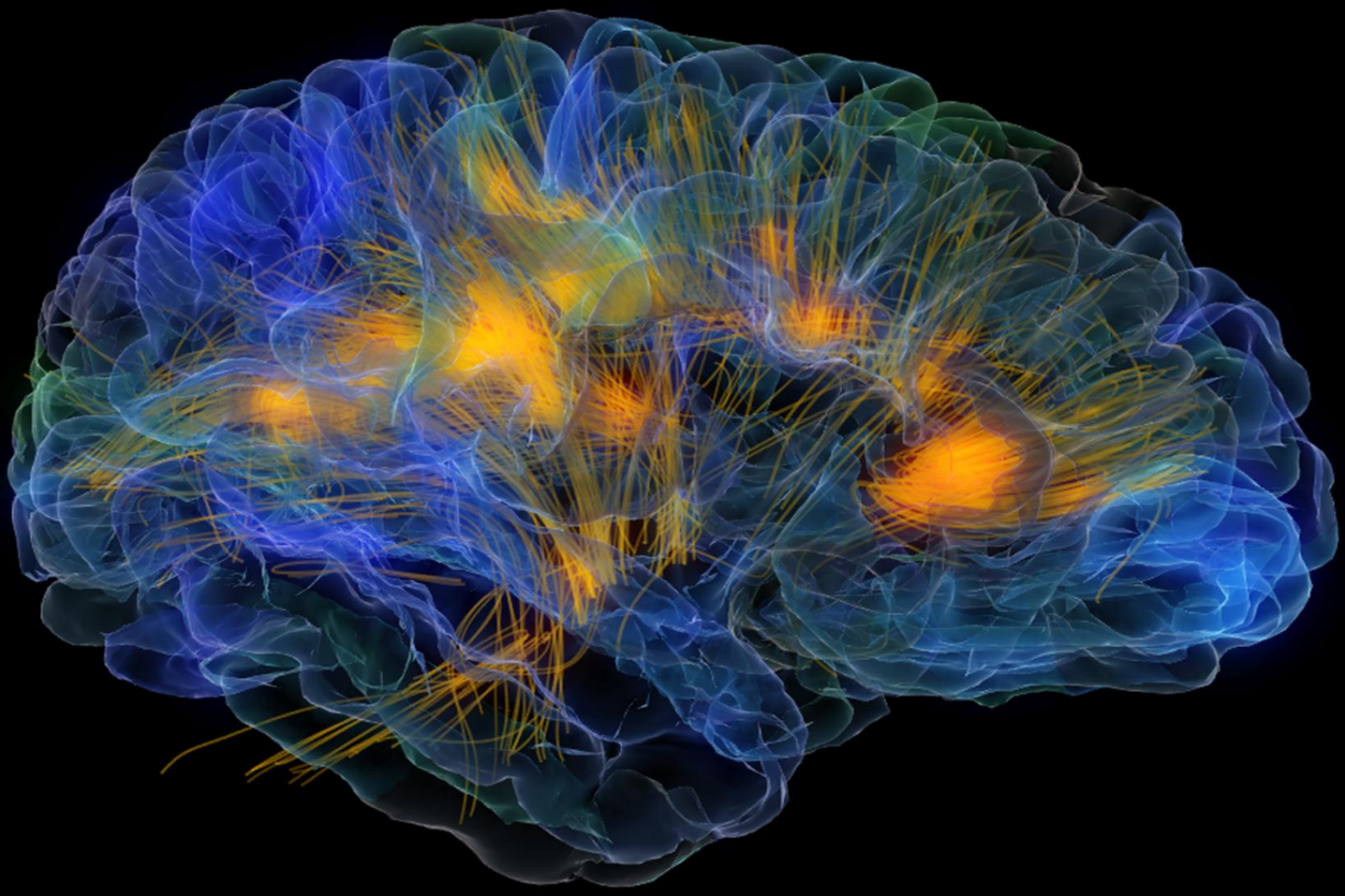
The Undergraduate Journal of PSYCHOLOGY at Berkeley



University of California, Berkeley

Volume X

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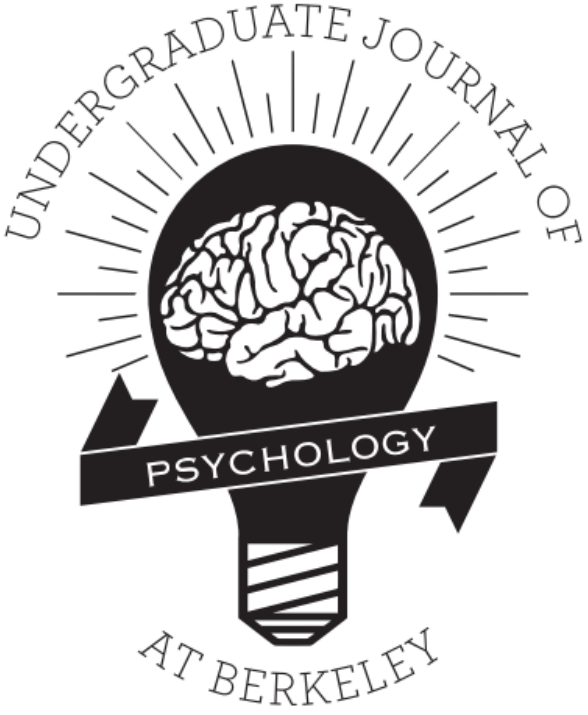
PSYCHOLOGY

AT BERKELEY



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EDITOR'S NOTE

Welcome to the Spring 2017 edition of the Undergraduate Journal of Psychology at Berkeley. In this edition, you will find psychological research articles that intersect with various disciplines, including linguistics and neurobiology.

This year, the journal celebrates its 10th year as an academic publication. On this momentous occasion, it is necessary to acknowledge the dedication and passion of previous Editors-in-Chief. Today we carry their vision forward, having grown our membership and reach, and we hope to use every opportunity in the future to further expand our visibility.

We would like to thank our authors for the privilege of publishing their work, our tireless editors, and our invaluable website and graphic design teams. We would also like to acknowledge the support and guidance of our faculty sponsor, Professor Ann Kring. Finally, we would like to thank our talented Executive Directors, Juwon Kim and Olivia Cavagnaro, whose leadership, tenacity, and intelligence have made our work as Editors-in-Chief a joy.

With gratitude,

VANITA BORWANKAR
Editor-in-Chief

JIGYASA SHARMA
Editor-in-Chief

PREFACE

Welcome to the 2017 edition of the Undergraduate Journal of Psychology!

One of the pleasures of being Chair of the Department of Psychology at UC Berkeley is the privilege to work with the student editors who have put together this journal. It is inspiring to see how they work so carefully to select and edit articles that reflect the very best of psychological science.

At UC Berkeley, we are committed to supporting and promoting research of the highest quality, in order to understand the brain and mind, personality and social interactions, lifespan development, cognition, and mental illness. The papers in the 2017 volume showcase many exciting new findings in different domains of psychology.

Our faculty have the great good fortune to teach and collaborate with a very talented group of undergraduates at Berkeley. Our students not only engage in the intensive study of a problem that reflects their personal interests, but, as important, gain skills in the scientific method. An important part of this skill set is clearly writing about complicated laboratory observations.

Congratulations to all of the participants – contributors and editors alike - who have created another amazing edition of the Undergraduate Journal of Psychology.

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The Biological Attribution Intervention: Effects on Stigma and Help-Seeking Behaviors Among Men of Color

Elizabeth Rangel
Pomona College

Though mental health services have improved drastically over the last 50 years, research has uncovered serious problems concerning access to mental health care. Amongst these problems, the disparity in access to mental health services between People of Color (POC) and Whites is one of the most critical issues. Two behavioral phenomena have been referenced in the literature to explain these disparities− stigma and low help-seeking behaviors (U.S. Department of Health and Human Services, 2001). One intervention that appears to increase help-seeking behaviors is the biological attribution model intervention. The biological attribution model is often thought of as the "medical" model of mental illness, in which a "mental-illness-as-a-disease" framework is applied during the intervention. However, this intervention model has also been shown to increase levels of stigma (Han, Chen, Hwang, & Wei, 2006) amongst predominantly White participants. This study focused on the effects of the biological attribution model of depression intervention on stigma and help-seeking behaviors across race. The intervention did not affect stigma across race, but it did show an effect on help-seeking behaviors. While the White participants in the biological attribution intervention condition indicated increase in help-seeking behaviors, People of Color in this intervention saw a decrease. This work should be used to further guide investigation on help-seeking discrepancies. Implementing a culture-based research approach will help address help-seeking behaviors and barriers to mental health resources without excluding People of Color.

Keywords: depression, biological attribution intervention, People of Color (POC), mental health

Acknowledgements: I'd like to thank Professor Weekes, my Thesis advisor, for her endless support, kindness, and inspiration. I'd like to thank the Pomona College Psychology Department, but most importantly Professors Lewis, Goto, and our Psychology admin Sandy Price. Thank you for your support and input on my work. It was an honor to work with you.

In the last decade, the United States has seen a rise in cases of mental illness (Whitaker, 2011). While interventions and therapies have improved over the last 50 years, there are still serious issues regarding the barriers to accessing mental health services (U.S. Department of Health and Human Services, 2001). More specifically, there are significant disparities in the allocation of mental health services between American ethnic populations, a group of populations collectively referred to as "People of Color," and White Americans (Chunn & Il, 1983). Two behavioral phenomena, stigma and help-seeking behaviors, have been cited in the literature to

help understand these disparities (U.S. Department of Health and Human Services, 2001). By further understanding these phenomena, research will be better able to implement appropriate interventions to address the disparities between White Americans and People of Color.

A report from the United States Department of Health and Human Services (2001) found that racial and ethnic minorities bear a greater burden from unmet mental health needs than White Americans, such that individuals from minority backgrounds suffer a greater loss to their overall health and productivity (U.S. Department of Health and Human Services, 2001). Moreover, a report from the Surgeon General found that stigma attached to mental illness could affect how a patient pursues help through mental health resources (U.S. Department of Health and Human Services, 2001). Stigma is defined as "a process whereby a label sets the labeled person apart from others, links the person to undesirable characteristics and leads to rejection and discrimination," and connotes a separation between the normal and the abnormal (Link & Phelan, 2001). Labels such as "unstable," "crazy," or "dysfunctional" contribute to an environment of blame, discrimination, and distress amongst those suffering from mental illness, thus stigma associated with mental illnesses appears to be a crucial component in understanding the barriers to mental health resources.

Stigma has been proposed to be a barrier in accessing mental health, but the majority of research in stigma has not considered how it affects those who are already part of marginalized groups, such as people from minority ethnic groups. Most studies on mental health and stigma have been conducted using college-educated, higher socioeconomic status, White participants (U.S. Department of Health and Human Services, 2001). Most interventions, therapies, and other mental health resources are modeled after and geared toward addressing the needs of the majority group of White Americans. However, some of the literature have attempted to research populations that fall outside of this group. For example, one study investigated a college population of 5,555 students and found that students who were members of marginalized groups, such as Asian students, international students, and students from poorer families, tended to report feeling higher levels of stigma associated with mental illness (Eisenberg, Downs, Golberstein, & Zivin, 2009). The same study found that stigma was more prevalent amongst students who were younger and male. Additional studies suggest that men report higher levels of stigma than women and are also less likely to seek help (Oliver, Pearson, Coe, & Gunnell, 2005).

A classic study demonstrated support for these gender differences by asking participants about their own attitudes towards seeking psychotherapy (Leong, & Zachar, 1999). The data showed that, as predicted, women demonstrated more positive attitudes towards help-seeking than did men. Furthermore, men reported higher levels of stigma around mental health issues than their female counterparts. Although this was a dated study with older measures, the differences in gender have been replicated in more recent studies that investigated these

differences in adolescence (Chandra, & Minkovitz, 2006).

Research that focuses on gender differences in mental health help-seeking and stigmatizing behaviors can be used as a framework for approaching differences among ethnic groups. A study using the National Ambulatory Medical Care Survey was able to analyze data on help-seeking behaviors amongst minority groups, noting any and all access to mental health counseling, ranging from general advice to treatment. In both primary care settings and psychiatric settings, Lasser and colleagues (2002) found that Black and Latino patients had lower visit rates for drug therapy, mental health counseling, and psychotherapy than their White counterparts. The researchers found data to support the idea that minorities, defined here as both Blacks and Latinos, receive about half as many outpatient services as White Americans (Lasser et al., 2002). A study by Alegria and colleagues used nationally representative data from a sample of 8,762 participants with depressive disorders (Alegria, Chatterji, Wells, Cao, Chen, Takeuchi, & Meng, 2008). The researchers assessed whether racial disparities were found in reports of access to treatment for acute depression and found that racial minority groups were significantly less likely than Whites to receive access to any mental health treatment (Alegria et al., 2008). Even after adjusting for social class-related variables, like poverty, insurance coverage, and education, racial differences still had an independent effect on access to depression treatment (Alegria et al., 2008). These patterns continue to help us understand differences across racial groups and the disparities in access to mental health resources.

Data from other studies suggest that racial minorities are less likely than white middle class people to seek professional help (U.S. Department of Health and Human Services, 2001). Karasz's (2004) research looked at whether this discrepancy had a relationship with causal models, also know as attribution models. Taking a cross-cultural approach to the question, Karasz (2004) compared South Asian immigrants to a group of European Americans to determine the differences in how these two groups contributed to causal models of depression. European Americans were more likely to attribute the causes of mental illness to more explanatory conditions, such as hormonal imbalances or situational stress and they were more likely to recommend seeking professional help, while South Asian women were more likely to respond with self-help ideas (Karasz, 2004). By analyzing how participants conceptualized mental illness, the researchers found that European Americans were more likely to seek medical help because they attributed biological factors as the causes of mental illness. By creating such causal attribution models, researchers can further explain how participants conceptualize this phenomenon and its basis. In contrast to European Americans, women from the minority group did not constitute this "depression-as-a-disease" model, or biological attribution model, into their responses, leading to at least one possible explanation for disparities in seeking professional help (Karasz, 2004).

The previous study highlighted the critical role of a person's attributional models of mental illness and their possible effects on help-seeking behaviors. These attribution models are also thought to have an effect on stigma (Weiner, 1995). The biological attribution model appears to be the common theme in White participants' perception of mental illness (Karasz, 2004). This model emphasizes the biological components that underlie mental illness, raising awareness of these as "real" biological diseases in contrast to the stereotyped idea of mental illnesses as "weaknesses of the mind" (Phelan, 2002).

Studies have investigated the biological attribution model as an intervention and its effect on the willingness to perform help-seeking behaviors. In one of these studies, participants either received a biological attribution essay, a de-stigmatization educational essay, or a control essay to determine the effects of different attribution models on willingness to seek help. Two weeks after reading the essay, the participants were given a stigma scale and a "Help-Seeking Willingness Scale" to determine the likelihood of reaching out to professional help in the event that depressive symptoms were present. Though both biological and educational interventions decreased stigma towards the mentally ill, only the biological attribution intervention increased willingness to seek aid (Han et al., 2006).

However, not all previous literature agreed with the effective nature of the biological model. In the wake of the "genetics revolution," Phelan, Cruz-Rojas, & Reiff, (2002) had participants read a vignette about a person with schizophrenia and then asked about their own attribution models, or causal model. For participants who listed biological components in their attribution of the mental illness, the researchers found lower levels of social distancing. However, these participants were also less likely to believe that the person's condition could improve. Such mental representations related to mental illness could thus lead to an increase in stigma and negative feelings about the effectiveness of therapy. This begins to show the "double-edged sword" that is the biological attribution model, where an intervention might yield a positive effect such as an increase in help-seeking behaviors and a decrease in social distancing, but a negative effect as participants showed an increase in stigmatizing attitudes.

The data supports the findings that biological models may actually increase stigma (Phelan, Cruz-Rojas, & Reiff, 2002) while increasing help-seeking behaviors (Han et al., 2006). This work has only begun to investigate ethnic and cultural differences in response to the biological model of mental illness. Stigma reduction research in the U.S. tends to focus on White, higher socioeconomic status, college-educated participants, leaving us with limited literature that focuses specifically on racial minorities (Anglin, Link, & Phelan, 2006). Since stigma is felt differently across minority ethnic groups (Abdullah & Brown, 2010), the levels of stigma could be affected by the biological model intervention in different ways. Before eliminating the biological model as an intervention that is not effective, research must focus on

cultural and ethnic differences in the effects of this model.

By acknowledging the limited research on access to mental health resources for People of Color, the main goals of this study are to investigate "baseline" differences in stigma levels between White Americans and people from minority populations, collectively known as People of Color, in the United States. This study also hopes to determine if there are differences in how the biological attribution model affects stigma and help-seeking behaviors across racial/ethnic groups. The major hypotheses in this study are twofold; the first hypothesis is that initial stigma will be higher amongst People of Color compared to White participants based on differences in the way mental illness is perceived in different racial/ethnic groups and the second hypothesis is that the biological attribution intervention will have different effects on White participants and participants who identified as People of Color. This work will give us insight on the effectiveness of biological attribution intervention and its effects on help-seeking behaviors and changes in stigma between these two groups.

Methods

Participants. Since males have been shown in previous studies to demonstrate more stigmatizing behaviors towards mental illness than have females (Eisenberg, Downs, Golberstein, & Zivin, 2009; Chandra, & Minkovitz, 2006), we included only male college-aged individuals as participants in the present study. The survey and intervention program were designed and distributed using the Qualtrics Research Suite and participants were recruited using Qualtrics, Facebook, and electronic mailing lists for students. Of the 42 men recruited, 23 identified as Persons of Color and 19 identified as White Americans.

Materials. The informed consent included the names and the contact information of the investigator and the faculty advisor, as well as the general procedures of the experiment. Participants were informed that there would be a one-week period between the first session (pre-intervention, Week 1) and second session (post-intervention, Week 2) of the survey. Finally, participants were informed that once they finished the second session, they would be entered into a raffle for 10 $50.00 Amazon gift cards.

In the first survey during Week 1, each participant was asked to fill out a survey for causal factors (Okumura & Sakamoto, 2012). The causal factors ranged from social (life stress, low self-esteem) to psychological (childhood trauma, negative thinking patterns) to biological (genetic predisposition, chemical imbalance) in nature. Participants were asked to rate these factors for how likely they were to cause depression on a Likert Scale from "Strongly Disagree" to "Strongly Agree" for how likely each factor was responsible for depression. For our analysis, we combined the social and psychological factors (psychosocial) and compared them to the biological causal factors. After that, the participants filled out a survey assessing their cultural-related stigma with the Cross-Cultural Depression Stigma Scale (Prentice,

2014). The survey asked the participants to self-identify their heritage culture and then answer questions relating to the perceived levels of stigma felt by their heritage culture group.

Stigma was measured as a score on the Social Distancing Scale (Norman, Windell, & Manchanda, 2012), which is a Likert type scale that assesses social distancing towards someone with depression. The questions asked the participants about the likelihood that they would perform a certain behavior with/towards a person with depression. The participants then filled out the Help Seeking Outcome Expectancies (HSOE) Scale (Siegel, Lienemann, & Tan, 2015), which asked questions ranging from "seeking help can assist a person with their depression" to "seeking help is needed if a person is going to get better." These were also rated on a Likert Scale. Next, each participant was randomly selected to read one of the two the intervention vignettes. The biological attribution intervention consisted of a biological attribution essay, which stressed the main character's symptoms as based in genetic, neuroanatomical, and neurochemical underpinnings. The other condition consisted of a psychoeducational attribution essay that stressed the main character's symptoms as related to social problems and psychological experiences. These vignettes were adapted to mention a male who is suffering from depression, so that we could control for gender (Lebowitz & Ahn, 2014). Questions about the male in the story were presented immediately after the reader had finished reading the vignette to ensure that the participant thoroughly read and understood the vignette.

After one week, each participant filled out the Causal Factors Scale, the Social Distancing Scale (Norman, Windell, & Manchanda, 2012), and the Help Seeking Outcome Expectancies (HSOE) Scale (Siegel, Lienemann, & Tan, 2015) again, along with a demographics questionnaire.

