain. They are: the substantia nigra (SN) (projects to the dorsal striatum, thalamus, and putamen, forming the nigrostriatal pathway), the mesolimbic (ventral tegmental area projected to PFC, nucleus accumbens (nAc), amygdala, cingulate gyrus, hippocampus) and the mesocortical (also projects from ventral tegmental area to PFC). The nigrostriatal pathway is involved in motor planning and execution of planned movement (Albanese, et al., 1986). Through the research on planned movements executed by monkeys, it was inferred that the cortico-basal ganglia-thalamic circuit is innervated by dopaminergic fibers from SN (Filion, 1979). The activation of SN is known to be linked to the reward pathway. In line with the observation, the experimental procedure was modeled such that the monkey was encouraged to learn a specific pattern of movements reinforced by a rewarding stimulus (juice) which was associated with the activation of SN (assessed through single unit recordings) and the release of DA. The dysfunction of the nigrostriatal pathway is associated with the reduced levels of DA produced that may lead to the development of movement impairments or disturbances such as in Parkinson's disease (will be discussed later in the paper). The mesolimbic pathway is thought to be involved in learning modulation, operation of working memory, and long-term memory formation. When a person perceives primary (e.g food, sex) or secondary (e.g. money, trophies) rewarding stimuli, dopamine through this pathway will be released and bind the DA receptors located in the nAc (ventral striatum) and the PFC, to ultimately cause feelings of pleasure, excitement, and increasing motivation. The action of the mesolimbic pathway allows a person to reinforce beneficial behaviors, thus, can play an important role in motor learning on the behavioral-executive levels as can be seen from the behaviorist operant conditioning experiments and Pavlovian conditioning. The mesocortical pathway controls the execution of many cognitive processes. Through the connection to PFC, it affects decisions and actions as well as executive skills and planning (Albanese, et al., 1986). The main focus of this paper will be the nigrostriatal dopaminergic pathway, projecting to the striatum.

Synaptic Plasticity

Plastic changes that occur within the mammalian brain are usually defined as the adaptation in response to experience (Bear, et al., 2020). The space within the skull is limited and the brain is organized such that the cortical surface area is packed in this limited space effectively, so there is not much space available for the new neurons to form new neural circuits as one acquires new motor skills or learns other relevant information from life experiences. In a situation where the neurogenesis is limited, synaptic plasticity becomes extremely important as it allows to make changes in connections between the existing synapses or forms new synapses, by strengthening or weakening connections between the existing neurons.

There are 2 main theories underlying the mechanisms of synaptic plasticity. The classical paradigm refers to homosynaptic plasticity (also called Hebbian activity-dependent synaptic plasticity). This type of plasticity requires presynaptic activation of the synapse, which induces the activation of a neuron, so the induction process can occur (Sejnowski, et al., 1989). Originally, Donald Hebb proposed that the firing of the pre/post-synaptic neurons which happens close in time can potentiate (or increase) the strength of the connection between the 2 neurons for a long time (evoke LTP). Hebbian plasticity implies associativity between the activation of 2 neurons (the golden rule: neurons that fire together, wire together) and input specificity (the plastic change will occur only in response to the specific cell firing) consistent with the molecular mechanisms of synaptic plasticity discussed previously (Speranza, et al., 2021).

The homosynaptic plasticity theory gives rise to Spike-Timing Dependent Plasticity (STDP) which contributes to learning and memory operations, being controlled by temporal pairing between the action potential (AP) spikes of pre/post-synaptic neurons. As the STDP takes place, a repeated presynaptic AP spike arrives at the synapse within 2 milliseconds before the LTP is evoked by a postsynaptic AP (potentiation or increase in strength between 2 synapses happens). Alternatively, if a repeated presynaptic spike reaches the synapse 2 milliseconds after the postsynaptic spike the LTD is induced (depression or weakening in strength between 2 synapses happens). As shown in research with rodents, dopamine plays a modulatory role in STDP and expands the time period required to detect a "coincidence" in spiking in the pre-/postsynaptic neurons. Therefore, one can induce LTP or LTD by manipulation of DA levels in STPD.