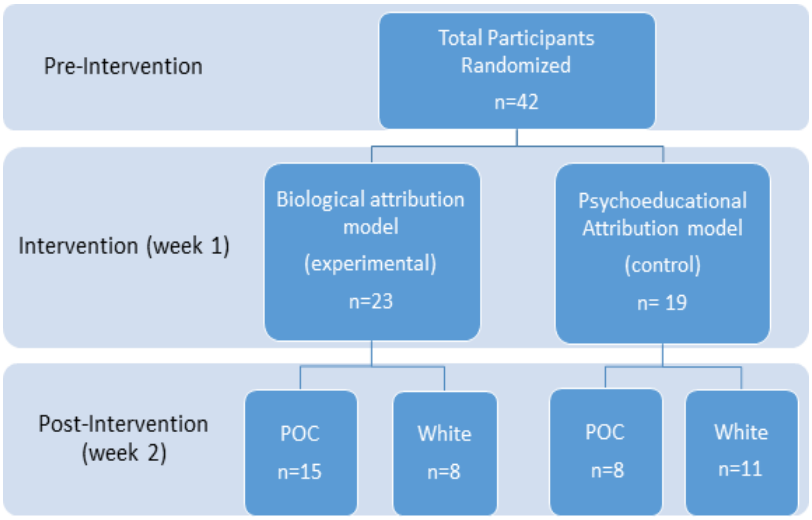

Figure 7. Flowchart of Intervention. Pre-Intervention refers to the participants that enrolled and then randomized. After being randomized into one of the two conditions (biological or control), Week 1 consisted of the participants completing the Intervention and a set of surveys. At Week 2, Post-Intervention, the participants responded to the same set of surveys and differences per condition and across race were noted.

Results

The data on each participant was collected across a one month period. At the end of week 1, we were able to analyze the data for pre-intervention differences that were related to culture. The Heritage Culture Stigma scores were divided into White participants and People of Color (POC). We found that there were significant differences between the cultural stigma associated with both groups, $t(36)=-3.13$, $p<0.05$. White participants ($M=18.00$, $SD=5.88$) had lower cultural stigma than participants who identified as People of Color ($M=23.39$, $SD=5.12$) (See Figure 1). Once the participants' information was gathered, three-way repeated measures ANOVAs were run on four dependent variables. The two between-subject variables were Race (White or POC), and Experimental Condition (Biological or Psychosocial intervention). The one Within-subject variable was time (Pre-intervention and Post-intervention). The four dependent variables were (i) number of biological causal factors, (ii) number of psychosocial causal factors, (iii) stigma levels, and (iv) help-seeking behaviors.

Analyses were ran for a three-way interaction of Race (White or People of Color), Experimental Condition (Biological intervention or Psychosocial intervention), and Time (Pre-intervention and Post-intervention), for changes in (i) number of reported biological causal factors. There was a main effect of time on number of biological causal factors reported, $F(1,38)=5.02$, $p<0.05$. There was no main effect for race, $F(1,38)=.001$, $p=0.97$ or for condition, $F(1,38)=0.19$, $p=0.67$. There were no significant two-way interactions between Race and Condition, $F(1,38)=0.46$, $p=0.50$, Race and Time, $F(1,38)=1.62$, $p=0.21$ or Condition and Time, $F(1,38)=0.97$, $p=0.33$. However, the three-way interaction (interaction of the independent variables) approached marginal significance, $F(1,38)=2.74$, $p=0.10$ (See Figure 2).

We ran the same set of analyses for the change in (ii) number of reported psychosocial causal factors in our three independent variables. The data showed a marginal main effect for Race, $F(1,38)=3.50$, $p=0.06$, but no main effects for Condition $F(1,38)=0.00$, $p=0.99$, or for Time, $F(1,38)=0.98$, $p=0.33$. The interaction between Race and Condition showed no statistical significance, $F(1,38)=0.04$, $p=0.85$, however, the data did approach marginal significance in the interaction between Race and Time, $F(1,38)=2.70$, $p=0.100$. There was no two-way interaction between Condition and Time, $F(1,38)=0.38$, $p=0.55$.The analysis for the three-way interaction in number of reported psychosocial causal factors was not significant, $F(1,38)=1.08$, $p=0.30$ and there was no significance in the three-way interaction on (ii) psychosocial causal factors, $F(1,38)=1.08$, $p=0.31$.

We ran the three-way interaction analysis for differences in groups in (iii) levels of stigma in our three independent variables. There were no main effects for Race $F(1,38)=0.44$, $p=0.51$, Condition, $F(1,38)=0.09$, $p=0.76$, or Time, $F(1,38)=0.25$, $p=0.62$. The two-way interaction between Race and Condition and Race and Time showed insignificant differences, $F(1,38)=0.75$, $p=0.39$,

F(1,38)=0.05, p=0.82. The interaction between Condition and Time showed no significance, F(1,38)=0.05, p=0.82. There were no significant differences in the three-way interaction on the (iii) levels of stigma reported, F(1,38)=0.93, p=0.34 (See Figure 3).

Finally, we ran a three-way interaction analysis for changes in (iv) help-seeking behaviors. There were main effects across Race, F(1,38)=6.24, p<0.05. There were, however, no main effects for Condition, F(1,38)=0.26, p=0.61, or for Time, F(1,38)=0.58, p=0.45. There was no two-way interaction between Race and Condition, F(1,38)=0.11, p=0.75, or between Race and Time, F(1,38)=0.02, p=0.89. Although no two-way interaction was found, the data approached marginal significance between Condition and Time, F(1,38)=2.11, p=0.16. The results for the three-way interaction showed a marginal difference, F(1,38)=3.51, p=0.06. More specifically, it appears that both Race and Condition affected (iv) help-seeking behaviors (See Figure 4).

To further explore these results, we accounted for our limited sample size by calculating effect sizes for changes in help-seeking behaviors between groups. We took the data from Week 2 and subtracted the values from Week 1 to find mean difference scores. We then focused on effect size analyses in the same race (See Figure 5). There was a small effect size between White participants in the Biological condition (M=0.75, SD=3.45) and White participants in the psychosocial condition (M=0.27, SD=2.15), d=0.17 (Cohen's d). There was a large effect size between the POC in the Biological condition (M=-1.53, SD=4.02) and the control Psychosocial condition (M=2.25, SD=4.27), d=0.91. There was a large effect between White participants (M=0.27, SD=2.15) and People of Color (M=2.25, SD=4.27) in the Psychosocial condition, d=-0.58 (See Figure 5). There was also a moderate effect size between White participants in the Biological condition (M=0.75, SD=3.45) and People of Color in the Psychosocial condition (M=2.25, SD=4.27), d=-0.40 (See Figure 5). We were most interested in how the biological attribution intervention affected help-seeking across Race. There was a large effect size between White participants (M=0.75, SD=3.45) and People of Color (M=-1.53, SD=4.00), d=0.61 in the Biological condition (See Figure 6).

Discussion

The major hypotheses in this study were two-fold. The first hypothesis was that stigma would be higher amongst People of Color, compared to White participants, based on differences in the way mental illness is perceived in different racial/ethnic groups. The second hypothesis was that biological attribution intervention would have different effects on White participants and participants who identified as People of Color. We predicted that these differences would be manifested in changes in (i) biological causal factors, (ii) psychosocial causal factors, (iii) stigma, and (iv) help-seeking behaviors between pre-intervention and post-intervention times.

As hypothesized, there were differences in initial levels of heritage culture-related stigma between White

participants and participants that identified as POC. Moreover, POC were more likely to report that their cultural group had higher levels of perceived stigma associated with mental illness, in comparison to White participants. These results are consistent with previous literature stating that cultural differences lead to differences in the ways mental illnesses are stigmatized (Abdullah & Brown, 2010). These "baseline" differences in stigma levels prior to interventions are crucial to understanding why certain interventions may be more efficient than others for different ethnic groups.

It was hypothesized that the biological attribution model intervention would have different effects across racial/ethnic backgrounds. The literature suggested that while the biological model could increase help-seeking behaviors (Karasz, 2004; Han et al., 2006), this model could also lead to increases in reported levels of stigma amongst participants (Han et al., 2006). Some literature also noted that causal factors could be changed due to an intervention, at times leading to a more "biological" or "medical" model of mental illness (Phelan, 2002).

In our study, we analyzed how the Biological intervention affected causal factors related to mental illness. Prior to the intervention, we asked participants about which factors they found more likely to cause depression, with factors ranging from psychological factors, such as "personality," to more biological factors, such as chemical "imbalance." No significant differences were found after the biological attribution intervention, however, some trends were noted that could be of importance. For example, white participants in the biological attribution intervention condition were more likely to report that biological causal factors were more responsible for mental illness than were POC participants. While this finding would seem to suggest that the biological attribution intervention was more effective in White than POC subjects, there is a further complexity in the findings. Namely, POC in the Psychosocial (or control) group were also more likely to report that biological factors were most likely the cause of mental illnesses, showing us that the intervention may not have conveyed exactly what we wanted it to. It is also possible that our control intervention led to an increased belief in the causal role of biological factors, and that those in the psychosocial intervention ended up rating both biological and psychosocial attributions as more for causing mental illnesses, potentially making the psychosocial condition more effective. Moreover, it is also possible that our intervention did not stress the "biological" components enough to change causal factors post-intervention. The vignettes were adapted from previous literature (Lebowitz & Ahn, 2014), and so it is possible that they were not efficient at creating attribution changes.

The interventions did not appear to have the predicted effect on reported levels of stigma. More specifically, while previous literature studies like Han and colleagues (2006) found that levels of stigma increased after the biological attribution intervention, the effect was not replicated in our study. This is extremely important because, while there were no significant differences, effect

size analyses showed that white participants in the Biological condition saw a decrease in reported stigma while POC saw virtually no change. In contrast to our hypothesis that the biological model would positively affect POC, only POC in the Psychosocial condition saw a decrease in stigma. White participants in the Psychosocial conditions saw a slight increase in stigma, but this finding was not statistically significant. These results suggest White participants benefit from the Biological intervention, while POC might benefit more from our control condition than from the biological attribution model.

Help-seeking behaviors also changed marginally across race and condition. White participants in the Biological condition saw an increase in help-seeking, but POC participants in this intervention actually saw a decrease in reported help-seeking. Furthermore, POC participants in the Psychosocial condition saw an increase in their help-seeking, while White participants in the Psychosocial condition saw no change in their help-seeking. These findings suggest that the beneficial effect of Biological interventions reported in previous literature on help-seeking may only hold for white subjects. People of Color might benefit more from the Psychosocial condition due to the reported increases in help-seeking behaviors and the trends showing decreases in perceived stigma.

In our work, we found marginally significant differences in help-seeking behaviors across race and condition. The White participants benefitted only from the biological attribution intervention, with an increase in help-seeking behaviors as a result of our Biological intervention. Here, the need of increasing help-seeking among White participants was met by a biological model. However, help-seeking behaviors were different between White people and POC in the Biological intervention, where POC actually saw a decrease of help-seeking in the Biological condition. This supports the findings that interventions and therapies are mostly tailored towards the needs of White individuals (U.S. Department of Health and Human Services, 2001).

Our results suggest that the biological attribution model, an intervention that could increase help-seeking in members of the majority groups, might end up being detrimental for members of minority groups. This finding could be one of the many reasons behind the underutilization of mental health resources by POC. Advocates such as the National Alliance for Mental Illness, The International Journal of Mental Health, and many more continue to push for a biomedical model, where mental illnesses are being treated like “brain diseases” (Watters, 2010). Our results, however, show trends suggesting that this model could be decreasing help-seeking amongst minority populations. These negative effects have also been found in more studies; a recent meta-analysis showed that biogenetic causal models were associated with increases in rejection of people with mental illness, and are therefore inappropriate for interventions (Angermeyer, Holzinger, Carta, & Schomerus, 2011). Although this last study looks only at stigma and stereotypes, the conclusion remains that the biological model is not effective for all. Another meta-analysis noted that the “medicalization” of

mental illness appears to show negative effects relating to stigma and barriers to the access of mental health resources (Kvaale, Haslam, & Gottdiener, 2013). Kvaale and colleagues noted that biogenetic perspectives on clinical populations are gaining momentum. Their meta-analytic review agreed that while the biological models tend to reduce blame on the mentally ill, they also tend to induce pessimism about recovery (Kvaale, Haslam, & Gottdiener, 2013).

Help-seeking among People of Color only increased in the Psychosocial condition, suggesting that the efficiency of interventions differs across groups. POC in this study benefitted from understanding the psychosocial aspects of depression. The participants were more willing to look for help once they read about all the psychological and social problems that come with dealing with a mental illness. These results were mirrored in a classic study by Mehta and Farina (1997). In the wake of the "disease view," these researchers found that this model induced harsher behaviors than the psychosocial intervention among college-age men. While the biological model did not improve attitudes towards mental illness, the Psychosocial intervention induced more positive attitudes (Mehta & Farina, 1997).

There were many limitations in our study that restrict the generalizability of our findings. We only collected 42 participants, with very few participants in each condition. This made it harder to further generalize the findings. Though small, this sample size emphasizes an important trend in the literature. There is still no consensus on the benefits of the biological attribution model. The other major issue that we ran into is the underrepresentation of black men in the data.We found that men of color were the hardest demographic to gather, and we were only able to randomize three African American men. This greatly limits the generalizability of our data on black men. Our under-representative sample is an important limitation of the study. Another limitation of the study was the nature of the intervention used. The vignette was adapted from the work of Lebowitz and Ahn (2014), who focused on a population of mental health clinicians. Additionally, they investigated models of mental health attribution that would increase empathy and therapeutic alliance (Lebowitz & Ahn, 2014). It is possible that the intervention vignette was tailored for empathy among mental health professionals, and therefore had a different effect on our undergraduate participants. The vignettes were short and concise, perhaps leaving out characteristics of depression that mental health professionals could infer but were not clear for our participant pool. For future studies, a pilot study for the effect of the vignette should be implemented.

Another limitation of this study could be the focus on depression, a mental illness perceived as more common and has a wide range of symptom severity (WHO, 2013). We chose this mental illness because it was the most applicable to our population. The 2014 National Survey on Drug Use and Health found that major depressive disorder was most prevalent in 18-25 year olds (Center for Behavioral Health Statistics and Quality, 2015). It was also the mental illness

addressed in the literature that we replicated (Han et al., 2006). However, perceptions of depression might be less stigmatizing compared to more stigmatized mental illnesses, such as schizophrenia and alcohol dependence (Sears, Pomerantz, Segrist, & Rose, 2011). Research that sought to apply a biological attribution intervention on schizophrenia saw a rise in perceptions of "dangerousness" and "unpredictability" (Walker & Read, 2002). Perhaps using Biological intervention on a mental illness that is perceived to be both more severe and more biologically rooted would provide different results among our population.

Future studies could also divide People of Color into their respective ethnic/cultural groups. Since different cultures have different histories, values, and traditions, it is not surprising that they also have different perceptions of surrounding mental illnesses. People from minority groups come from different cultures, and they could experience stigma differently. One article attempted to highlight the differences in mental illness beliefs and stigmas across groups of American Indian, Asian, African, Latino, Middle Eastern, and European descent (Abdullah & Brown, 2010). This meta-analysis found that the research on stigma varied across minority groups, suggesting that different minority cultures experience different causal beliefs, levels of stigma, and help-seeking behaviors (Abdullah & Brown, 2010). Future studies should also contain a control condition. The comparison between People of Color and White participants in the Psychosocial condition had a large effect size, although this condition was initially assumed to be our control. A replication of this study should include a condition with no intervention, where we could see if there are significant differences when comparing the effects of the Biological intervention to the effects of no intervention.

The literature, coupled with our findings, could mark the way for further research in psychosocial interventions for People of Color, potentially aiding in minimizing barriers to mental health care. Through this work, we were able to investigate key differences in attribution models and their effects on stigma and help-seeking behaviors. Research must continue to acknowledge how mental health resources, interventions, and therapies are not fully addressing the needs of People of Color.

Understanding the effects of causal model interventions could help raise awareness of the stigma associated with mental illnesses. By understanding fundamental differences in cultures and ethnic groups, we may be able to more efficiently help members of minority groups who are living with mental illnesses. In a country that will see a rise in minority populations in the next four decades (Vincent & Velkoff, 2010), health professionals cannot continue to assume that the resources modeled after White Americans, a majority group in the United States (U.S. Department of Health and Human Services, 2001), are beneficial for all. Future works should seek to implement culture-focused research approaches that address causal beliefs, stigma, and help-seeking behaviors amongst all people, without excluding People of Color.

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Appendix

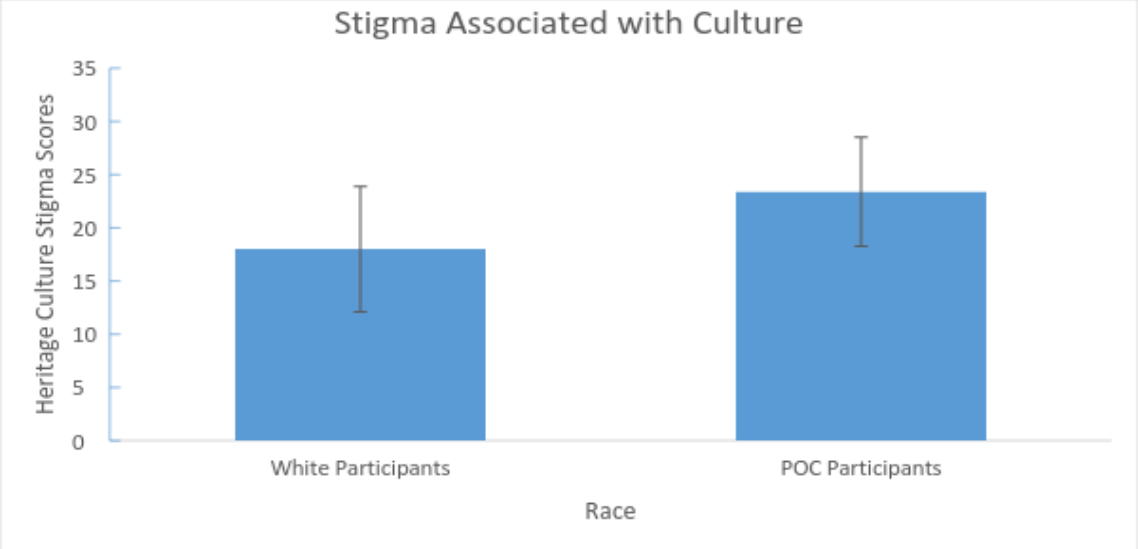


Figure 1. Average levels of perceived stigma associated with heritage culture (the culture a person was from) taken prior to the intervention. We found that there were significant differences between the cultural stigma associated with both groups, $t(36)=-3.13$, $p<0.05$. White participants ($M=18.00$, $SD=5.88$) had lower stigma than participants who identified as People of Color ($M=23.39$, $SD=5.12$).

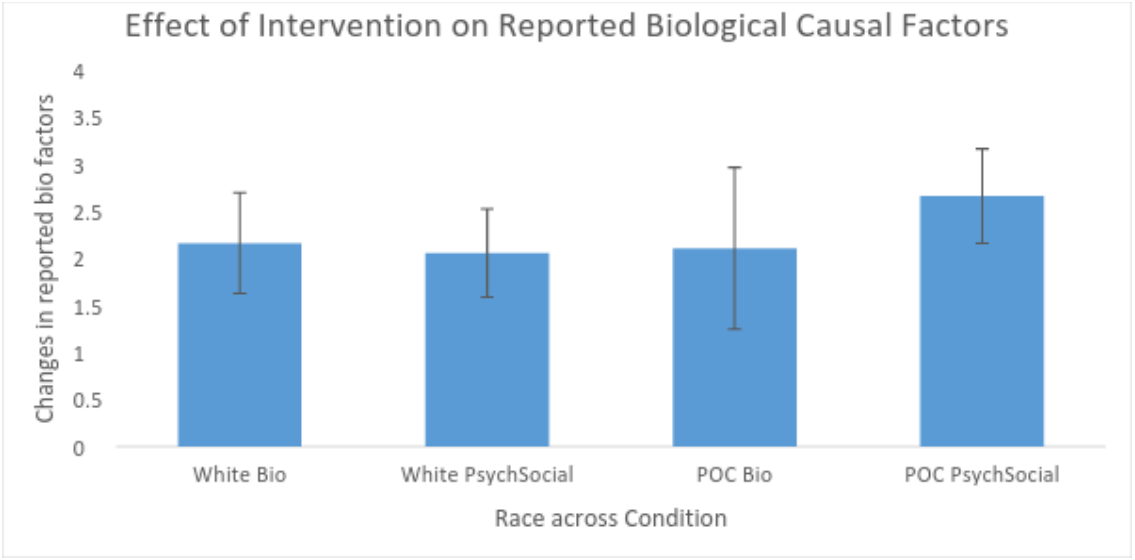


Figure 2. Effect of intervention on biological causal factors. There were no significant interactions. Shown are the changes in reported factors (T2-T1). Only those in the biological attribution intervention were expected to see an increase in reported biological causal factors; however, we see that POC in the Psychosocial condition also saw an increase in Biological causal factors. This could mean the intervention affected each participant's ideas of causal factors in ways not controlled by the study.

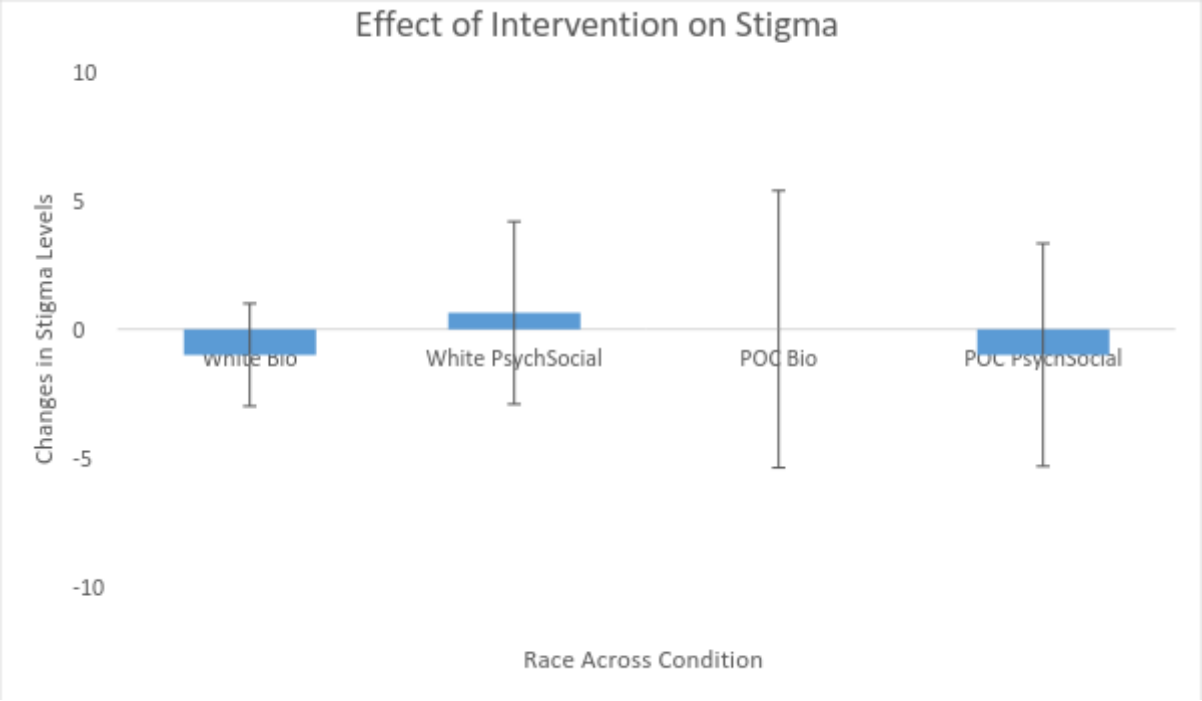
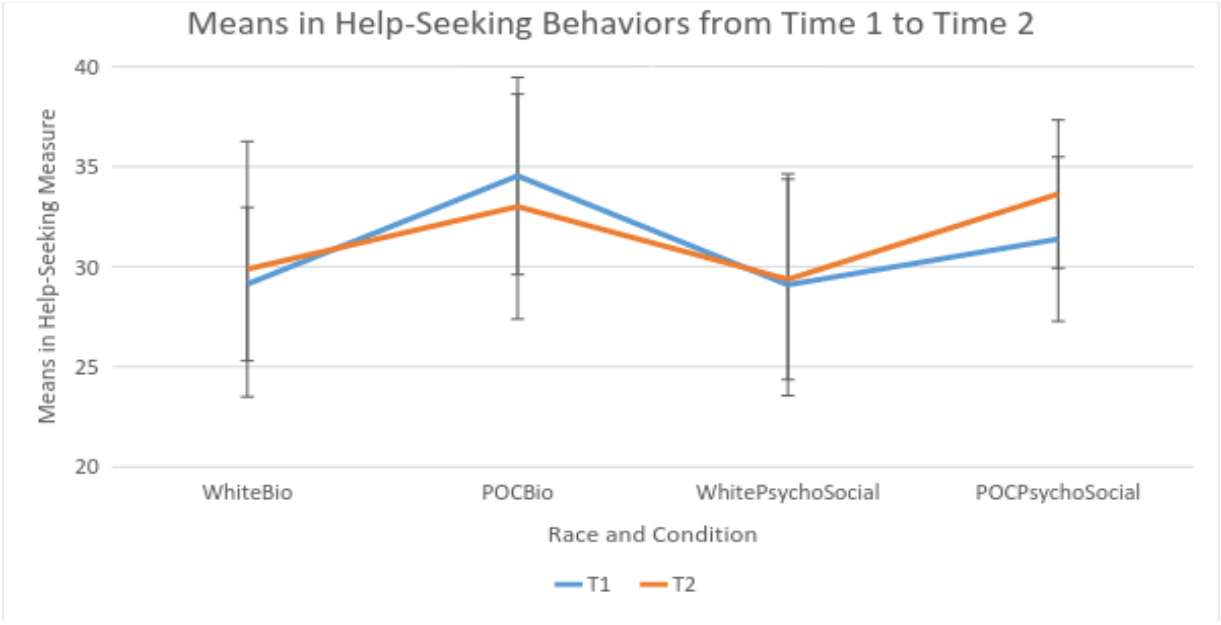


Figure 3. Stigma across Race, Condition, and Time. There were no main effects for Race $F(1,38)=0.44$, $p=0.51$, Condition $F(1,38)=0.09$, $p=0.76$, or Time, $F(1,38)=0.25$, $p=0.62$. There were no significant differences in the three-way interaction on the levels of stigma reported, $F(1,38)=0.93$, $p=0.34$.



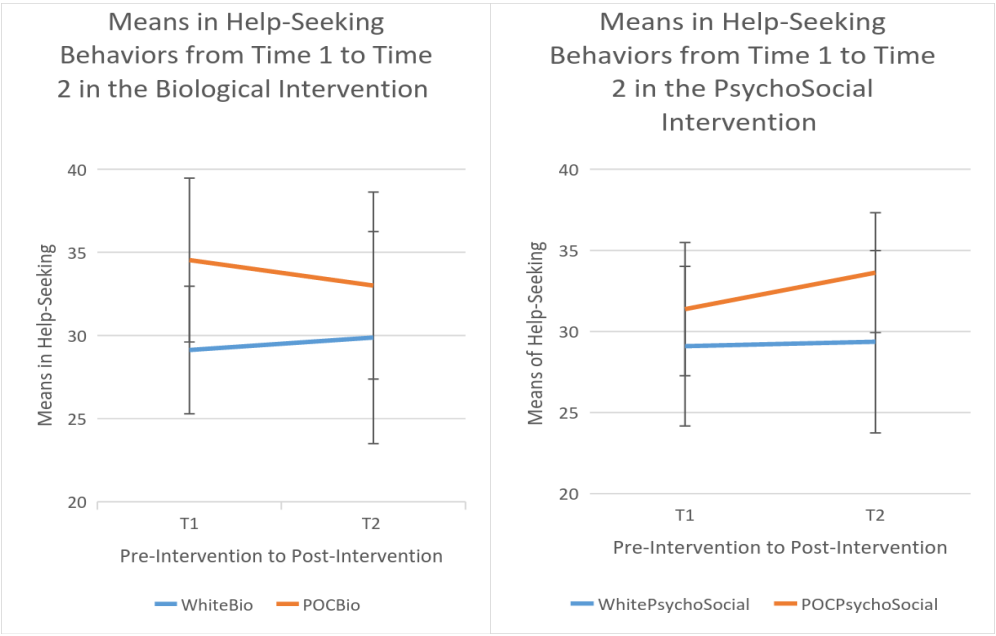


Figure 4. Effect of the intervention on help-seeking behaviors. Analyses were ran for a three-way interaction of Race (White or People of Color), Experimental Condition (Biological intervention or Psychosocial intervention), and Time (Pre-intervention and Post-intervention), for changes on help-seeking behaviors. Results for the three-way interaction showed a marginal significance, $F(1,38)=3.51$, $p=0.06$.

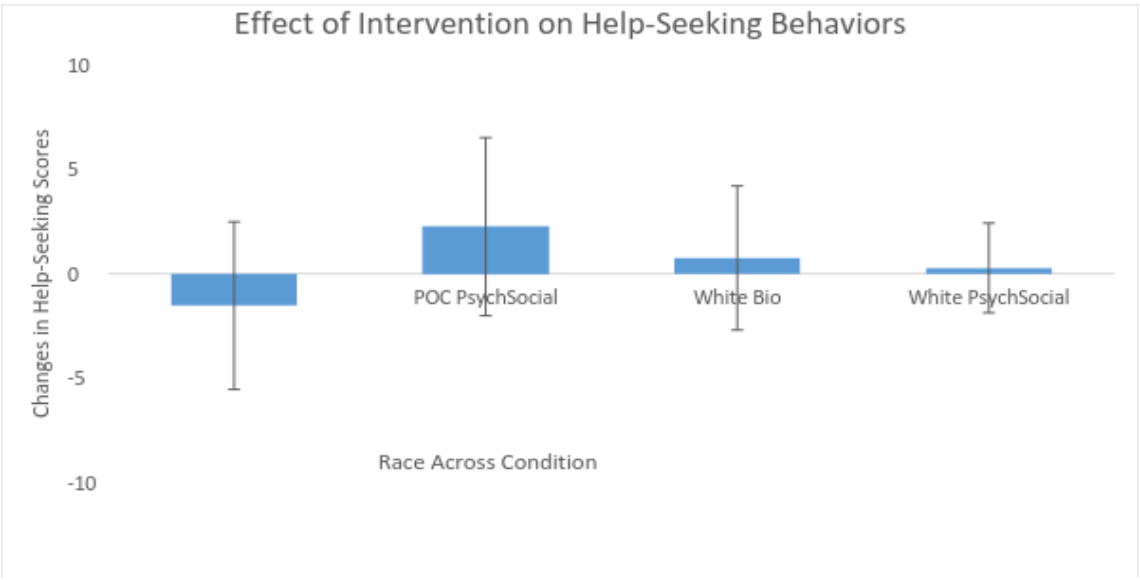


Figure 5. Effect Sizes of our intervention on help-seeking behaviors. There was a small effect size between White participants in the Biological condition (M=0.75, SD=3.45) and White participants in the Psychosocial condition (M=0.27, SD=2.15), d=0.17 (Cohen's d). There was a large effect size between the POC in the Biological condition (M=-1.53, SD=4.02) and the control Psychosocial condition (M=2.25, SD=4.27), d=0.91. There was a large effect between White participants (M=0.27, SD=2.15) and People of Color (M=2.25, SD=4.27) in the Psychosocial condition, d=-0.58. Our major finding was the moderate effect size between White participants in the Biological condition (M=0.75, SD=3.45) and People of Color in the Psychosocial condition (M=2.25, SD=4.27), d=-0.40 and the large effect size between White participants (M=0.75, SD=3.45) and People of Color (M=-1.53, SD=4.00), d=0.61 in the Biological condition

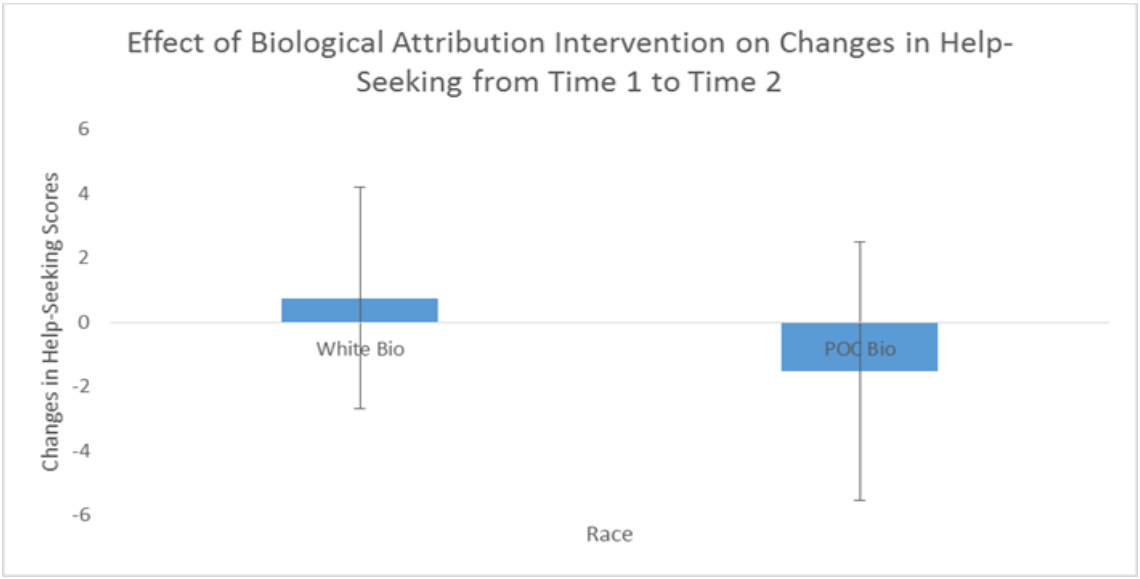


Figure 6. We were most interested in how the biological attribution intervention affected help-seeking across Race. There was a large effect size between White participants (M=0.75, SD=3.45) and People of Color (M=-1.53, SD=4.00), d=0.61 in the Biological condition.

Examining the Neural Circuitry and Physiology Associated with Heightened Stress in Non-Suicidal Self-Injury (NSSI)

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University of Minnesota

Non-suicidal self-injury (NSSI) is characterized by causing harm to one's own body without the intent to commit suicide and is hypothesized to be a coping mechanism when an individual experiences high levels of stress. Neurobiological research has recently advanced the study of NSSI, primarily through measures of neural circuitry and psychophysiology. Research has included various paradigms to understand NSSI as a mechanism for distress tolerance. The current review of literature examines the biological factors associated with stress regulation and how self-injury helps reduce high emotionality. Evidence for neurobiological dysregulation has been found with functional magnetic resonance imaging (fMRI), cortisol release, and galvanic skin response. The current review also proposes multiple directions for future research, especially in regard to conducting longitudinal research to determine causality and temporality between neurobiological dysfunction and reinforcement of NSSI, and considers the study of NSSI independent of a psychiatric diagnosis.

Keywords: self-injury, neuroimaging, psychophysiology, stress, suicidality

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Non-suicidal self-injury (NSSI) is the act of causing harm to one's own body without the intent of suicide (Nock, Joiner, Gordon, Lloyd-Richardson, & Prinstein, 2006). Behaviors include cutting, burning, hitting, punching walls, breaking bones, ingesting toxic substances, and picking scabs. Skin cutting remains the most common method of NSSI and occurs in 70 to 90 percent of individuals engaging in NSSI (Klonsky & Muehlenkamp, 2007). NSSI is a deliberative condition and does not include physical harm that occurs by accident. Other terms used for NSSI include deliberative self-harm, self-mutilation, and parasuicide, and in some cases more inclusive terms (e.g., self-harm) may be non-suicidal and suicidal

self-harm. Theories on NSSI implicate the behavior as a method of coping with extreme stress. The primary goal of this paper is to review the literature relevant to the neurobiological factors behind heightened stress and consequential distress tolerance in individuals who practice NSSI. The current review will emphasize which specific neural circuits are dysregulated following heightened stress and offer preliminary evidence of how this activity is reduced following self-injury. Additionally, the review will examine how self-injurers experience dysregulated physiological responses to stress when compared to non-injurers. Previous research implicates self-injury as a method of self-regulation in response to stressful situations. Understanding the neurobiology of those who engage in self-injury will provide insight into why NSSI is used as a coping mechanism and why it aids in reducing stress. This information will allow researchers and psychologists to help self-injurers cope in more adaptive ways and reduce the prevalence of NSSI.

Prevalence

NSSI is a behavior seen mainly in adolescent and young adult populations, with a typical onset between 12 and 14 years of age (Groschwitz & Plener, 2012). Estimates range from 400 to 1,400 cases of NSSI per 100,000 individuals annually (Favazza, 1998). NSSI is highly comorbid with a variety of diagnoses such as borderline personality disorder (BPD) and major depressive disorder (MDD; In-Albon, Ruf, & Schmid, 2013). Eighty-one percent of adults (18-35 years of age) diagnosed with BPD reported engaging in NSSI within the previous two years (Groschwitz & Plener, 2012). Despite being highly comorbid, NSSI has been proposed under "Conditions for Further Study" in the The *Diagnostic and Statistical Manual of Mental Disorders* (5th ed.;
DSM–5; American Psychiatric Association, 2013) as its own diagnosis, as individuals may engage in NSSI without meeting criteria for a current psychiatric disorder. This proposition requires that more empirical evidence be collected before NSSI is considered as a clinical diagnosis and thereby emphasizes the importance of continued study on NSSI. Therefore, while research of NSSI within BPD populations is included in this review, it is important to note that NSSI may not be represented well when assessed only in the context of BPD. For that reason, it is important to continue studying NSSI across a broader range of clinical diagnoses—or lack thereof—to develop a more thorough profile of self-injury as a method of self-regulation.

Severity and Relationship to Suicidality

Although NSSI is distinct from suicidal behavior, up to 70 percent of self-injurious adolescents in clinical samples report a history of a suicide attempt (Nock et al., 2006). While NSSI does not always lead to suicidal behavior, those who engage in NSSI are 30 percent more likely to die by suicide than the general population is (Nock et al., 2006). These statistics exemplify how NSSI has the possibility to be lethal. Additionally, NSSI is often persistent, with most individuals continuing to self-injure after their first episode. Those who engage in NSSI typically have three to over 50

episodes of this behavior in their lifetime (Klonsky & Muehlenkamp, 2007). Due to the severity and frequency of NSSI, it is a condition that requires a more in-depth analysis to understand why it develops, what factors lead to its maintenance, and how to reduce its frequency.

Self-Injurious Behavior as Stress Tolerance

Widely distributed biological systems are likely to be implicated in NSSI, but current research is mostly focused on negative emotionality and maladaptive thought processes. Many studies have demonstrated that individuals who practice NSSI display higher rates of negative emotionality, self-derogation, and deficits in emotional functioning (Klonsky & Muehlenkamp, 2007). Those who self-injure report higher scores of negative temperament and emotional dysregulation (Andover, Pepper, Ryabchenko, Orrico, & Gibb, 2005). Sachsse, Von der Heyde, and Huether (2002) also theorized that NSSI is a method of regulating extreme stress. NSSI may serve the function of emotional punishment, as means to address aversive thoughts and self-criticism. Self-punishment and self-deprecation are often reported as reasons for NSSI behaviors (Nock & Mendes, 2008), which indicates that self-injurers may have greater levels of negative, self-focused attention. Accordingly, self-centered rumination has been linked to minimized coping skills and interference with developing constructive solutions (Burwell & Shirk, 2006). It is also hypothesized that the level of distress self-injurers are able to handle is compromised, including a reduced functioning of the hypothalamic-pituitary-adrenal (HPA) axis (Kaess, Hille, Parzer, Maser-Gluth, Resch, & Brunner, 2012).

Given the nature of cross-sectional research, though, it is difficult to determine whether neurobiological disruption precedes the development of NSSI or if it is caused by the behaviors. Research also indicates that life stress may be a factor in emotional dysregulation (Nock, 2009), but it is uncertain if life stress causes this dysregulation (Liu, Cheek, & Nestor, 2016). It is also difficult to conclude that life stress is a cause of NSSI when life stress is also seen as a precursor for different psychopathologies (Nock, 2009). Because of these difficulties, the current review contends that the biological exploration of self-injury requires further, longitudinal study. It is important to examine the results and limitations of previous research to develop more thorough and methodologically sound research. The primary goal of this paper is to highlight neurobiological research on NSSI in regards to stress tolerance and self-regulation through two main facets: neural circuitry and physiology. By analyzing mechanisms such as fMRI, salivary cortisol, and galvanic skin response, this review develops a more thorough profile of stress responses in individuals who self-injure with the hope that it will inform the development of more thorough research on self-injurious behavior.

Neural Circuitry

Many studies have been conducted to induce acute stress in individuals and

measure the variance in reactions between non-injurers and those who self-injure. Following the induced stress, researchers have tracked the reactions through neural activation. Functional magnetic resonance imaging (fMRI) measures brain activity through a measure known as blood oxygen level dependent (BOLD) signals. Higher BOLD signals are associated with a reduction in deoxygenated blood, indicating higher neuronal activity (Huettel, Song, & McCarthy, 2009). FMRI has accordingly been used to further understand the neural activation behind NSSI.