Another theory of synaptic plasticity is heterosynaptic plasticity. It is not as input-specific as homosynaptic plasticity and can still induce changes at synapses that remain inactive during the induction of plasticity. In this type of plasticity, the strengthening or weakening of the synapse does not depend on the activity of pre/postsynaptic neurons, but can be influenced by firing an AP by a distinct modulatory neuron.

Recent research (Speranza, et al., 2021) suggests that there are 2 major forms of heterosynaptic modulation - associative and non-associative. The mechanism described above is relevant to the non-associative form of heterosynaptic modulation, but the associative form incorporates the mechanisms of both heterosynaptic and homosynaptic types of plasticity. The associative type of heterosynaptic plasticity is known to influence procedural memory involved in motor learning and is hypothesized to play a modulating role in dopaminergic innervation of the hippocampus by either VTA or locus coeruleus as an additional source of dopamine. For the subsequent understanding of DA effects on the synaptic plasticity in motor learning, the paper will focus on the homosynaptic plasticity theory proposed by D. Hebb since it will be most relevant among the 2, although heterosynaptic plasticity may also be involved in motor learning (requires further research).

The Underpinnings of Motor Learning

The primary motor cortex (M1) along with the supplementary motor area (SMA) is known to be critical for motor skill learning. Recent research showed that repetitive training of a particular motor skill could mediate changes in motor map organization (Hosp, et al., 2011). For instance, sequential skill training interventions expand movement representations that refer to trained limb areas (i.e. execution of a particular pattern of movement becomes possible) in the motor cortex of rodents, primates, and humans. These changes are associated with functional and structural synaptic plasticity which occurs in the motor cortex. Animal research studies demonstrate a significant increase in synaptic density in layers II/III or pyramidal neurons in layer 5 as the new skill is acquired, however, there are no plastic changes observed in the process of skill learning. Synaptic plasticity is the key element in the acquisition of new motor skills as its molecular mechanisms help to enhance (LTP) the neural circuits associated with the newly acquired skill or break (LTD) the neural circuits that are no more relevant (the circuits degrade as there is no repetitive skill training and reinforcement).

As discussed earlier, motor skill learning and performance are highly dependent on the basal ganglia pathways along with the nigrostriatal pathway that connects the VTA and dorsal striatum. According to the research, the dorsal striatum can be mostly involved in "automatized fine skills and micromovements embedded in an action". (Cataldi, et al., 2021) More clearly, the role of the dorsal striatum in motor learning can be identified from the distinct steps of the learning process (Figure 1).
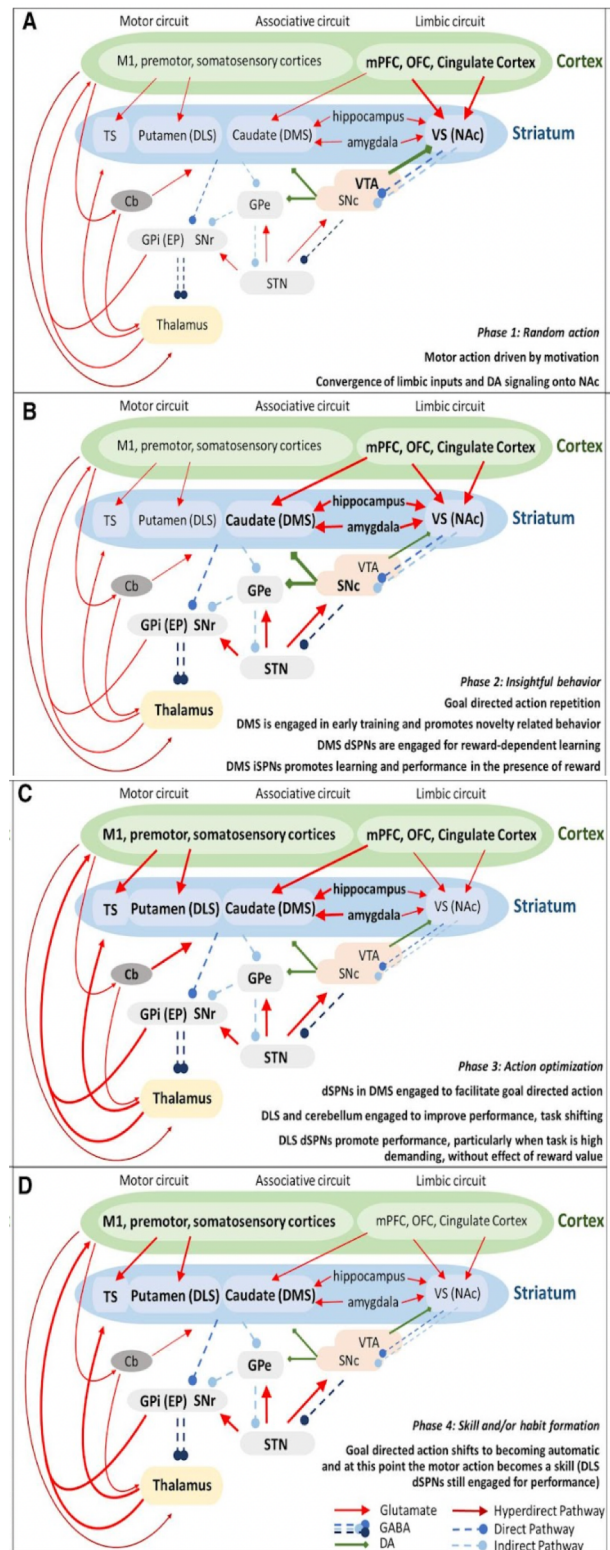
(Figure.1) The schematic representation of circuits involved in motor learning A - phase 1, B - phase 2, C - phase 3, D - phase 4 (Sourced from Cataldi, et al., 2021)