A study conducted on the neural processing of social exclusion in adolescents highlights self-injurious behavior as a method of stress regulation (Groschwitz, Plener, Groen, Bonenberger, & Abler, 2016). Researchers elicited the feeling of social exclusion during an fMRI scan using the "Cyberball" paradigm. This virtual ball-toss game ostracizes the participant, as the computerized players toss the ball back and forth with limited tosses to the participant (Williams & Jarvis, 2006). Following the task, all participants reported feeling socially rejected, but depressed adolescents who practice NSSI showed different neural activation from both depressed adolescents who do not practice NSSI and adolescents without any psychiatric diagnosis. Specifically, self-injurers showed increased activation in the medial prefrontal cortex (mPFC) and the ventrolateral prefrontal cortex (vlPFC). Activation of the mPFC has been linked to thinking about oneself, self-perception, and processing negative affect, and vlPFC activation has been linked to processing negative experiences, including social exclusion (Domsalla et al., 2013). Higher activation in these two prefrontal areas suggests comparatively higher rates of unsuccessful regulatory effort by self-injurers following distress. The results of this study may indicate that the high activation creates a need for a compensatory mechanism that will provide successful regulation of these areas. However, a longitudinal design is needed to determine whether this activity leads to self-injury and a need for self-regulation, or if this activity is due to the presence of NSSI.

Connectivity between prefrontal regions and limbic regions is conceptualized as playing a key role in emotional regulation. Therefore, the amygdala has also been implicated as a major region in individuals who engage in NSSI. A study conducted in adolescent females who self-injure demonstrated altered amygdala functioning in relation to NSSI-related material (Plener, Bubalo, Fladung, Ludolph, & Lule, 2012). In this study, self-injurers rated images related to self-injury as more arousing and eliciting greater negative emotion than controls. Activation in the amygdala, hippocampus, and anterior cingulate cortex (ACC) was also significantly higher for the NSSI group in response to emotional pictures. These results are supported by a study conducted by Niedtfeld and colleagues (2010) on individuals with BPD. Specifically, researchers induced stress by showing negative images, and those with BPD demonstrated an increased activation in the amygdala, insula, and ACC in comparison to controls. Additionally, amygdala activation

was positively correlated with self-reported ability to regulate emotions.

Due to the amygdala's central role of responding to perceived threat, these studies indicate that those who engage in NSSI may be more sensitive to potentially threatening stimuli. Due to this susceptibility, self-injurers may react more negatively to stress, and this heightened response may provide an explanation for why individuals self-injure. This hypersensitivity is consistent with other psychological research on NSSI, indicating that those who self-injure report a lower threshold for social stressors (Klonsky, May, & Glenn, 2013; Nock & Mendes, 2008). Longitudinal studies would assist in verifying whether this susceptibility to dealing with stress is a cause of self-injurious behavior or develops due to the presence of NSSI. It is also important to understand what effect self-injury has on amygdala activation; if activation is reduced, it will implicate the role of self-injury as a method of self-regulation following heightened emotions.

The relationship between self-injury and regulation has been supported in a study conducted by Reitz and colleagues (2015) in which a sample of women with BPD all reported at least one episode of NSSI in the previous six months. Acute stress was induced using the Montreal Imaging Stress Task (MIST; Dedovic et al., 2005), a paradigm that elicits disappointment due to the difficulty of solving complex arithmetic in a constrained period of time. The task is manipulated so that performance ranges from 45 to 50 percent correct. Following the MIST, participants were administered either a small incision on the right forearm or a sham treatment, and then underwent resting state fMRI scans. The incision led to a significant decrease on subjective stress levels, as well as decreased levels of physical tension in those with BPD and NSSI. Additionally, amygdala activity showed a substantial decrease following the incision, as well as more normalized functional connectivity with the superior frontal gyrus compared to healthy controls.

The existing neuroimaging research demonstrates dysfunctional neural circuitry, specifically related to prefrontal and limbic regions, with an emphasis on the amygdala. Research points to dysfunctional prefrontal-amygdala activity, which may explain why those who engage in NSSI are more hyper-aware of stress. This idea is paired with results from Reitz and colleagues (2015), which show a normalized profile of neural circuitry following a simulation of NSSI. This normalization, along with a reduction in subjective stress, corresponds with theories on reinforcement of NSSI (Bentley, Nock, & Barlow, 2014). A decrease of aversive emotionality, or stress, may negatively reinforce NSSI as an automatic coping method in times of high stress.

Summary

Current research relies on a cross-sectional method, which limits our ability to understand if individuals who practice NSSI are predisposed to these neural abnormalities or if these circuits become dysfunctional due to the reinforcement of self-injurious behavior. Reitz and colleagues (2015) provide preliminary evidence that a dysregulation of neural circuitry leads to self-injury. This idea highlights the need to

fund and develop research dedicated to longitudinal development of NSSI and its relationship with biological mechanisms. Exploring causality between maladaptive neural circuitry and NSSI will help further determine whether dysregulated emotional regulation is a cause or effect of NSSI.

Physiology

Cortisol Release

Response to stress and perceived threat are mediated by the hypothalamic pituitary adrenal axis (HPA axis). There is evidence that altered HPA axis functioning is present in those who self-injure (Nater et al., 2010). When an individual faces a stressor, the hypothalamus is activated and corticotropin-releasing hormone (CRH) and arginine vasopressin (AVP) are secreted (Guilliams & Edwards, 2010). The influx of hormones elicits a release of adrenocorticotropin hormone (ACTH) from the anterior pituitary gland, which leads to the release of glucocorticoid hormones in the adrenal gland. Glucocorticoids act on the hypothalamus and pituitary gland in a negative feedback loop, suppressing CRH and ACTH production when necessary. Other regions of the brain also interact with the HPA axis. The hippocampus and prefrontal cortex (PFC) inhibit the HPA axis, whereas the amygdala stimulates CRH neurons in the hypothalamic paraventricular nucleus (PVN). Excessive stress may also influence such regions, as increased cortisol exposure can have adverse effects on hippocampal neurons and the PFC, which in turn cause dysregulation of the HPA axis (Heim, Plotsky, & Nemeroff, 2004).

A healthy HPA axis functions as a negative feedback loop—the production of CRH and ACTH is reduced when there are high levels of cortisol in the blood. Chronic stressors lead to the disruption of the HPA axis, thus disrupting cortisol secretion. When presented with a high amount of stress, the HPA axis responds with an allostatic shift in functioning (Juster, McEwen, & Lupien, 2010). This shift, known as the allostatic load theory, refers to how the body attempts to maintain a homeostasis given the environment around it. In the short run, adjustment to stress is beneficial. However, when there are frequent novel stressors or a failure to adjust to the same stressors, the result may be a negative effect on the stress system. Prolonged secretion of cortisol leads to a blunted effect on the HPA axis in the face of stress. This effect leaves the individual less defensive to stress-related disorders, such as self-injury, because he or she cannot process and react to stressors appropriately (McEwen, 1998).

A study conducted in adult, female patients with BPD explores this theory of HPA axis dysregulation in self-harming individuals (Nater et al., 2010). When compared to healthy controls, female BPD patients who engage in self-injury displayed attenuated salivary cortisol release after undergoing the Trier Social Stress Test (TSST). The patient group and the control group, however, displayed significantly different salivary cortisol levels before the TSST was administered. When these pre-TSST cortisol levels were controlled for, post-TSST cortisol levels were still significantly lower in the BPD group. Thus,

the results demonstrate a significantly attenuated cortisol release in self-injuring BPD patients when compared to non-BPD controls. The reduction in cortisol response is consistent with a dysregulated HPA axis system. This phenomenon is a possible explanation of why those who engage in NSSI may experience a limited ability in coping with acute stress.

Furthermore, research in adolescents who self-injure shows consistency with the theory of dysregulated HPA axis functioning. A study was conducted in female adolescents who engage in NSSI that demonstrated a reduced level of cortisol, which provides further support of a hyporesponsive HPA axis in those who self-harm (Kaess et al., 2012). Kaess and colleagues (2012) conducted a study using TSST to compare those who self-injure to non-injurers. When assessing pre-stress salivary cortisol levels, both the NSSI group and control group displayed similar levels before the TSST was administered. After the stress test, there was a significant difference in salivary cortisol response between the NSSI group and controls. The findings of this study demonstrate a reduction of salivary cortisol levels when presented with external stressors, indicating hypo-responsivity of the HPA axis when presented with acute stressors. Therefore, a reduction in cortisol secretion may be implicated in maladaptive coping mechanisms, such as NSSI, due to a limited ability to cope with acute stress. This phenomenon corresponds with the allostatic load theory, as individuals who have experienced "burn-out" from prolonged stress show a blunted response when faced with acute stressors. The presence of reduced cortisol levels would emphasize the decreased ability to cope with acute stress, the experience of heightened stress-reaction, and the presence of maladaptive coping mechanisms such as self-injury.

Skin Conductance

An alternate psychophysiological measure was utilized in a study conducted with adolescents who practice NSSI (Nock & Mendes, 2008); skin conductance is related to the state of sweat glands in the skin. Since sweating is controlled by the sympathetic nervous system, skin conductance is a measure of this system. When the autonomic nervous system reacts to emotional cues, such as fear or stress, the sympathetic nervous system activates sweat glands and skin conductance increases. Thus, skin conductance has become a measure of psychological and emotional reactivity (Critchley, Elliott, Mathias, & Dolan, 2000).

Results of the study conducted by Nock and Mendes indicated that those who engage in NSSI experienced higher levels of physiological response following the Social Problem-Solving Skills Test (SPST; Nock and Mendes, 2008), an experiment that provides hypothetical social scenarios involving potential problems with peers. Once given the scenarios, participants had to solve problems related to the scenarios and explain their thought process. Explanations were then rated as being self-critical (attributing the problem to his or herself), critical of the antagonist (blaming the problem on others), or non-critical (not blaming anyone). Adolescent self-injurers

were compared with non-injurers in skin conductance level, self-critical attributions, and number of solutions generated for each scenario. The goal was to understand how arousal is associated with distress and to what extent arousal inhibits problem solving. The researchers discovered that self-injurers showed higher physiological reactivity during the Social Problem-Solving Skills Test, as well as a decreased ability to tolerate distress and limited problem-solving skills. The results from this study emphasize disrupted levels of arousal and decreased ability to tolerate distress. Additionally, the disruption of problem-solving skills during distress may indicate another vulnerability those with NSSI face.

Summary

The results from current research on psychophysiology in NSSI may point to an attenuation of cortisol release due to an allostatic shift in HPA axis functioning. A blunted HPA axis may cause individuals to less effectively cope and may lead to heightened emotions. This hypothesis supports the idea that individuals who engage in NSSI are more vulnerable to acute stress and use maladaptive behaviors such as self-injury in an effort to reduce extreme stress (Sachsse et al., 2002). Additionally, research on skin conductance in those who self-injure indicates a heightened sympathetic nervous system response, explaining a heightened reaction to stress and use of less effective coping mechanisms.

Discussion and Future Research

The goal of this review is to compile the current neurobiological literature and examine self-injury as a method of coping with acute stress and self-regulation when faced with heightened emotions. The role of self-injury in stress-regulation is seen using various methods. FMRI studies display patterns of activity consistent with self-perception, processing negative emotions, and stress regulation (Domsalla et al., 2013). While many lack the causality to determine whether neural patterns are precursors to NSSI or occur due to NSSI, Reitz et al. (2015) demonstrate that NSSI regulates self-injurers' neural circuitry in a pattern consistent with non-injurers. The existing neuroimaging research emphasizes heightened activity in the amygdala following stressful situations and a reduction in this activity following simulated NSSI. This evidence points to NSSI as a method of emotion regulation and emphasizes why it is used as a coping mechanism. Additionally, physiological research using cortisol levels and galvanic skin conductance demonstrates dysregulated stress-response systems in individuals who self-injure, as compared to non-injurers.

This review also serves to inform the direction of research on NSSI and emphasizes the need for continued research on the topic of self-injury. While the existing research provides a comprehensive understanding of non-suicidal self-injury as a mechanism of distress tolerance, it is important to note that much of the research is novel and preliminary. Additionally, much of the existing research relies on self-reported measures of emotion regulation,

which may not be as objective and are dubious in accuracy. As mentioned previously, another need for research on NSSI is to study the topic across a more broad range of functioning, rather than just within the diagnosis of BPD. With the proposal of NSSI in the DSM-5 under "Conditions for Further Study" (American Psychiatric Association, 2013), neurobiological research should continue to emphasize NSSI as its own entity and conduct studies on NSSI regardless of a psychiatric diagnosis. With a more thorough understanding of NSSI as its own condition, research on self-injury can be applied to a more heterogeneous range of individuals. Initially discussed in the "Prevalence" section of the current review, this need is evident, as previous studies demonstrate biological differences between MDD with NSSI and MDD without NSSI (Groschwitz et al., 2016). Continuing diverse research on the neurobiology of self-injury will help further understanding of why self-injury is used as a coping mechanism in distinct psychiatric diagnoses.

Furthermore, research should focus on the development of NSSI using a longitudinal design. It is difficult to tell from cross-sectional research whether the neurobiological responses demonstrated through research is a cause or a consequence of self-injurious behavior (Liu et al., 2016). Longitudinal designs will give greater insight into the neurobiological profile of individuals before and after the onset of NSSI, which will help identify biological markers associated with a heightened risk for developing self-injurious behaviors. This information, in turn, will aid in the development of more effective prevention and treatment methods.

Lastly, current research indicates the need to further study levels of physiological arousal and how heightened emotion hinders problem solving. The current review examined physiological research by Nock and Mendes (2008) and demonstrated that high emotional reactivity corresponds with a lack of effective problem solving. This finding should be expanded on, as studying the effect of arousal and heightened emotion on cognitive functioning could provide the link between understanding distress and maladaptive ways of coping with this distress. A vast majority of current cognitive research on NSSI implicates self-deprecation and rumination as factors associated with the frequency of NSSI (Burke et al., 2015). These factors should be further examined to understand how they are affected by high stress and how they inhibit problem solving. The proposed future research will be crucial in developing further insight into the maintenance, prevention, and treatment of self-injurious behaviors.

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Establishing Validity of the Relationship Formation Task within a Psychiatric Population

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Background: Positive social relationships are important for wellbeing and life satisfaction. It is important to understand the basic processes that facilitate relationship formation, especially within clinical populations that show impairments in this particular capacity. The focus of the current research is validation of a method used to measure these processes, specifically looking at the method's convergent, divergent, and discriminative validity. *Methods*: Clinical participants (n=107) had current diagnoses of either an anxiety disorder or depression and control participants (n=27) had no prior history of any psychiatric illness. Participants and trained confederates took part in a relationship formation task (RFT) by taking turns answering a series of increasingly intimate questions. Participants then completed the following measures: Inclusion of the other in the Self (IOS) Scale (a measure of closeness achieved with conversation partner), Attention Control Scale (ATTC), Desire for Future Interaction (DFI) and Social Connectedness Scale Revised (SCS-R). *Results*: Consistent with our predictions for convergent validity, positive correlations were found between the IOS with the SCS-R and DFI. Consistent with our predictions for divergent validity, there was not a significant relationship between IOS and ATTC. Consistent with our predictions for discriminative validity, the clinical group reported feeling less close to their partners after the interaction, as compared to the control group. *Discussion*: The study provides preliminary evidence for the psychometric properties of the task; however, even further psychometric research is warranted.

Keywords: psychometrics; validity; relationship formation; behavioral measure; anxiety and depression

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Positive social relationships have been shown to be important for well-being and life satisfaction. Having such relationships is often associated with environmental mastery, self-efficacy in social situations, hope, happiness, and a

higher quality of life (Segrin & Taylor, 2007). Conversely, social relationship impairment is a key characteristic of a number of psychiatric conditions, including social anxiety disorder (SAD) and major depressive disorder (MDD) (Alden & Taylor, 2010; Eberhart & Hammen, 2006). For these reasons, it is important to understand the basic processes that facilitate social relationship formation, especially within clinical populations that show impairments in this particular capacity. The focus of the current research is to identify a valid way of measuring these social processes in an experimental setting, which is an integral step to better understanding social relationship formation with individuals who have anxiety or depression.

Intimate social relationships have been found to be formed through sustained, reciprocal, escalating, and personal self-disclosure, in which each individual feels her/his innermost self validated and understood by the other (Aron, Aron & Smollan, 1992; Aron, Melinat, Aron, Vallone & Bator, 1997). The key construct in relationship formation is interpersonal closeness, or "including other in the self or a feeling of interconnectedness of self and the other" (Aron et al., 1992; Aron et al., 1997). Therefore, the goal is to develop a feeling of interpersonal closeness with the interaction partner, which is important in the process of relationship formation.

SAD and MDD are characterized by impairment in social relationships (see Alden & Taylor (2010) for review). Individuals with SAD have fewer social relationships, are less likely to date or marry, have fewer friends, have lower levels of perceived social support, and are more likely to be socially isolated than non-anxious individuals (Mendlowicz & Stein, 2000). SAD is also associated with not expressing emotions, avoiding conflicts, and not asserting opinions within relationships; all of which could lead to problems in developing as well as maintaining close relationships (Davila & Beck, 2002). Even within the relationships that they have, individuals with SAD have difficulty opening up, engaging in positive nonverbal behaviors, and thus their relationships are generally characterized by lower levels of intimacy (Kashdan & Wenzel, 2005), which has been shown to be important in forming relationships (Reis & Shaver, 1988).

Further research into social relationship development processes may also contribute to understanding of depression, as individuals with depression also portray difficulty with relationship formation and maintenance. Individuals with MDD, similar to those with SAD, tend to withdraw from or avoid social situations, display self-critical cognitions before and after social interactions, attribute negative social outcomes to themselves, and believe that other people have negative opinions of them (Ingram, Ramel, Chavira & Scher, 2001). Individuals with MDD have also been shown to have poorer quality interpersonal relationships, to be lower in self-perceived and peer-rated social competence, and to portray insecure models of attachment. They have also been shown to have social skill deficits, but not to the extent that the individuals themselves predict. Individuals with depression are also more likely to perceive their relationships as

having communication problems, alienations, and low levels of trust (Eberhart & Hammen, 2006). Thus, as demonstrated from prior research, both individuals with SAD and those with MDD are characterized with difficulty in social relationships (See Alden & Taylor (2010) for a review). Further study of these processes is warranted, especially to examine how individuals with SAD and MDD form new relationships, using measurement tools that are amenable to use with these clinical populations.

Existing measures of social relationship functioning are mainly self-report based paper-and-pencil assessments such as the Relationship Closeness Inventory (RCI) (Berscheid, Snyder, & Omoto, 1989). However, introspective measures have inherent error or bias; people are often inaccurate at judging how they will behave or how they feel. A behavioral interactive measure could provide more information than an introspective self-report measure because one can observe how the participant will actually behave in a social situation with a stranger rather than how they think they will behave. A few laboratory based, interactive measures exist, but these are either unstructured getting acquainted situations (e.g. Berry & Hansen, 1996 or Kashdan & Wenzel, 2005), or interaction situations with a person whom the participant already knows, e.g. a close friend or significant other (e.g. Impett, Kogan, English, John, Oveis, Gordon, & Keltner, 2012). These paradigms most likely tap into social processes different from those required to form new social relationships. These paradigms also lack experimental control, which is important, as to observe how different participants behave when put in the same social situation. Currently, to the best of our knowledge, there is only one validated, unstructured, laboratory based paradigm designed to facilitate relationship formation (Aron et al., 1997).

The laboratory based experimental paradigm referred to above, designed to examine relationship formation among non-clinical samples, was developed within the field of social psychology by Aron et al. (1997). The paradigm was constructed considering sustained, escalating, and reciprocal self-disclosure: the basis of developing an interpersonal relationship. There were two conditions: (1) the "closeness" condition which called for self-disclosure and other intimacy related behaviors, and (2) the "small talk" condition which only involved minimal self-disclosure. Participants were randomly assigned to one of the two conditions. To begin the experiment, the experimenters paired two participants, who did not know each other and were explicitly told that their task was to get to know each other and become closer after the interaction. The participants were then given three sets of questions, corresponding to their specific condition (i.e. closeness vs. small talk), with 15 minutes per set. The participants were instructed to answer the questions in the following manner: one participant would read the question out loud, both the participants would answer the question, and this would alternate until they had finished the questions of the set or time was up. The closeness condition was shown to produce statistically significant increases in closeness

between participants, as compared to the small talk condition. On average, subjects rated the closeness achieved as about as close as the average relationship in their lives or in the lives of other people (Aron et al., 1997).

Although this tool provides an interactive means of assessing processes related to relationship formation, the paradigm has some limitations as well. One, it lacks experimental control, as the participants can answer the questions with any level of intimacy they deem appropriate. They could also get off topic or not be willing to share private or vulnerable information with one another. This could lead to different participants achieving different levels of closeness, not because of how they get along, but because of the unstructured nature of the task. For example, partners might interrupt each other or spend all the time conversing on one question, which would limit the researcher's ability to measure participant's capacity to develop closeness. Second, the task implemented by Aron and colleagues is relatively long; it contains about 36 questions and takes approximately 45 minutes to complete. The long duration may make the assessment impractical to administer in clinical settings. Third, the paradigm was formed and validated using a sample of college undergraduates, limiting the generalizability of the paradigm.

For the current study, a paradigm similar to that of Aron et al. (1997) for relationship formation was developed in a sample of individuals with anxiety and depression. Based on the limitations of the original paradigm, the following changes were made. The level of experimental control was increased, by having a confederate interact with a participant, rather than having two participants interact. This way, there is a standard level of intimacy for each of the confederate responses, which remains consistent across all interactions. While maintaining escalating intimacy of the questions, the current study attempted to shorten the task to six questions per interaction, estimating that it would take the participants no longer than 25 minutes to complete. The present study also attempted to generalize the procedure for use in a clinical population, as well as in a wider age range of individuals. The current study examined the modified relationship formation paradigm's construct validity in relation to other established measures of interpersonal closeness, as well as whether it could discriminate between clinical (i.e. those with anxiety or depression) and non clinical (i.e. those without anxiety or depression) individuals.

Specifically, for convergent validity, it was hypothesized that interpersonal closeness will be positively correlated with theoretically related constructs, specifically overall social connectedness and desire for future interaction. For divergent validity, it was hypothesized that interpersonal closeness will show no significant correlation with theoretically unrelated constructs, specifically an individual's capacity of attention control. Finally, for discriminative validity, it was hypothesized that on average, interpersonal closeness achieved after the interaction, will differ for clinical versus non-clinical participants.

Methods

Participants. Data for this study were collected in the context of three ongoing treatment studies for anxiety and depression. Participants (n=130) were volunteers recruited from the San Diego area, via posted flyers and an online research recruitment service (e.g. ResearchMatch, Craigslist, etc.). Each participant completed a structured clinical interview (Mini International Neuropsychiatric Interview, Version 6.0.0; Sheehan et al, 1998), to determine their clinical diagnostic status, before participating in any study. Clinical participants (n = 103) were considered eligible if they were diagnosed with either an anxiety disorder or depression. Controls (n = 27) were eligible if they had no prior history of any psychiatric diagnosis, and no current social anxiety symptoms above minimal levels, as determined by the on-site clinician as well as their score on the Liebowitz Social Anxiety Scale – Self Report (LSAS – SR; Liebowitz, 1987). There were less controls, as only one of the three treatment studies had recruited non-clinical participants. Clinical and non-clinical participants were compared on numerous demographic variables; including age, gender, and ethnicity (refer to Table 1). There were no significant differences amongst the clinical or non-clinical group on these demographics.

Procedure. As noted above, all data were collected as a part of three ongoing treatment studies, investigating experimental computer based training programs for anxiety and depression. All participants provided informed written consent after the study procedures were explained. Relevant to the current study, participants completed the SCS-R, DFI, ATTC, IOS, and the Relationship Formation Task. Participants were randomly assigned to form A or form B for the Relationship Formation Task (RFT) (See Appendix).

Relationship Formation Task (RFT)

The participants engaged in a relationship building task with a trained confederate. The interaction was modeled after the originally validated relationship building task (Aron et al, 1997), in which two participants took turns responding to a series of questions which gradually escalated in intimacy and mutual disclosure to encourage mutual feelings of closeness between the participants. In the modified paradigm, the participant and confederate were clearly instructed to get to know each other through answering a series of questions. Each participant was randomly assigned to one of two interaction forms (See Appendix). All interactions began with an ice-breaker (i.e. “Tell your partner a bit about yourself”) and were followed by five relationship building questions, chosen carefully from paradigms tested by Aron et al. (1997) and Page-Gould, Mendoza-Denton & Tropp (2008). The questions were chosen to maintain an average level of intimacy and comfort, as assessed by research staff. This was done by having several research assistants rate the questions on intimacy and comfort. The ratings were then averaged and questions was chosen accordingly. In all interactions, the confederate was asked to read aloud and answer the first question (i.e. the ice-breaker), followed by the participant’s

response to the same question. The person who read aloud and thus, answered first, alternated until both the participant and the confederate finished answering all the questions. Before the start of the conversation, the experimenter started a camera to record the entire interaction in plain view of the participant and confederate. The recorded interaction was later rated by other research assistants to ensure confederate consistency, as well as to assess participant behavior. The experimenter left the room before the start of the interaction, as to allow the confederate and participant to interact privately.

The main outcome measure of the RFT is the Inclusion of Other in the Self (IOS) Scale (Aron et al., 1992), which the participant completes after the interaction. The IOS is a single item, pictorial measure of closeness, where the respondent picks the picture that best describes the interpersonal closeness achieved with the confederate, from a set of seven linearly progressing overlapping circles.

Clinical Measures

All participants completed a battery of self-report symptom measures [e.g. Leibowitz Social Anxiety Scale (LSAS-SR; Liebowitz, 1987), Beck Depression Inventory – II (BDI – II; Beck, Steer & Brown, 1996), and Overall Anxiety and Severity and Impairment Scale (OASIS; Norman, Cissell, Means-Christensen & Stein, 2006)].

Construct Validity

For the purposes of the current study, several measures were chosen for the analysis of construct validity of the RFT. Construct validity is commonly defined as how accurately a measure captures the underlying construct (Bhattacherjee, 2012). It has two main subtypes, convergent validity and divergent validity, which are further elaborated on below.

Convergent Validity

Convergent validity refers to how well a measure correlates to other assessments, which measure the same underlying construct differently or other constructs that should be theoretically related to the construct of interest (Bhattacherjee, 2012). The RFT is a task designed to instill feelings of interpersonal closeness between individuals, and we hypothesize that degree of social connectedness experienced during and immediately after this task reflects capacity for forming interpersonal closeness in general. If this hypothesis is true, then previously validated social connectedness measures, specifically, the Social Connectedness Scale – Revised (SCS – R; Lee & Robbins, 1995) and the Desire for Future Interaction (DFI; Coyne, 1976) should be correlated to the RFT outcome measure.

The Social Connectedness Scale – Revised (SCS-R) is a 20 item questionnaire with a 6 point response scale, where 1 represents strongly disagree and 6 represents strongly agree. It asks about an individual's perceptions of their degree of how

connected they feel to people such as their friends, family, or a stranger.

The Desire for Future Interaction (DFI) is an 8 item questionnaire with a 7 point response scale, where 1 represents not at all and 7 represents very much. It asks about an individual's willingness to interact with the person with whom they just completed the RFT, in future hypothetical situations, for example, as friends, at work, or as a roommate.

Divergent Validity

Divergent validity refers to the idea that a measure does not correlate with other measures that tap into theoretically unrelated constructs to the construct of interest (Bhattacherjee, 2012). The capacity to feel social connectedness is theoretically separate from the ability to control attention. Thus, we predicted that previously validated attention control measure should not be correlated with the RFT outcome measure. The Attention Control Scale (ATTC; Derryberry & Reed, 2002) is a 20-item questionnaire, with a 4 point response scale, where 1 represents almost never and 4 represents always. It measures an individual's capacity to focus and shift their attention.

Discriminative Validity

Discriminative validity refers to the idea that a measure can differentiate between two different groups (Beidel, Turner, Hamlin & Morris, 2000). Theoretically, individuals with anxiety or depression have higher rates of problems in social relationships. Thus, we hypothesize that they will show a lower capacity of relationship formation and consequently, a lower RFT outcome measure (i.e. the IOS) than the non-clinical controls.

Personnel

All experimenters and confederates were undergraduate or bachelor level research staff. The confederates were kept blind to the participant's clinical diagnoses and experimental condition throughout the study. The confederates were also blind to the participant's ethnicity and gender, up until their first interaction.

Confederate Consistency

All confederates were trained in a standardized manner. They were asked to provide written answers to all questions used in the RFT interactions. Those answers were then reviewed by a lab coordinator, to ensure consistency of answers on levels of self-disclosure, intimacy, and length, compared to a set of gold standard responses. The gold standard responses were answers drafted by research staff a priori to maintain appropriate intimacy, warmth and self-disclosure for each question. Confederates were instructed on how to act when in a confederate role – encouraged to display warm and friendly nonverbal behaviors, such as leaning forward, maintaining eye contact, and looking interested in the conversation. They were also instructed on how to handle problematic situations, for example if the participant takes too long to answer or asks too many follow up questions, as to maintain consistency for all interactions. Confederates were also asked to watch gold standard confederate training videos, and

after their confederate responses were approved, asked to make a mock video with a fellow research assistant from the lab. Mock videos were then reviewed, and feedback was given, to modify answers or behavior, if deemed necessary.

Results

Convergent Validity

We conducted a series of bivariate correlations between scores on the IOS with scores on the DFI and SCS-R (Refer to Figures 1 & 2). Consistent with predictions, significant positive correlations were found between participants' self-reported closeness with their conversation partner (IOS) and their desire for future interaction (DFI; $r = 0.452$, $p < 0.001$), as well as between participants' self-reported closeness (IOS) and how connected they felt out in the real world (SCS-R; $r = 0.300$, $p < 0.001$).

Divergent Validity

We conducted a bivariate correlation between scores on the IOS with the ATTC (Refer to Figure 3). Consistent with predictions, there was no significant correlation between a participant's self-reported closeness (IOS) with their attention control (ATTC; $r = 0.145$, $p > 0.05$).

Discriminative Validity

We conducted an independent measures t-test to determine if there was a difference between the clinical and non-clinical participants on IOS scores (Refer to Figure 4). Consistent with predictions, there was a significant difference ($t = 2.466$, $p = 0.019$) found between the IOS scores in the clinical group as compared to the non-clinical group. The clinical group, consisting of individuals with anxiety and depression, had consistently lower closeness ratings after the interaction as compared to the non-clinical group, providing evidence for discriminative validity.

Discussion

The focus of the current research was to identify a valid way of measuring the basic processes behind social relationship formation in an experimental setting, with individuals who have an anxiety disorder or depression. The current study provided preliminary evidence for the initial validation of the relationship formation task. Specifically, there was evidence to support the measure's convergent validity, divergent validity, and discriminative validity.

Convergent validity examines whether a measure correlates with other measures that are assessing either the same or theoretically related construct. The RFT showed evidence for convergent validity, as there was a strong positive correlation between interconnectedness after the interaction and desire for future interaction, as well as with an individual's capacity for social connectedness out in the world. Divergent validity ensures that constructs unrelated to the construct of interest are not significantly correlated. The RFT showed evidence for divergent validity as well, as there was no significant correlation between interconnectedness after the interaction and an individual's capacity to shift and control attention. Discriminative validity looks at whether the outcome measure can be used to differentiate between different groups of interest. The RFT showed preliminary

evidence of discriminative validity, as connectedness formed after the interaction was significantly lower for individuals with anxiety or depression as compared to non-clinical controls.

It is well documented that individuals with anxiety and depression have social relationship impairments, and thus it is important to find out where that stems from. Using a validated behavioral measure, such as the RFT, would allow one to examine how individuals behave when in a social situation with someone that they don't know, but are expected to interact with. Do individuals with anxiety and depression self-disclose less than nonclinical controls when given the same questions? Do they not show approachable behaviors when they first meet someone, such as smiling and nodding in response to their partner? If the RFT were to be further validated, all these questions could be addressed. For example, one could have research assistants go back and rate the behavioral data, to see if individuals with anxiety and/or depression behave differently than non-clinical controls. The current study was the first step to the beginning of psychometric testing to ensure that the relationship formation task is a valid and reliable measure.

Future research should examine different types of validity and reliability; including test retest reliability, parallel form reliability, and sensitivity to change. Researchers may want to look at the change in a participant's behavior in a social situation after an intervention. Thus, the RFT's test – retest reliability should be examined to ensure that exposure to a novel social situation in itself is not causing an increase in closeness each time the participant engages in the RFT. As the RFT only consists of six questions, it is also important that the RFT displays parallel form reliability. This is so that the participants do not have to answer the same six questions each time they engage in the relationship formation task. It is critical to have two or three different sets of questions that have comparable levels of intimacy and achieve similar levels of closeness. That way, no matter what form the participant is randomly assigned to use during the interaction, each participant will experience similar levels of increasing intimacy with the trained confederate and thus, theoretically achieve the same level of interpersonal closeness. It would also be important to look at the task's sensitivity to change after treatment, to see if the measure can pick up on actual changes in the capacity of relationship formation after participants have gone through treatment. If further shown to be reliable and valid, then the RFT could also be used as a treatment outcome measure.

If this measure were shown to be psychometrically valid and reliable, it would be a rich source of data. Each time the participant completes the relationship formation task, not only does the researcher obtain self-report data from the participant, the researcher can also obtain self-report data from the confederate. The current study showed that individuals with anxiety and depression achieved lower levels of closeness with the confederate. We would now be able to see whether the reverse is true as well, if the confederate achieves lower levels of closeness when interacting

with individuals with anxiety and depression. Furthermore, we can look at the videotaped interactions to examine whether individuals with anxiety or depression show different facial expressions, different observable behaviors (e.g. fidgeting, stuttering or stumbling over words, eye contact, and appearing tense or rigid), or have different levels of self-disclosure.

The RFT could also be subject to further experimental manipulation (e.g. changing levels of confederate self – disclosure). It would be interesting to look at whether there is an optimal level of self – disclosure from the confederate, to encourage the most interpersonal closeness with the participants. One limitation of the current study is that it only examines initial relationship formation. Future research could examine the development of closeness after multiple interactions. On average, the closeness scores after the interactions were relatively low, so it would be interesting to see whether closeness increases after multiple interactions and if there is some maximum level of closeness that can be achieved.

Another limitation of the study is that the interaction took place in a laboratory, when participants knew that they were being recorded. This could change the way that the individuals behaved, making it different from how they would interact if they were not being recorded. Furthermore, it was a very structured interaction. Participants were told what questions to talk about and were discouraged from making extraneous comments or straying from the questions. This amount of experimental control was helpful for the study, but it limited our external validity. Thus, it would be critical to examine whether all these experimental findings hold up in the real world, where people are allowed to talk about anything they want to and can flow from one topic to another at will.

Additionally, participants and confederates were not matched on gender, ethnicity or age. While this increases the generalizability of the findings, it is also a limitation. It could be that certain demographics predicted how close the individuals got. For example, two females may be closer at the end of the interaction as compared to a male and a female or two males. Thus, future research should look at if matching participants and confederates on a particular demographic construct changes the level of closeness achieved at the end of the interaction. Finally, the group of non-clinical controls was considerably smaller than the group of clinical participants. If possible, future research should maintain an equal number of individuals in both groups.

Future research should also examine whether the relationship formation task can be used in other clinical populations with impaired capacity of relationship formation, such as individuals with Schizophrenia, Autism Spectrum Disorder, or Dementia. Having a validated behavioral measure could allow us to observe whether these clinical populations show similar relationship formation impairments as compared to individuals with SAD and MDD. Finally, it would be interesting to look at whether closeness achieved after the relationship formation task could discriminate between various types of clinical populations.

Conclusion

The present research provides the first evidence that the relationship formation task is a valid measure that can be effectively used in a clinical population. Specifically, the convergent validity, divergent validity, and discriminative validity of the task were documented. This raises the possibility that the measure may be useful for understanding social relationship formation in many different clinical populations, and that it could be used to analyze individual differences in levels of self-disclosure, nonverbal responsiveness, and emotional displays.

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Appendix

List of questions used for the relationship formation task.

Form A:

1. Tell your partner a bit about yourself. (Ice-Breaker)
2. What would constitute a perfect day for you?
3. For what in your life do you feel most grateful?
4. Is there something that you've dreamed of doing for a long time? Why haven't you done it?
5. What is your most treasured memory?
6. If you were going to become a close friend with your partner, please share what would be important for him or her to know.

Form B:

1. Tell your partner a bit about yourself. (Ice-Breaker)
2. What would your ideal or perfect life be?
3. What is the greatest accomplishment of your life?
4. If a crystal ball could tell you the truth about yourself, your life, the future, or anything else, what would you want to know?
5. Can you envision how you are likely to look back upon the things you are doing today? If so, how much do you try to live now as you think you will one day wish you had lived?
6. Do you believe our life is predetermined by fate or is solely a consequence of the choices we make (or both)? Explain why.

Table1: Participant Demographics

N	Clinical (n = 103)	Non-Clinical (n = 27)
Primary Clinical Diagnoses (Overall Sample %)	Social Anxiety (49.2) | Depression (18.5) | Generalized Anxiety (7.7) | Other diagnoses(2.4)	No diagnoses (22.3)
Age (Mean | SD)	25.94 | 8.21	28.22 | 7.74
Gender (%Male|%Female)	37.9 | 62.1	25.9 | 74.1
Race (%White|%Asian|%Other)	44.7 | 27.2 | 28.2	59.3 | 29.6 | 11.1

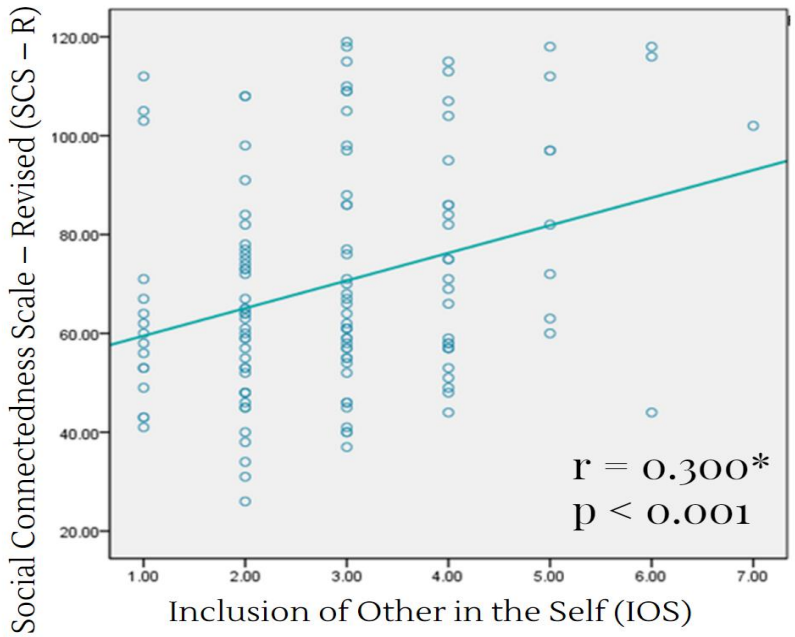

Figure 1: Bivariate Correlation between Inclusion of Other in the Self (IOS) Scale and Social Connectedness Scale – Revised (SCS-R).

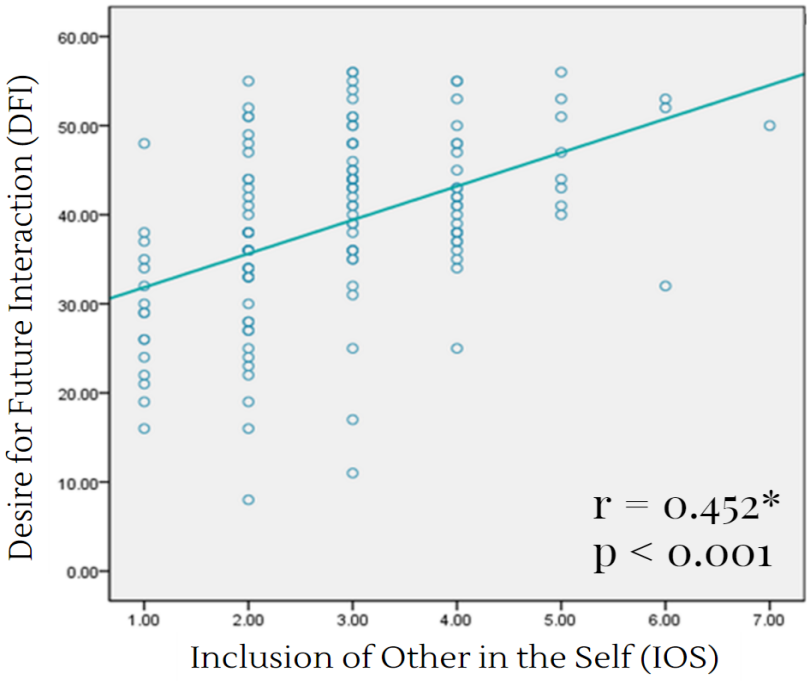

Figure 2: Bivariate correlation between Inclusion of Other in the Self (IOS) Scale and Desire for Future Interaction (DFI).