The researchers found that the first step in learning is based on random actions driven by motivation followed by the 2nd step which depends on "insightful behavior" (a person forms an association between a motor action and a specific goal, deciding on the most appropriate ways of achieving the goal to begin repetitive training of the skill). During the 3rd step the goal outcome is optimized with the adjustment of motor activity to reinforce the learned skill until it becomes a stable skill or habit in the 4th step. The nigrostriatal pathway may be particularly important in steps 3 and 4, since DA is involved in motivation and reward mechanisms (tested through pharmacological toxins that block the activation of DA1 and DA2 receptors) necessary for skill reinforcement and strengthening of the formed association between a motor action and action goal (e. g. for a planned movement to reach an object with a hand) (Cataldi, et al., 2021).

Additionally, various lesions to the basal ganglia pathways result in motor impairments. For instance, the lesions in a monkey's caudate and putamen are known to be associated with slow movements and decreased amplitude of executed movements.

Equally important is the fact that motor learning depends on procedural memory according to the case of H. M.; a patient subjected to a lesion of ⅔ of his hippocampi. As the result of the lesion, H. M. had impaired long-term memory which resulted in the inability to form new memories (anterograde amnesia), as well as to recollect old memories (retrograde amnesia). However, contrary to declarative memory, procedural memory remained intact in H. M., so he was able to show improvement in motor learning tasks consistently in the mirror-tracing task. The case of H. M. suggests the importance of the hippocampus for the 2nd step in motor learning (Scoville and Milner, 2000).

Overall, the evidence from behavioral studies, lesions, and pharmacological manipulation with DA receptors demonstrate the importance of basal ganglia in the motor learning process which is also supported by procedural memory.

Dopamine effects on synaptic plasticity in motor learning:

As was mentioned above, the dorsal striatum receives dopaminergic axonal projections from the substantia nigra (SN) and VTA. The role of the dopaminergic pathways in motor learning refers to motivation-reward mediation as well as the reinforcement of relevant motor actions (have positive outcomes) or degradation of irrelevant motor actions (have aversive outcomes) within steps 3-4 in motor learning discussed earlier. Aside from motivation-reward mediation, dopamine can indirectly regulate the velocity, accuracy, and execution of planned motor actions in motor learning (e.g. the inhibition of SN activity prior to the executed motor action can result in failed attempts to execute a movement and reduction of the following motor performance) (Molina-Luna, et al., 2009).

The striatum is preliminarily composed of spiny neuron cells which are targeted by the dopaminergic neurons that project from the VTA areas to the dorsal striatum. The spines receive the dopaminergic input symmetrically (at their "necks" and "heads"). The striatum also receives excitatory inputs from the M1 and thalamus. The DA neurons form synaptic connections with the medium spiny neurons (MSNs) that express DA receptors of different types (D1, D2, D3, etc.).
There are 2 main pathways in the striatum which convey direct spiny neuron projections (dSPNs) and indirect piny neuron projections (iSPNs). dSPNs express D1 excitatory receptors, whereas iSPNs express D2 inhibitory receptors. The difference in the expressed dopaminergic receptors for 2 distinct pathways accounts for the different effects of DA release in the striatum. On the striatal pathway level, the DA release allows either inhibition or promotion of movements through the preceding suppression/activation of thalamic activity upon DA release.

By taking into account this regulatory mechanism and Hebbian homosynaptic plasticity

theory it is possible to link the nigrostriatal pathway with the molecular mechanisms of LTP and LTD which can be involved in the process of motor learning as a person acquires a new motor skill (e.g. a post-stroke patient during the training exercise in the recovery therapy).

The latest research findings (Kida and Mitsushima, 2018) suggest that dopaminergic neurons within VTA can convey a representation of movement. This idea is supported by the fact that DA neurons are involved in the interaction of cognitive and motor systems which can be explained through the exploration of SPNs on the molecular level. Moreover, it was demonstrated that the changes within the nigrostriatal pathway related to the aging process can lead to slower cognitive activity as well as reduced DA release, especially prominent in impaired muscular tonic responses and smoothness of movement associated with Parkinson's disease (PD).

On the molecular level, the shaping of motor behavior patterns and actions can depend on the dopaminergic signaling that mediates LTD and LTP. The experimental data showed that the inhibition of K+ voltage-gated channels in the dorsal striatum (K+ conductance is inhibited with a pharmacological drug) reduces the probability of LTD and verifies the existence of distinct molecular mechanisms for LTD and LTP regulation within the nigrostriatal pathway connected to MI and, therefore, involved in motor learning. The levels of DA release are correlated with the effectiveness of skill learning in the situation where a person is involved in repetitive training of a new motor skill. In such situations, the dopamine precursor (*Levodopa*) distributed as a medication is associated with the improvement of motor activity in stroke patients, as they learn new motor skills. The acquisition of new motor skills requires subsequent plastic changes within the synapses of the existing neural circuits which can be modulated by DA, as DI and D2 receptors are also present in MI. In accordance with the molecular mechanisms of LTP and LTD discussed earlier, MI neurons can either express LTP or LTD, upon activation of

DI or D2 receptors respectively. The expression of LTP in MI will enhance the neural circuit associated with a newly trained skill, whereas the expression of LTD will result in the degradation of the irrelevant circuits which underlie the motor skills which are no longer trained for a long time (Trusel, et al., 2015).

As the research showed, motor skill learning may enhance synaptic strength, claiming that LTP actually strengthens the synapses as the process of learning takes place (Kida and Mitsushima, 2018).

The collective research data (Galvan, et al., 2001; Molina-Luna, et al., 2009; Rioult-Pedotti, et al., 2015) is consistent with the idea that DAergic neurotransmission in the primary motor cortex promotes the learning of new motor skills through the modulation of MI synaptic plasticity modulating. Animal experiments (conducted with rats) with the eliminated DA terminals within MI (intracortical injection of 6-hydroxydopamine (6-OHDA) was made) demonstrate the impairments in the motor learning process. After the injection, the rats performed significantly worse in the "reaching task". In this case, it would be reasonable to think if the impairments in the learning process are linked with disturbances of LTP in MI. Available data shows that inhibiting dopaminergic receptors in MI decreases the probability of expressing LTPs.