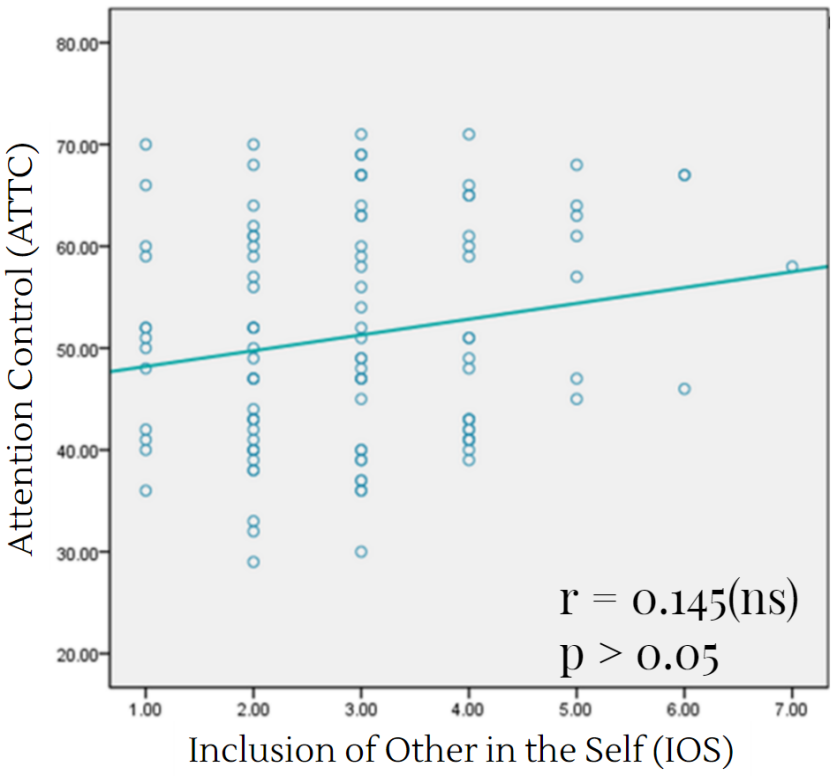

Figure 3: Bivariate Correlation between Inclusion of Other in the Self (IOS) Scale and the Attention Control Scale (ATTC).

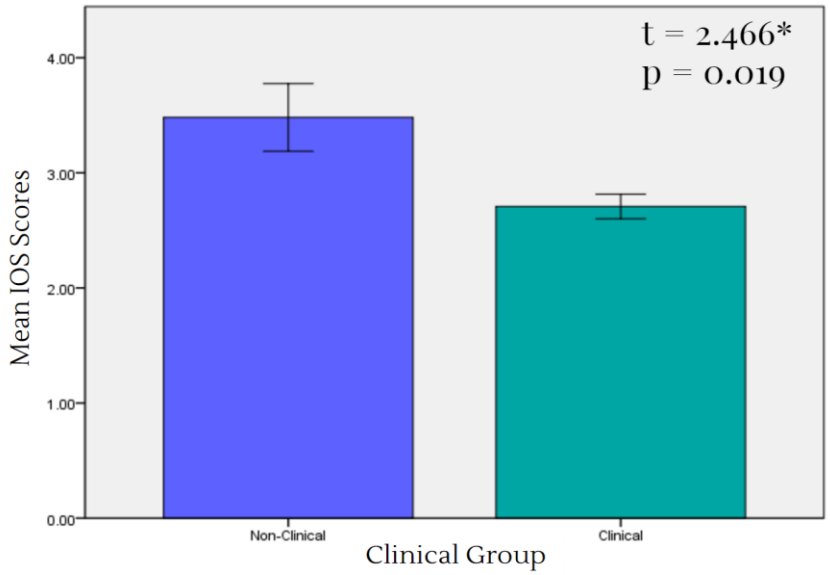

Figure 4: Mean measure of interpersonal closeness (IOS score) achieved after the interaction, for the clinical and non-clinical groups. Error bars represent the standard error of the mean.

Representational Gesture and Memory: An Empirical Analysis

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Gestures are nonverbal, visible indexes of cognition (Hostetter & Alibali, 2008), interesting in part for what they reveal of mental representations on behalf of a speaker during communication. While study of those performing gesture is extensive, a great deal is yet to be understood about the role gesture serves for those viewing it. In an empirical study we explore how viewing gesture that accompanies speech (co-speech gesture) impacts memory and mental representation of a story scene relayed in English to both native and non-native English speakers. We find that gesture is significantly associated with accurate memory of an episodic story scene among non-native speakers of English, yet surprisingly provides minimal aid to accurate memory of gesture-only story details across participants.

Keywords: Co-Speech Gesture, Working Memory, Episodic Memory, Viewpoint, Spatial Cognition

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Gesture accompanies verbal communication across languages and cultures (Goldin-Meadow & Beilock, 2010). This study examines the explicit conveyance of information to clarify and supplement speech for a listener (Cassell, McNeill, & McCullough, 1999). "Spoken words […] are inherently ambiguous" (Kendon, 2000, p. 51). Gesture is a solution for this communicative dilemma.

Working memory is the term used to describe the subgroups of memory that function together as the moment to moment workhorse of cognition (Baddeley & Logie, 1999; Shah & Miyake, 1999). By connecting sensory experience to mental representation, and manipulating and integrating incoming information, working memory acts as the bridge between the transient and longer term memory stores (Baddeley, 2007). It is important to consider paradigms of working memory, as they may provide a means for

understanding how gesture holds utility for the listener.

Gestures described as representational are those whose function is to represent or depict (Kita, 2000). For instance, placing one fist on top of the other and swinging arms in a reenactment of a batter striking a ball illustrates a character viewpoint – one representational gesture subtype. A storyteller slowly moving their hand in an upward arc and then plunging it downwards uses an observer viewpoint representational gesture subtype to illustrate the speed and drama of a rollercoaster ride. Deictic gesture is used when a speaker defines the boundaries of an imagined space and shares it with a listener by using discrete motions towards the regions of space in front of them. In these examples, gestures clarify and enrich an accompanying verbal account (Beilock & Goldin-Meadow, 2010), bringing the listener's mental representation of a scene into closer alignment with that of the speaker.

The communicative transfer from the gesturing speaker to the viewing listener is dependent upon listener cognition. Working memory is a critical part of cognition (Shah & Miyake, 1999), and therefore important in the communicative transfer. To understand how transfer occurs, two current models of working memory – the Baddeley and Hitch Multicomponent Model, and the Cowan Embedded-Processes Model - were considered (Baddeley & Logie, 1999; Cowan, 1999).

A speaker who gestures while talking - thus exhibiting co-speech gesture - is presenting information simultaneously in two modalities: the auditory through verbal utterances, and the visual through their gesture. An individual attending to a gesturing speaker therefore, will have two channels of information available to them. Even when listeners are unaware of attending to gesture, it has been demonstrated that they do assimilate unspoken with spoken content (Cassell et al., 1999; Goldin-Meadow, Wein, & Chang, 1992). Attentional awareness therefore, may not be prerequisite to the memory of gestural information. Per both the Multi-Component and Embedded-Processes Models of working memory, both incoming verbal and visual information must pass through working memory to be stored long-term (Baddeley, 2007; Baddeley & Logie, 1999; Cowan, 1999), and long-term storage is required for retrieval (Foster & Jelicic, 1999; Glenberg, 1997).

Under the Multi-Component Model, the *phonological loop* processes incoming auditory information; co-speech gesture is processed separately by way of the *visuospatial sketchpad*. The two modalities are coordinated, and the semantic contents of each are brought together by conjoined processing of the *episodic buffer* and the *central executive*. Information cycling through the *visuospatial sketchpad* – such as co-speech gesture on the part of a speaker – has been interpreted as a form of internal mental rehearsal which aids memory (Wesp et al., 2001). In addition to a communicative purpose, this raises a cognition function for gesture - but on behalf of the speaker, not the listener.

Under the Embedded-Processes Model, visual and verbal information are routed to working memory via universal

channels that do not distinguish between modalities. As with the Multi-Component Model, a *central executive* manages attentional control - raising a portion of each modality of content onto the central stage of focus at any given time. Novel information is given attentional priority over that which is familiar or repetitive, meaning new content is more likely to be "activated" and thus more likely to be stored in long-term memory (Cowan, 1999). Under this model, a listener exposed to a story coupled with co-speech gesture may therefore be more likely to remember story content due to its novelty. Counter to the Embedded-Processes Model though, the dual funneling of auditory and visual information into the same channels could create competition between the two modalities for attentional resources.

Study of representational gesture use provides an important window into a speaker's mental processes (Cartmill, Beilock, & Goldin-Meadow, 2012; Hostetter & Alibali, 2008). It has also been argued that gestures function not just as communicative devices, but as aids to working memory on the part of the gesturing speaker (Wesp, Hesse, Keutmann, & Wheaton, 2001). On the part of the listener, viewing gesture can clarify ideas and impact thoughts (Beilock, & Goldin-Meadow, 2010). How this occurs, and what role working memory has in this process, are both questions yet to be answered. To move towards an understanding of these processes, we raise the question of whether co-speech gesture impacts *what* a listener remembers.

We hypothesize that a listener presented with co-speech gesture will exhibit greater and more accurate memory than a listener presented with speech only. In the case where verbal information is not concrete, we expect a listener's working memory to enable integration of gestural information into their mental construct of a scene to compensate. Predicted by the Multi-Component Model, the *central executive* would prioritize content from the visuospatial sketchpad – gesture – when incoming information to the *phonological loop* is ambiguous. Interpreted through the Embedded-Processes Model, the lack of competition from verbal information would render novel gestural information more likely to be raised to an attentional center stage – increasing the likelihood it will be stored in long-term memory.

To test this hypothesis, we conduct an empirical study in which an episodic story is relayed to participants. Verbal details in the story were intentionally ambiguous, with the presence or absence of clarifying gesture employed as the independent variable. Participant recall of verbal details and memory of the depicted scene was assessed, and analysis of differences in performance was carried out.

Methods

Participants. Twenty-six students from the Pembroke-King's International Programme at the University of Cambridge took part in the experiment. All participants were between the ages of 18 and 42, with a mean age of 21. Participants self-identified as native or non-native English speakers, but all had college-level English fluency per criteria for international student admission to the program. Fourteen of the total participants, 11 females and 3 males, were

native English speakers (E). Twelve of the total participants, 7 females and 5 males, were non-native English speakers (O).

Participants were recruited from a program attended by students originating from a range of countries and cultural backgrounds. Controlling for all potential differences was not feasible. This was acknowledged about the participant population. Participants were randomly assigned to control and test groups as a pool. Native language was considered vital to consider during data analysis, but did not impact group assignment. On completion of the experiment, data from 1 E female and 1 O female was excluded due to a data collection error in the first case and participant failure to follow experimental directions in the second case. All participants had normal hearing and vision, with or without correction.

Materials. The first group watched a video that included both speech and gesture usage (SG). The second group watched a video with speech only and no gesture (SO). Both videos showed a speaker, the experimenter, in front of a neutral background (Figure 1, Figure 2), verbally relaying a short story (Figure 8). Video recording, rather than live experimenter presentation, both of which are utilized in study of gesture (see Kelly, Özyürek, & Maris, 2009; Kelly, McDevitt, et al., 2009; for examples) was chosen for consistency of experience across participants. In the SO video, no arm or hand gestures are present. In the SG video, 15 separate gestures occur, 12 of which are representational (Figure 8). In a study of gesture and working memory, Wagner and colleagues showed that conflicting verbal and gestural content adversely impact participant memory (Wagner, Nusbaum, & Goldin-Meadow, 2004). To avoid this effect, only gesture that reinforced and elucidated speech was utilized in the SG video. Effort was made by the experimenter to use similar vocal intonation and emphasis in each case, however each video was separately recorded. Each video was 43 seconds in length.

The story relayed in both SO and SG videos was novel to this study (Figure 8). It is intentionally episodic and action-based to facilitate the use of gesture, previously shown to naturally co-occur with speech at a greater rate during spatial descriptions (Lavergne & Kimura, 1987). Story length was limited to six active tense sentences comprised of common American English words (Figure 8). The arc of the story followed a logical progression of sequential events to facilitate comprehension. The main character in the story was described as a child, with the gender-neutral moniker “C”. During the interview phase of the experiment, all participants confirmed the story was easily understood.

Figure 1: Frame from SG Video: Speech with Gesture.

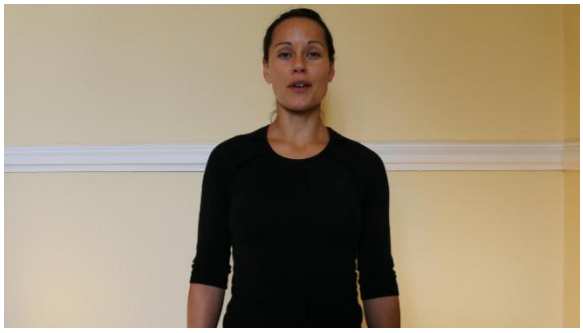


Figure 2: Frame from SO Video: Speech `Only.

After the participants watched the video, they were provided with a tray holding 4 paper origami objects with which to perform a physical scene reconstruction task (SR-P). Since participants differed in cultural background as well as native language, physical scene reconstruction was chosen as paradigm to minimize cultural biases (Rogoff & Waddell, 1982). SR-P objects included a House, a character C, a Puppy, and a Ball. On completion of the SR task, the participant was provided with a pointer object to indicate the vantage point from which they mentally visualized the story scene. Prior studies of mental scene reconstruction in response to reading an episodic narrative have shown that participants may assume a first person perspective envisioning the story scene unfolding around them (i.e.internal viewpoint), or they may assume a third person perspective as a detached viewer who watches the story scene unfold at a distance (i.e. external viewpoint) (Bryant, Tversky, & Franklin, 1992). Through the pointer object, viewpoint was established.

Participant accuracies in recollection of story events and story object positioning were assessed by three means, each novel to this study. This included a questionnaire instrument (Figure 9), a physical scene reconstruction task (Figure 10), and an interview conducted by the experimenter (Figure 11), in which participants explained their recall of events and choices in positioning objects. The questionnaire instrument was comprised of 11 questions. Two of the questions required participants to make inferences about object positioning that were communicated only through deictic co-speech gesture in the SG video. SO participants lacked access to this information. Correct SO participant responses to those two questions therefore, were expected to be at chance. Similarly, correct completion of the SR-P task was dependent on gestural information relayed only through the SG video – where gesture indicated which story object was positioned to each side of the character. SO participants were also expected to perform at chance in the SR-P task.

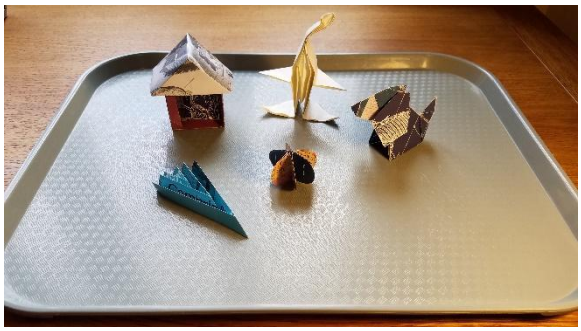


Figure 3: Scene reconstruction task objects and tray.
Clockwise from top left: House, Character, Puppy, Ball, Pointer.

For baseline comparison between participants, verbal and visual memory was assessed with a 25-word list (Figure 12), and an image, respectively. The 25 words were a random selection from a longer list of common nouns individuals learning English as a second language encounter. The image chosen was a black and white line drawing of a complex scene that contained at least 30 identifiable noun objects. Memory tasks were separated to account for separate sensory processing modalities.

Procedure. Participants were randomly assigned to one of two groups; both groups progressed through the same experimental phases. A single participant completed the experiment at a given time, within a 30-minute time period. The room where the experiment was conducted was a private, artificially lit space with a single window. Environmental cues have been shown to impact participants frame of reference, a possible confound when the task of interest involves positioning objects within a scene (Li & Gleitman, 2002). Thus, view of the outside was closed off by drawn curtains.

At the start of the experiment, the participant was instructed to take a seat at the single desk in the room, on the surface of which was a laptop only. The participant was advised that instructions would be provided on the screen, and that the experimenter would be present to facilitate and answer any questions they had. The experimenter remained present in the room throughout the entire course of the experiment in each case. On-screen instructions were presented via Qualtrics, which followed a survey format designed by the experimenter.

Each participant was presented with an online consent form and was advised a recorded interview would occur. The stated reward for participation was entry into a raffle for one of several small prizes, each valued at £15 or less, to be held after completion of all scheduled experimental sessions. All participants provided informed consent.

After consent was provided, the experimenter brought onto screen the SG or SO video as determined by random group assignment. The participant initiated viewing when they were ready. After the participant watched the video, the experimenter placed a tray holding 4 paper origami objects (House, Character, Puppy, Ball) on the desk while the participant was presented on screen with instructions for the

physical scene recreation task (SR-P). On completion of object positioning, pointer task instructions (Figure 10) followed, and the experimenter placed the pointer on the desk for the participant. Next, the participant was prompted on-screen to answer a series of questions presented in randomized order, without time constraints to test their memory of story details. On completion of questionnaire items (Figure 9), the experimenter requested the participant move to an adjacent seat and began the recorded interview (Figure 11).

Following the interview, the experimenter provided verbal instructions and administered verbal and visual memory tests. By conducting these tests after the main experiment, it was expected that all participants had an equal possibility of being primed by the previous tasks. In the verbal memory test, participants were instructed to write down all words they recalled hearing, in any sequence, after the experimenter read aloud the list of 25 words (Figure 12). In the visual memory test participants were instructed to write down all objects they recalled after viewing an image for 30 seconds. Finally, participants completed a brief demographic questionnaire and were then debriefed by the experimenter.

Results

In the verbal memory test, SG participants scored a mean of 10.2 words recalled with a standard deviation of 2.85. SO participants scored a mean of 10.0 words recalled with a standard deviation of 2.77. In the visual memory test, SG group participants scored a mean of 14.7 noun items recalled with a standard deviation of 3.01; SO participants a mean of 14.3 noun items recalled with a standard deviation of 2.81. No significant baseline difference in demonstrated verbal or visual memory ability between participant groups was noted (Table 2, 3).

SG and SO groups were subdivided into native (E) and non-native (O) English speakers to enable further analysis. E and O participant response accuracy to questionnaire items dependent upon verbal content only was compared to determine if any language barrier may have impacted comprehension. Accuracy was 67% for E participants in the SG group (ESG) and 64% for O participants in the SG group (OSG). Accuracy was 65% for E participants in the SO group (ESO), and 54% for O participants in the SO group (OSO). These differences were not significant (Table 4, 5).

Questionnaire responses were grouped into those that related to gestural content and those that did not. In the SG group, 58% of participants responded correctly to story questions reinforced by co-speech gesture. In the SO group, 45% of participants did so. The difference is not considered significant, $p < 0.13$, but is in the expected direction (Table 7).

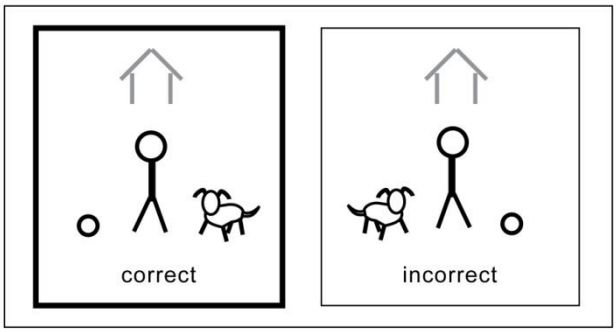


Figure 4: Correct and incorrect SR tasks. Variances other than correct sequence not depicted also scored as incorrect.

Participant performance in the SR task was assessed by evaluating the participant's SR-P and their mental construct of the scene as explained during the interview (SR-I). For both SR-P and SR-I, objects ordered left to right: Ball → Character → Puppy, as positioned in a group in front of House, were considered correct (Figure 4). For example, if during the interview a participant described object positioning correctly, but had failed to correctly position them during the physical task, the SR-I response for that participant was considered correct and their SR-P response was considered incorrect. SR-I and SR-P tasks for both SG and SO groups were coded based on these criteria.

For the SR-P task, 25% of SG participants correctly completed it while in the SO group, 17% did so. As can be seen in Table 1, for the SR-I task, 67% of SG participants correctly completed it, while 25% of SO group participants did so. The difference in correct SR-I task completion between the groups is considered significant, $p < 0.05$ (Figure 5).