Similarly, it was found that enhancing new motor skill learning via MI LTPs may be associated with activating phospholipase C upon activation of DI and D2 receptors in rats. (The inhibition of phospholipase C was linked with a decreased probability of LTP expression) Finally, the research that systematizes the chain of processes related to motor learning described above tested a hypothesis of the role of the dopaminergic VTA projection to MI in the mediation of motor skills learning as the result of induced synaptic plasticity events within MI. The researchers applied the Retrograde Tracing from MI and tyrosine hydroxylase immunohistochemistry in rats in order to confirm the presence of DA cells in VTA. Additionally, the

inhibition of VTA dopaminergic neurons with the antagonists of D1 and D2 resulted in impaired motor learning in rats subjected to the reaching task as opposed to controls. Whereas the learning potential was restored upon the injection of a DA precursor (*Levodopa*) into the primary motor cortex of the antagonist-exposed rats (Kida and Mitsushima, 2018).

After the review of the scientific findings that investigate the links between the key structural components and processes associated with DA and motor learning, the theoretical mechanism of modulation of synaptic plasticity in motor learning by DA can be proposed, which includes the following chain of events: Dorsal striatum receives the DAergic input from the SN via direct and indirect pathways conveying the excitatory or inhibitory effect of DA1 and D2 receptors on the LTPs and LTDs. The effects of LTPs and LTDs determine the function of the spiny motor neurons (SPNs) and modulate the changes in synaptic plasticity within M1 indirectly, as the new motor skill is acquired and reinforced later.

Dopamine effects on synaptic plasticity in motor learning in Parkinson's disease:

The logic described in previous sections of this paper is largely based on animal research. Due to the ethical concerns and specific constraints of human-subject research, the exact molecular and cellular mechanisms of dopaminergic impact on the synaptic plasticity in motor learning can be assessed in the research with Parkinson's disease (PD) patients.

It is known that the disruptions of DA neuromodulation in humans is associated with a set of neurological disorders such as PD, attention deficit hyperactive disorder (ADHD), schizophrenia, and cocaine addiction (Pisani, et al., 2005).

For Parkinson's disease the disturbances of dopaminergic pathways (convey excitatory inputs which are involved in the control of movement execution) along with the

extrapyramidal pathway are thought to contribute to motor dysfunctions. Such disturbances conventionally are thought to be associated with the lowered activity of the striatonigral pathway (Whone, et al., 2003; Obeso, et al., 2008; etc.).

The studies featuring the role of basal ganglia and dorsal striatum in PD patients (Whone, et al., 2003) usually identify the impairment of medial spiny neurons and low DA levels as the main causes of the inhibition of thalamocortical and brainstem motor systems. The lack of DA within the striatum in PD patients diminishes motor control, making it hard for them to learn new motor skills and favoring the development of PD symptoms such as tremors, slowness, and stiffness of movement. Instead, excessive DA concentrations often result in the development of hyperkinetic disorders, such as chorea (induced jerky involuntary, uncontrollable movements, etc.) or neurological tics.

Following the logic of animal studies described above in which the scientists manipulated the DA receptors activity with the implication of injected pharmacology (regulates LTP/LTD), it is reasonable to expect that changes in synaptic plasticity of the striatum as the result of a disrupted activity of DA receptors may underlie the impairment of the spiny neurons (DA imbalance leads to the disrupted bidirectional input in SPNs) in PD as well as the observed neurological symptoms (indirect pathway expressing D2 receptors dominates in the pathological PD condition). In addition to motor performance, memory systems involved in motor learning may also be impaired. The evidence derived from the PD research in humans (Obeso, et al., 2008), which is centered on the plastic reorganizations of the motor cortex regions that receive DAergic inputs, suggests consistent findings with the animal research (inferred from electrophysiology data and behavioral observations). In the first place, there was an identified association between the synaptic plasticity in M1 (contributed to changes in motor neural circuits in PD) and striatonigral dopaminergic projection. Another confirmed

association was the different roles of D1 and D2 receptors in the regulation of synaptic plasticity within the primary motor cortex (M1). Finally, the dysfunction of SPNs as the result of DA deprivation within the striatum was correlated with the observed behavioral deficits in the process of motor learning along with alterations in memory functioning in PD.