Table 1: Comparison of correct SR-I responses between SG and SO groups

	SG	*SO*
Mean	0.6667	0.2500
Variance	0.2424	0.2045
Observations	12	12
P(T<=t) two-tail	0.0420	

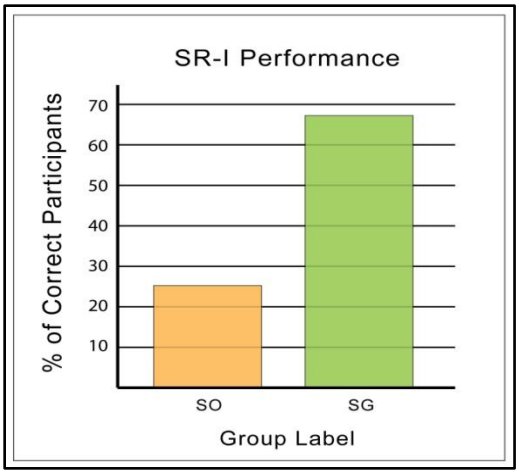
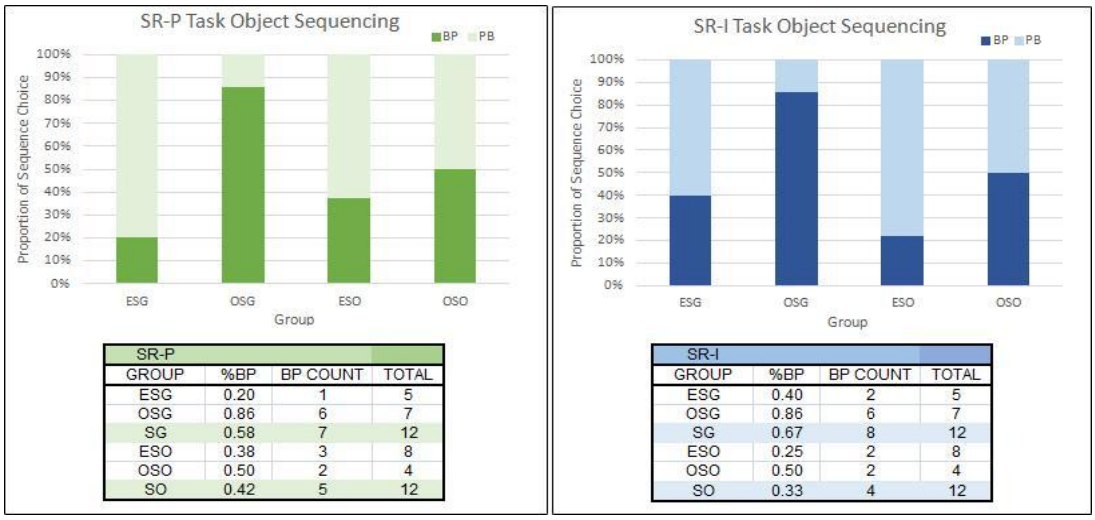


Figure 5: Comparison of SG and SO groups during SR-I task. Difference between groups is significant, p<0.5.

In the SG video, deictic gestures established the positions of the Ball and Puppy. The position of the character was not made explicit through gesture, but could be inferred by the story content. To separate the impact of gesture alone then, an analysis of participant positioning of the Ball and Puppy, regardless of C positioning, were considered. OSG participants were more accurate than ESG participants in recalling the correct sequence, with 86% OSG and 20% ESG participants correct in the SR-P task, and 86% OSG and 40% ESG participants correct in the SR-I task (Figure 6).



SR-P			
GROUP	%BP	BP COUNT	TOTAL
ESG	0.20	1	5
OSG	0.86	6	7
SG	0.58	7	12
ESO	0.38	3	8
OSO	0.50	2	4
SO	0.42	5	12

SR-I			
GROUP	%BP	BP COUNT	TOTAL
ESG	0.40	2	5
OSG	0.86	6	7
SG	0.67	8	12
ESO	0.25	2	8
OSO	0.50	2	4
SO	0.33	4	12

Figure 6: SR-P and SR-I Task responses considering only Ball (B) and Puppy (P) placement. Ball to left and Puppy to right (BP) is correct response, reverse (PB) is incorrect.

The viewpoint a participant assumes within a story scene has direct impact upon their recall of object positioning within the

scene, with those assuming an external viewpoint possibly having greater accuracy in recall of element and character positioning (Abelson, 1975). Within SG and SO groups, 42% of participants in each stated during the interview that they had assumed an internal viewpoint at some point when listening to the story. This is in line with prior research positing that an internal viewpoint poses a lower load to working memory, and that participants often assume internal viewpoints when reading narratives that describe space around a character (Bryant, Tversky, & Franklin, 1992). Where participants ultimately chose to place the pointer object in the SR-P however, was considered their dominant viewpoint. In the SG group, 58% of participants positioned the pointer object facing *towards* the house – an external viewpoint. In the SO group, 25% of participants did so. Though the sample size is small, with n = 12 in each case, the difference between groups in this second aspect of perspective is approaching significance, $p < 0.11$.

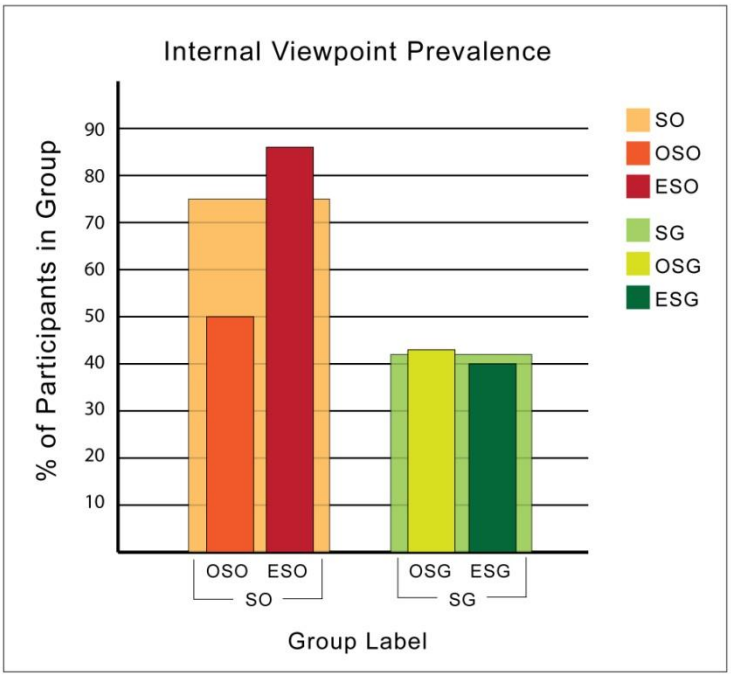


Figure 7: Analysis of participant viewpoint between groups.

Upon closer analysis of the SO group, it was noted that only one of the eight ESO participants had correctly reconstructed the scene during the interview – well below chance. The single correctly responding participant was also the only one out of eight to indicate an external viewpoint, hence viewing the scene in front of them. The remaining seven ESO participants had assumed an internal viewpoint. Six of those seven made the same error of reversing ball and puppy positioning.

Discussion

We hypothesized that listeners who had access to gestural information, the SG group, would demonstrate greater memory for details than the SO group – listeners who had access solely to ambiguous verbal

information, facilitated by listener working memory. By using different tasks to assess what listeners remembered, we were able to identify several factors that seemed to be impacting participant responses.

For questionnaire items, no significant difference was found between the SG and SO groups. Though no ceiling effect was present, it is possible that the questionnaire was not a sensitive enough tool to reveal differences in perception between participants. In which case, further questionnaire revision and testing would be warranted. Additionally, because questionnaire and SR-P tasks were not counterbalanced, in each case the questionnaire was completed after the SR-P. Participants may have been better able to recall story events specifically related to the scene they had just reconstructed. The presence of tangible items in scene reconstruction meant that participants had a visual referent available to them while completing the questionnaire. This may have impacted their recollection of other story elements. Repeating the study with a larger participant group, counterbalancing tasks, and assessing the impact of scene presence or absence after reconstruction would address these concerns.

In the SR-I task, a significant difference between the SG and SO groups was found. The task was designed to reveal individual differences among participants – vital in a participant group that was diverse in both language and cultural background – and succeeded in doing so. The verbally relayed story was intentionally ambiguous in object placement. Were gesture not playing a role, no difference in correctly reconstructing the scene would be expected between the groups. However, this was not the case. Initial analysis supported that listeners viewing gesture had indeed incorporated that information into their memory of the scene. The sensitivity of this task shed light on several differences across participant groups that were able to be further analyzed.

Within the SG group, where 67% had correctly answered the SR-I task, it was found that of the O participants, 86% had been correct and of the E participants, only 40% had been correct (Figure 6). This difference between native and non-native English speakers is far below chance. Even considering the low sample size of ESG (n = 5), this is a significant difference. These results might indicate that within the SG group gesture was a communicative factor impacting memory only among non-native English speakers.

This raised the further questions: what factors may have contributed to non-native English speaker's performance in the SR-I task? Was the OSG subset of the SG group better able to incorporate information from gesture, or was there something else common to the group that gave them an advantage? A weakness in the study is the presence of more than a single variable of difference between groups, which makes difficult causal attribution of differences in performance solely to the presence or absence of gesture.

Among the OSG group, all 4 participants who had assumed an external viewpoint were correct in the SR-I task, compared with 2 out of 3 from the ESG group. It is possible that assuming an

external viewpoint correlated with greater accuracy in recall of spatial relationships between objects as was the case in an earlier study (Abelson, 1975). Another consideration is the strong connection to story characters that can develop with an internal viewpoint, which may lead to distortion of recalled details (Bower, 1978). The external viewpoint then, could be considered the more objective of the two.

Of the other OSG group members, 2 out of the 3 who assumed an internal viewpoint did correctly complete the SR-I task, yet none of the ESG members who shared that viewpoint did so. Within the SO group, ESO participants overwhelmingly adopted an internal viewpoint. Additionally, all 7 of the 8 who did so were incorrect in the SR-I task. OSO participants were evenly divided by both viewpoint and correctness in the SR-I task. These results suggest that English speakers may have been biased to assume an internal viewpoint. A follow-up study, analyzing viewpoint alone among a larger group of English speakers would be required for a definitive answer.

Aside from viewpoint, another factor considered was the impact that perception of temporality may have had upon English speaking participants. Story content unfolded temporally, as is the case with all verbally relayed narratives. Participants heard a sequence that first, mentioned a Ball, and second, mentioned a Puppy. When individuals create the mental map of a scene, they have been shown to do so serially – in order of the verbal presentation of information (Tversky, 1991). As participants reconstructed the scene, it is possible they did so by employing a strategy of recalling, in sequence, the major events, and reconstructing step by step accordingly. In a study of English and Mandarin speakers, English speakers responded more quickly to left positioned items in a horizontal pair when it represented "earlier," whereas Mandarin speakers showed both a left bias and a top vertical bias (Boroditsky, Fuhrman, & McCormick, 2011). For English speakers then, it might seem natural to position the first item in a sequence, to the left. O group participants, like the Mandarin speakers in the study, may have been more flexible in their positioning of the first item they recalled.

The directionality conventions of written language may also contribute to this "left first" bias. In one study of how directionality conventions of English, Chinese and Taiwanese writing systems impacted performance on spatial tasks – Taiwanese participants -–exposed to both horizontal writing and vertical writing - showed greater flexibility in sequencing than did English and Chinese participants who were strongly biased to horizontal, left to right sequencing (Chan & Bergen, 2005). Supporting this idea is the account of one participant who, during the interview after the SR-I task, explained that because she was accustomed to reading left to right, it seemed most natural to her to place the objects in sequence from left to right – also the order in which she remembered hearing them introduced. Exploring that impact of gesture on memory through a task that allowed for positioning of items beyond the horizontal plane, and with a difference type of story, would be a way to examine if a directionality bias is always present for

English speakers, or if it only arises when verbal information is ambiguous.

In a review of research on working memory, Awh and Jonides discuss the links between eye movements – saccades – and spatial memory. Participants exhibiting greater saccades might be at an advantage to perceive and integrate gestural information (Awh & Jonides, 2001), another potential avenue for future study.

In this study, unique access to a diverse participant population allowed for some comparison across language and cultural groups. Self-reported native languages across participants included Arabic, Cantonese, Chinese, English, Kazakh (Kazakhstan), Lebanese, Mandarin and Tagalog. Countries of origin included Australia, Canada, China, Egypt, Hong Kong, Kazakhstan, Lebanon, the Philippines, Singapore and the United States. Future studies isolating and comparing subsets of these populations to establish what cultural and language differences are linked to memory of gesture would be of interest, and key in answering more pointed questions about these specific populations.

In a commentary response to Arthur Glenberg's article, *What memory is for*, Karl MacDorman raised the critique that Glenberg's discussion of memory failed to account for the role that "internal feedback" – the meshing of newly formed memories with pre-existing experience – plays (Glenberg, 1997). This study, which has raised a number of questions for further pursuit, has certainly provided an example of that which is pre-existing, interfering with that which is novel – at least for speakers of English.We found, as hypothesized, that gesture was indeed associated with accuracy in memory for story details. Unanticipated were the differences in how participants assumed perspective within their own story scene visualizations. These differences, emerging not only between those who did and did not view co-speech gesture, but also between native and non-native speakers of English, demonstrate that individual predispositions may impact not only what is encoded in memory, but also perhaps, perception of the same events. Teasing apart the circumstances in which "internal feedback" is a factor strong enough to override novel information, and for whom, are questions to be addressed in future research.

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Appendix

	Transcript of STORY		Coding of Gesture	
1	C [[is 5 years old]]	g1:	(RH)	indexical
2	[[and wants to play.]]	g2:	(RH)	abstract
3	But playing [[is not allowed]]	g3:	(RH)	abstract
4	[[inside the house,]]	g4:	(RH)	deictic, model-world-making
5	so [[C runs down the stairs]]	g5:	(RH)	observer viewpoint
6	[[and outside]] into the yard.	g6:	(RH)	deictic, model-world-making
7	[[On one side of the yard is a ball,]]	g7:	(RH)	deictic, model-world-making
8	[[and on the other side, a puppy.]]	g8:	(LH)	deictic, model-world-making
9	[[C walks to the ball]]	g9:	(RH)	deictic, observer viewpoint
10	[[and picks it up,]]	g10:	(LH+RH)	character viewpoint
11	[[then throws it to]] the puppy.	g11:	(RH)	character viewpoint
12	[[The puppy catches the ball,]]	g12:	(LH+RH)	character viewpoint
13	and [[brings it to C.]]	g13:	(RH)	deictic, observer viewpoint
14	[[Before dropping it though]],	g14:	(RH)	abstract
15	[[the puppy runs in circles around]] C, excited.	g15:	(RH)	observer viewpoint

Figure 8: Story transcript and gesture (g) coding, one gesture per transcript line. Double brackets indicate co-speech gesture occurrence. Gestures made by the right hand (RH), left hand (LH), or both (LH+RH) are noted. Coding per Viewpoint Diagram (DeLiema & Sweetser, 2016).

Q 13 - What is the last thing the Puppy did?
***Q 14 - When C went outside, what was to C's left?**
Q 15 - Place these events in the order they occurred in the story.
Drag to position the events so that the first to occur is at the top of the list and the last to occur is at the bottom.
- C throws the ball
- the Puppy runs around C
- C picks up the ball
- the Puppy drops the ball
- C runs down the stairs
- the Puppy catches the ball

Q 16 - Which objects were NOT in the story?
Q 17 - How old is C?
Q 18 - Why did C go outside?
Q 19 - Are the stairs inside or outside of the house?
Q 20 - At the end of the story, where is C standing?
***Q 21 - Where was the Puppy standing when C entered the yard?**
Q 22 - After bringing the ball to C, what did the Puppy do?
Q 23 - What did C do outside?

Figure 9: Story sequence and event questions. * Indicates information conveyed only through gesture.

The Experimenter will now provide you with several objects:
A ball, a house, a puppy, and the character "C."
Using these objects, re-create the story scene as you remember it after C exited the house.
Take as much time as you need to complete this task. When finished press the button to proceed.

The Experimenter will now provide you with another object that indicates direction.
Position this object in the scene area you've created to indicate where YOU are. That is, when you imagine this scene, from what position are you viewing it in your mind's eye? Place the marker object in that spot, pointing in your direction of view.
When you have completed this, please continue.

Figure 10: SR-P task instructions.

Experimenter sets up camera, records interview (with consent)

Experimenter asks the Participant the following questions, allowing Participant to elaborate and talk freely.
Question : Were you able to understand the story?
Question : Was there any part of the story that was unclear or confusing?
Question : Referring to your scene recreation, please explain why you've placed each figure where it is.
(*Ensure Participant explains each Figure location: Child, Ball, Puppy, House, Observer* .)
Question : Were you unsure about where any of the figures should be placed?
Question : Did you have a strong mental image of the scene before recreating it here, or did you piece it together while performing this task?
Question : Is there any difference between the scene you've recreated and the scene you imagined while listening to the story?
Question : What perspective did you take when listening to the story? (inside the character, an observer viewpoint)
Question : Is that the same perspective you've recreated in your scene?
Question : Do you think the video had an impact on your perspective?
Question : When you hear stories about others, do you tend to put yourself in their shoes?
Question : Please use your own words to relate the story you heard back to me.
Question : What do you think the purpose of this experiment was?

Question : Do you have any questions?

Figure 11: Interview Questions.

raincoat	cabbage	key	mirror	socks
octopus	sofa	broccoli	noodle	motorcycle
banana	grapes	turtle	horse	kangaroo
pepper	building	snake	window	scorpion
bookstore	snail	chicken	hospital	carrot

Figure 12: Word list used in verbal memory test.

Table 2: Results of Auditory Memory Test

	SG	*SO*
Mean	10.16667	10
Standard Deviation	2.852874	2.768875
Observations	12	12
P(T<=t) two-tail	0.890683	

Table 3: Results of Visual Memory Test

	SG	*SO*
Mean	14.66667	14.33333
Standard Deviation	3.009245	2.808717
Observations	12	12
P(T<=t) two-tail	0.790761	

Table 4: Accuracy Analysis between ESG and OSG on verbal-only dependent questions

	ESG	*OSG*
Mean	0.666666667	0.642857
Variance	0.027777778	0.003968
Observations	5	7
P(T<=t) two-tail	0.733547288	

Table 5: Accuracy Analysis between ESO and OSO on verbal-only dependent questions

	ESO	*OSO*
Mean	0.645833333	0.541667
Variance	0.074900794	0.0625
Observations	8	4
P(T<=t) two-tail	0.538072939	

Table 6: Accuracy analysis between SG and SO groups on verbal-only dependent questions

	SG	*SO*
Mean	0.685185185	0.611111
Variance	0.01758324	0.059484
Observations	12	12
P(T<=t) two-tail	0.365347354	

Table 7: Accuracy analysis between SG and SO groups on gesture dependent questions

	SG	*SO*
Mean	0.583	0.450
Variance	0.247	0.252
P(T<=t) two-tail	0.146	

Music as a Reward: Implications for Music Therapy in Treating Major Depressive Disorder

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Music has the power to elicit intense feelings of pleasure, and these feelings are intimately tied to the neural system for reward processing. This review will (1) examine the brain regions in humans that are associated with reward processing in addition to areas that have altered activity while listening to pleasant music, (2) demonstrate that the symptom of anhedonia that characterizes major depressive disorder (MDD) largely results from reward system dysfunction and abnormal dopamine activity, and (3) consider the field of music therapy as a potentially successful treatment for people with MDD due to music's ability to activate the brain's reward system. This review concludes that music therapy, specifically improvisational music therapy, is a promising complementary treatment method to traditional psychotherapy and medication for those with MDD. However, further research is needed to clearly explain its efficacy and demonstrate its potential to alleviate symptoms of MDD as well as symptoms of other disorders that are associated with reward circuit malfunction and/or aberrant dopamine activity.

Key Words: music, reward system, major depressive disorder, music therapy

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Music, an art form which nearly every human society has developed, not only can become an expression of consciously experienced feelings, but also can directly influence human emotions. One of the most important powers of music is its ability to elicit intense feelings of pleasure. In this sense, the term "emotion" refers to the relatively brief, often unconscious physiological and psychological responses to a particular external or internal event (Juslin, Barradas & Erola, 2015). "Feelings of pleasure," alternatively, correspond to the conscious subjective awareness of a number of components related to positive emotion, including affect, mood, and various biological states, such as sexual arousal. While most studies have focused on neural activation based on the acoustic and cognitive components of music, little is known about its prospect as a reward (Menon & Levitin, 2005). Because it has long been acknowledged that music can evoke pleasurable feelings that are intimately tied to the brain's circuit for reward processing, research in recent years has delved into the neural mechanisms

underlying the relationship between music and activation of the reward system. Though this reward (or mesocorticolimbic) pathway and its related structures are involved in processes other than reward, such as responses to aversive stimuli and both positive and negative reinforcement, for the purposes of this paper, it will be referred to as the reward system (Volman et al., 2013). Given the involvement of the reward circuit in both music-evoked emotion and major depressive disorder (MDD), these findings must be integrated to better explain and advance the field of music therapy as an evidence-based treatment method.