These observations in human subjects with PD explain the potential influence of DA on synaptic plasticity in motor learning on the neural pathway-level and provide similar findings in rat studies with a degree of validity. However, due to the limitations of the technology available to be used in research with human subjects, it is hard to assess the plastic changes in motor learning mediated by DA on the cellular and molecular levels.

The research with mice subjected to artificially modeled PD-like conditions showed that the elimination of D1 receptors or the injection of D1 antagonistic drugs induced the lack of long-term potentiation (LTP), disrupting the stable activation of SPNs (or their complete degradation) in the striatum (Xu, et al., 2017). The inhibition of LTD also yielded similar results. Therefore, intact LTP cellular mechanisms may play an important role in the stable functioning of SPNs in PD patients, however, this consideration requires more profound future research.

Equally important is that the study with modeled PD physiological conditions justifies the antagonistic role of D1 and D2 receptors in the mediation of D1-dependent LTP and D2-dependent LTD, providing a scientific account for the maintained balance of the 2 pathways (direct/indirect) within the striatum which authorizes "dynamic adaptations" in synaptic plasticity, as the new motor skills are acquired and retained. Thus, PD-modeled research proposes an inversely parallel explanation for the cellular mechanisms of synaptic plasticity in motor learning, linking D1 and D2 receptors functioning with the functioning of SPNs (degradation or enhancement) (Xu, et al., 2017).

Overall, the context of Parkinson's disease

demonstrates a set of research works that form a solid scientific base for the logical sequence of structures and processes involved in synaptic plasticity in motor learning through the integration of molecular, cellular, organ-level, and behavioral data discussed in the earlier parts of this paper.

Critique of the proposed theory and future research perspectives

Despite the fact that there are multiple sources of scientific evidence of the involvement of the dopaminergic pathways (mainly nigrostriatal) and basal ganglia structures in the mediation of synaptic plasticity in M1 relevant for motor learning, the correlational nature of findings still makes it hard to separate the pathways and structures that are directly involved in the mediation of synaptic changes related to motor learning and reward pathways which are mainly involved in the reinforcement of the learned skills and behaviors.

Ethical concerns and limited technology (mostly electrophysiology and pharmacology, sometimes fMRI) in research with human subjects also make it significantly harder to accurately infer the exact role of the expressed cellular processes such as LTP and LTD in the motor learning process, as they were mostly researched in the context of memory formation and reorganization within the hippocampus. Moreover, further research on the plastic changes in the PD condition that constitute motor deficits tend to question the role of basal ganglia structures in the mediation of motor learning. Taking into account the complexity of the human brain, it may turn out that synaptic plasticity in M1 depends on the combination of activated brain structures and underlying alternative pathways (e.g. the role of mesolimbic DA pathway in motor learning is still not precisely clear despite its role in the reinforcement of learned skills) which go beyond the scope of the proposed DA-M1 mechanism of plastic changes in motor learning. Therefore, more profound research is needed to

address this theory.

For a more holistic understanding of the role of DA in the synaptic plasticity in motor learning its impact and mediational effects can be studied in conjunction with the cholinergic pathways that release acetylcholine (ACh) since it is largely involved in muscle contraction and movement execution (Kida and Mitsushima, 2018).

Conclusion

As a result of analysis of relevant research literature, it is possible to observe the molecular and cellular mechanisms of synaptic plasticity in motor learning within the primary motor cortex which refer to the DAergic mediation of LTP and LTD through the expression of distinct receptors D1 and D2 (supported by the implication of the Hebbian monosynaptic plasticity theory to experimental settings with animals). A wide range of animal studies and studies in the context of PD with human subjects link the DAergic neuromodulation with the function of the nigrostriatal pathway (SN → dorsal striatum), relying on the analysis of the excitatory and inhibitory impacts of LTP and LTD on the normal functioning of SPNs in the striatum which are believed to be involved in the mediation of changes in synaptic plasticity within M1 in the process of motor learning. The research in the context of PD also allows us to generalize key findings of the animal studies (which explore the dysfunction of the striatum, the effects of DA precursor and pharmacological agonists on the functioning of SPNs) in order to prove the consistency of the proposed mechanism of synaptic plasticity in motor learning.

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