Music as an Abstract Reward

The human reward system is typically activated by physical stimuli. This can be in the form of primary rewards, or those that address a basic need, such as food and sex, or secondary rewards, like money or other tangible items (Salimpoor, Benovoy, Larcher, Dagher, & Zatorre, 2011). However, humans have developed a unique cognitive ability to derive pleasure from abstract stimuli. Such stimuli are defined by their intangible nature, yet still have the power to elicit pleasurable feelings. Music, an example of one such abstract stimulus, is not a primary or secondary reward in the strict sense, but, through generations and across cultures, continues to provide a source of pleasure (Salimpoor et al., 2011). Music is able to utilize the neural processing of reward through the same mechanisms as other more biologically-salient stimuli, which demonstrates how human cognition has evolved to accommodate more complex classifications of reward (Blood & Zatorre, 2001). When considered from an evolutionary standpoint, this seemingly odd capability of an abstract stimulus becomes clearer. Because music has historically been experienced in a social setting, activation of the reward system has encouraged interpersonal relationships and cooperative efforts through sharing pleasurable feelings with others. Some researchers believe that music became a source of social cohesion and the neural circuitry underlying this adaptive mechanism has been passed on from generation to generation (Brown, Martinez, & Parsons, 2004).

The Role of Dopamine in Reward Processing

A major component required for normal reward processing is the neurotransmitter dopamine, which has been shown to have altered activity in people with MDD (see discussion below) (Tremblay et al., 2005). One of the main sources of reward-related dopamine signaling in the brain is the ventral tegmental area (VTA), and the nucleus accumbens is a major target for VTA cells (Menon & Levitin, 2005). This means that the nucleus accumbens is a region that receives many neuronal projections from the VTA. Other main targets of the VTA are the prefrontal cortex, an area associated with decision making and planning, and the dorsal striatum, which is implicated in habit formation. The VTA also releases dopamine through projections to the amygdala and the anterior cingulate cortex (ACC), as both regions are involved in emotion-related learning and subjective experience (Lepping et al., 2016). The ACC receives input from the prefrontal cortex in

addition to the VTA and is involved in positive and negative emotional processing (Lepping et al., 2016). This area is not only involved with emotion generation, but emotion regulation as well. Along with other regions associated with emotion regulation, the ACC plays a role in appraising emotional stimuli and also producing emotions that are appropriate for a given context (Donofry, Rocklein, Wildes, Miller, & Erickson, 2016). Thus, when a stimulus activates the VTA and causes dopamine release in its various target regions, the experience is perceived as pleasurable. These reward-related experiences in humans, which are linked to dopamine activity, assist in the formation of memories by creating associations between specific stimuli and feelings of pleasure. Dopamine thus plays a central role in the motivational processes that lead humans to seek out a particular rewarding stimulus (Bressan & Crippa, 2005). Dopamine release from the VTA is critically important for reward processing because the neurotransmitter is implicated in motivation, reward-seeking behaviors, and working memory (Stegemoller, 2014). All of these cognitive functions are necessary for potentially rewarding stimuli to effectively activate the reward circuit and to elicit feelings of pleasure.

Music Activates the Human Reward Circuit

Evidence that music, specifically, activates reward-related circuitry in humans has been provided using neuroimaging methods. Utilizing functional magnetic resonance imaging (fMRI), which uses blood flow as a measure of brain activity, Menon and Levitin (2005) observed significant activation in the nucleus accumbens and VTA in response to self-reported pleasurable music listening. They also noted increased activity in the left and right inferior frontal cortex and the ACC. Because pleasant music was considered a rewarding stimulus, activation of these areas was expected, but still a necessary first confirmation of their role. Moreover, there were significant correlations between ongoing activity in the nucleus accumbens and VTA, nucleus accumbens and hypothalamus, and VTA and hypothalamus while listening to pleasant music (Menon & Levitin, 2005). This indicates that the nucleus accumbens, the VTA, and the hypothalamus (a region that regulates autonomic responses), appear to be highly interconnected during music processing. Because the nucleus accumbens and VTA are known to play crucial roles in the neural reward circuit, these findings suggest that music can also serve as a source of reward system activation and stimulate dopamine release.

Additional studies have reported reward circuit activation in response to music listening during anticipation of pleasure and also during peak emotional responses. Salimpoor et al. (2011), based on the results of their fMRI study, reported increased activity of the caudate and nucleus accumbens during anticipation of pleasure while listening to pleasant music as compared to neutral music. While the caudate became less active during subjects' peak feelings of pleasure, activity in the nucleus accumbens continued to increase,

implying that the caudate is active only during anticipation of pleasure. The caudate, a subregion of the striatum, has connections to the sensory and motor cortices and is important for establishing stimulus-response associations (Salimpoor et al., 2011). The dorsal striatum, also known as the caudate nucleus, plays a role in encoding a specific stimulus as pleasurable by creating an association between that stimulus and feelings of pleasure, which helps guide future reward-seeking behaviors (Valentin & O'Doherty, 2009). Additionally, brain areas involved in working memory might also assist in forming this association (Treadway & Zald, 2011). The ACC and prefrontal cortex are involved in working memory functioning, and both areas are also main targets for dopamine. This is a necessary connection in order for pleasant music to act as a reward because working memory is required to encode it as a pleasurable stimulus. While the caudate is responsible for creating the association between music and feelings of pleasure, working memory helps facilitate the storage of the association into long-term memory and also its retrieval in future situations (Treadway & Zald, 2011).

Since the nucleus accumbens is a main target for dopamine, the results obtained by Salimpoor et al. (2011) also suggest a mechanism by which dopamine can contribute to subjective feelings of pleasure over time. Since activity in the nucleus accumbens continually increased from anticipation of pleasure to peak emotional responses, this implies that dopamine release also increased over time and thus contributed to the feelings of pleasure reported by participants. Taken together, these results show that music can be perceived as a reward in humans and can activate the same dopaminergic pathways as other, more tangible rewards do. Since music can activate the reward circuit, and therefore likely stimulates dopamine release, this can begin to explain why musical emotional experiences have been sought out by many people throughout history and why this practice persists today (Salimpoor et al., 2011).

Blood and Zatorre (2001) also noted several areas where activity levels increased from baseline during music listening. Using positron emission tomography (PET) scans, which use blood flow as a measure of brain metabolism, they observed increased blood flow in the left ventral striatum, dorsomedial midbrain, and anterior cingulate cortex. Interestingly, these regions are known to be directly affected by dopaminergic neuronal projections and are also more active while listening to pleasant music. The authors also noted increased activity in the supplementary motor area and cerebellum, both of which are involved in movement and motor control. As music often produces an inclination to move or dance, activation in these regions is unsurprising; whether this activation is related to the experience of pleasure is as of yet unclear. Overall, these results are consistent with the findings of Salimpoor et al. (2011) and Menon and Levitin (2005), further suggesting that pleasant music activates the reward circuit.

Due to the relatively poor spatial resolution of PET scans, it is unclear whether activity in the midbrain was localized to the VTA or also to either the

periaqueductal gray region (PAG) or the pedunculopontine tegmental nucleus (PPT) (Blood & Zatorre, 2001). However, both regions are also thought to be involved in reward processing. The PAG has many opioid receptors and thus is associated with reward derived from opioids, such as endorphins, which activate the same reward pathway as music and other rewards. Using the chemical naloxone, these opioid receptors can be blocked, which can decrease or inhibit participants' subjective feelings of pleasure. The PPT, on the other hand, is innervated by the nucleus accumbens and projects to areas including the VTA, thalamus, and amygdala. This region of the midbrain is hypothesized to be involved in creating associations between drugs and reward (Blood & Zatorre, 2001). This means that the PPT may be involved in learning that a certain drug elicits pleasurable feelings, and thus may also be important for establishing the memory that pleasant music produces similar feelings. Even though it remains unclear due to the poor spatial resolution of PET scans whether one or both of these areas were activated by music (in addition to the VTA), both are involved in reward processing. This indicates that pleasurable music has the ability to activate a wide range of regions within the reward circuit to contribute to more intense feelings of pleasure.

Another mechanism by which music may achieve maximum feelings of pleasure is by simultaneously activating the reward system and inhibiting areas that are associated with processing negative emotions (Blood & Zatorre, 2001). Both the amygdala and hippocampus have been shown to be active during the experience of emotions that are considered negative, such as fear, and tend to be overactive in people with MDD. While this is certainly not their only function since they also assist in processing positive emotions, both regions are known for their major role in experiencing negative emotions. Blood and Zatorre (2001) showed that while subjects listened to pleasant music, activity decreased in the left and right amygdala, left hippocampus, and ventromedial prefrontal cortex. Additionally, the amygdala and hippocampus receive direct inhibitory input from the nucleus accumbens. This suggests that when the nucleus accumbens, and therefore the reward circuit, is active, the amygdala and hippocampus are inhibited. As a result, music can both activate the reward system and inhibit pathways related to the processing of negative emotions, presumably leading to a maximal pleasure response signal. These findings are especially relevant to the discussion below of music as a potential treatment for people with MDD, as they have difficulty experiencing pleasure as well as hyperactivity in areas involved in processing negative emotions.

In addition to activating brain regions that mediate the subjective feeling of pleasure, music also causes changes in autonomic nervous system functioning that are associated with many other types of pleasurable experiences. Since feelings of pleasure can be difficult to measure quantitatively, physiological responses that occur are often used to judge emotional arousal (Salimpoor et al., 2011). This includes frequencies of "chills" or "goose

bumps" experienced while listening to pleasurable music as well as measures of autonomic activity changes, such as heart rate, respiration rate, and skin conductance. These same autonomic reactions accompany pleasure responses to other rewarding stimuli, like the consumption of a favorite food. Listening to pleasurable music results in significantly higher autonomic nervous system activity evidenced by increases in heart rate, respiration rate, and skin conductance and decreases in body temperature and blood volume pulse amplitude, or the amount of blood pumped by a single heartbeat. Intensity and frequency of chills has been shown to be significantly related to all five of these measures of autonomic nervous system arousal (Salimpoor et al., 2011). Since the hypothalamus is involved in monitoring autonomic responses, activation of this specific region while listening to pleasurable music is expected, as observed by Menon and Levitin (2005). These results show that pleasant music elicits the same physiological responses as many other typical primary and secondary rewards, providing further evidence that music itself can act as a rewarding stimulus.

In summary, studies have clearly shown that music can elicit physiological responses and activate brain reward regions associated with the processing of primary and secondary rewards (Blood & Zatorre, 2001; Menon & Levitin, 2005; Salimpoor et al., 2011). The VTA projects directly to the nucleus accumbens and is the site of dopamine production; thus, these areas are typically considered fundamental components of the neural basis of reward. Listening to pleasant music activates the reward circuit, elicits feelings of pleasure, and should be considered a type of abstract reward. This is of critical importance because it illustrates that the reward system in humans does not need an explicit (i.e. primary or secondary) reward, such as food or money, to become activated (Menon & Levitin, 2005). Certain abstract rewards, in this case music, can also serve as reward circuit activators. This implies that pleasant music likely stimulates dopamine release. Taken together, these results also suggest that pleasant music may have the potential to be an incredibly useful treatment option for disorders that are associated with an aberrant reward system and dopamine dysfunction, as in the case of MDD.

Reward System Dysfunction in Major Depressive Disorder

Research in recent years has begun to explore neural reward mechanisms as targets for treatment of certain neurological and psychiatric disorders. This is largely due to the ability of the reward regions to undergo synaptic and connective alterations in circuitry. It is hypothesized that this system can be artificially altered using medication or modified through naturally rewarding stimuli (Tremblay et al., 2005), such as pleasant music. One such illness that this approach may be particularly effective for is major depressive disorder (MDD), given the changes noted throughout the reward-related circuits. MDD is characterized by the symptom of anhedonia, a markedly reduced interest in activities or experiences that used to elicit pleasure (Tremblay et al., 2005), which can in some

cases include music listening. Additionally, abnormal activity of some neuroendocrine systems and neurotransmitters, such as serotonin, dopamine, and norepinephrine, are common in those with MDD (Tremblay et al., 2005). Since dopamine malfunction and anhedonia are both associated with MDD, this implicates the neural reward system in the pathophysiology of MDD and also suggests that pleasant music may be able to induce alterations in neuronal wiring, ultimately contributing to symptom alleviation.

Normal dopamine activity is essential for a fully functioning reward circuit, but this is usually not the case for people with MDD. Those with MDD typically have low dopamine release compared to healthy individuals, leading to abnormal dopamine activity. For example, a drug which is known to greatly stimulate dopamine release throughout the reward system in healthy people, dextroamphetamine, results in much greater feelings of pleasure in those with MDD (Tremblay et al., 2005). In this study, those with MDD were hypersensitive to the drug, meaning they experienced heightened feelings of pleasure relative to the control group. Furthermore, Tremblay et al. (2005) noted a positive association between the degree of hypersensitivity and the severity of anhedonia reported. The fact that subjects with MDD experienced a hypersensitivity to dextroamphetamine indicates that dopamine release or activity is not functioning correctly in these people and supports the hypothesis that the reward system is implicated in the symptoms of MDD (Tremblay et al., 2005).

Additional evidence for the idea that reward system malfunctioning is involved in MDD lies in the aforementioned brain regions that showed decreased activity compared to healthy subjects. These areas include the right ventrolateral prefrontal cortex, caudate, and orbitofrontal cortex (Tremblay et al., 2005). In terms of neuroimaging, the regions that are deactivated can be just as important as those that become more active. The caudate, specifically, is important in that it is associated with reward processing and contains dopaminergic projections. The researchers believe that use of dextroamphetamine (which may have inhibited receptors for glutamate) results in the disinhibition of dopaminergic neurons, cells that are normally inhibited in people with MDD. This dextroamphetamine-induced disinhibition could explain the hypersensitivity these subjects experienced (Tremblay et al., 2005). Dextroamphetamine is not currently used as a treatment for MDD. However, if exposure to pleasant music can result in the same process of dopamine disinhibition, then it would be an invaluable treatment for MDD patients, as it would more naturally produce intense pleasurable feelings.

Music Therapy: Integration of Music and Reward for MDD

As has been previously discussed, music is effective in activating the brain's reward system and this can induce changes in neuronal wiring. Because MDD is associated with a malfunctioning reward circuit, music could be a potential therapeutic tool and help alleviate

symptoms, such as anhedonia, in addition to eliciting more intense feelings of pleasure. This approach could be applied to other neurological and psychiatric disorders as well, such as schizophrenia and bipolar disorder (Castillo-Perez, Gomez-Perez, Velasco, Perez-Campos, & Mayoral, 2010).

Research on the therapeutic use of pleasurable music for MDD has only recently gained traction. A review of current studies investigating the potential effects of pleasant music on symptoms of MDD was conducted by Chan, Yang Wong, and Thayala (2011). Of the seventeen studies they included, eleven showed clear evidence of reduced self-reported depressive scores after repeated sessions of music listening. These beneficial results continued even after the music listening sessions were stopped, indicating that the improvement of MDD symptoms in response to pleasant music could be long-term. An important component of this research is that, for all subjects, music listening periods did not involve the direct involvement of a music therapist, indicating that music therapy is a very accessible treatment for those with MDD (Chan et al., 2011). The reduced depressive symptoms were largely produced by the music, which shows the power of pleasant music to alter cognitive functioning.

Additionally, this form of music therapy may even be more effective than more traditional forms of psychotherapy in treating symptoms of MDD. Psychotherapy typically involves a patient and therapist discussing feelings, thoughts, personal issues, and strategies for improving an individual's quality of life and/or dealing with symptoms of psychiatric or neurological disorders. This practice has been used for decades because it has proven effective in helping patients work through their problems, but newer methods, such as the formal practice of music therapy, have developed in more recent years. In a study by Castillo-Perez et al. (2010), participants with MDD either underwent music therapy by being exposed to pleasant classical music or underwent typical psychotherapy treatments. After eight weeks, the music therapy group displayed greater improvement of their depressive symptoms than the subjects who participated in psychotherapy (Castillo-Perez et al., 2010). Thus, not only is music an effective tool in decreasing levels of depression, but it may also be more successful than psychotherapy in some conditions. Psychotherapy is the most common form of therapy currently used to treat depression and these results suggest that incorporating music into this existing therapeutic method may have significant benefits for treatment outcomes. Medication treatment may also provide additional symptom alleviation, though its effectiveness in combination with music therapy is currently unexplored. With the recent development of music as a formal method of therapy, some therapists have already begun to incorporate it in their practices.

Improvisational Music Therapy and MDD

While simply listening to pleasant music is considered one form of music therapy for depression, other forms more directly involve the patient in the musical

experience. One example of this is improvisational music therapy, in which both the patient and the therapist use musical instruments, oftentimes drums, to interact. The therapist carefully listens to the patient's improvised rhythms and actively encourages the patient to express their emotions through a form of nonverbal communication. This can lead to a process of self-discovery, allowing the patient to gain insight into their feelings which may not have necessarily been achieved using words alone (Erkkila et al., 2011). The therapist can then utilize these realizations in later reflective discussions to better explore the patient's depressive thoughts and emotions. Another important component of improvisational music therapy is that it can allow for a more meaningful relationship to develop between the patient and therapist. Through music-making, both the patient and the therapist are encouraged to experience each other differently than in traditional psychotherapy sessions. This allows them to relate to each other in a way that talking exclusively may not achieve, which could help build a stronger patient-therapist bond (Maratos, Crawford, & Procter, 2011). As a result, improvisational music therapy may be able to help break down barriers that prevent patients from discussing their feelings. This suggests that music can be utilized as a mechanism for facilitating communication between patient and therapist, thus leading to more successful therapy sessions.

Additionally, Erkkila et al. (2011) demonstrated that this form of therapy is more effective in improving symptoms of depression, as well as anxiety and overall brain functioning, than standard psychotherapy alone. Based on results from various psychiatric tests (i.e. Montgomery-Asberg Depression Rating Scale, Hospital Anxiety and Depression Scale, and Global Assessment of Functioning), subjects who participated in improvisational music therapy had significantly greater decreases in depression and anxiety levels and increases in overall functioning compared to those who engaged in traditional psychotherapy. These findings demonstrate that integrating improvisational music-making with more traditional psychotherapy adds another dimension to the therapeutic approach that can significantly improve the symptoms of those with MDD. However, a similar study should be performed using fMRI to assess symptoms of depression, anxiety, and general brain functioning to corroborate the results obtained by Erkkila et al. (2011) as well as to investigate whether improvisational music therapy activates the reward circuit. Because the psychiatric tests used by Erkkila et al. (2011) are based on self-reports and do not provide a direct measure of neural activity, these results alone are not sufficiently conclusive. An fMRI study that clearly shows the association between improvisational music therapy and the reward pathway is needed.

Improvisational music therapy is successful in reducing levels of depression, but there are several factors which are thought to contribute to this phenomenon. For example, active music-making requires the patient to partake in physical movement (Maratos et al., 2011). This dimension of music therapy seems to be important to

MDD patients, and thus is thought to play a role in the effectiveness of improvisational music therapy (Erkkila et al., 2011; Maratos et al., 2011). Additionally, producing music is both a mentally and physically engaging task and becomes inherently social as the patient must interact with the therapist on an intimate, emotional level. For people with MDD, activities that incorporate both of these elements are incredibly important due to their general lack of motivation to seek out social encounters that also involve emotional expression. This form of therapy may be a particularly useful strategy for MDD patients or those affected by other disorders, such as generalized anxiety disorder or schizophrenia, who find it unusually difficult to engage with others (Maratos et al., 2011).

Most importantly, it is hypothesized that a major contributor to the success of all forms of music therapy in reducing the severity of depression is its ability to activate the neural reward system. As previously discussed, MDD involves a malfunctioning reward system and abnormal dopaminergic activity, typically associated with low levels of both dopamine and its receptors (Castillo-Perez et al., 2010). By activation of many of the brain regions associated with reward processing, music can also elicit pleasurable feelings and therefore increase positive affect in patients with MDD (Castillo-Perez et al., 2010). Given these findings, it seems plausible that the music component of music therapy can increase dopamine release and transmission throughout the brain in patients with MDD, just as listening to pleasant music does in those without the disorder. Up-regulation of dopamine release due to music can then, to some extent, combat the dopamine dysfunction that is associated with MDD and lead to reduced symptoms. Because dopamine is also involved in motivation, increased dopamine release could potentially encourage pleasure-seeking behaviors, which would also lead to increases in positive affect. Even though MDD is characterized by anhedonia, a lack of interest in previously pleasurable experiences, music therapy provides a means by which this symptom can directly be targeted through activation of the reward circuit.

Additional Benefits of Music Therapy

Music as a therapeutic tool has many additional benefits outside of possibly being an effective method for alleviating MDD symptoms. However, few studies have been conducted that clearly demonstrate the success of music therapy and further investigation is needed to clarify its potential efficacy. Many of the medications currently available to treat MDD are costly and can cause unwanted side effects, tolerance, and withdrawal symptoms. However, music is inexpensive and carries no unforeseen health risks. Additionally, even without the assistance of a therapist, music has been shown to decrease levels of depression in people with MDD (Castillo-Perez et al., 2010). This form of music therapy alleviates the financial cost of a therapist because the treatment can be self-administered. This may also be especially appealing for individuals who are reluctant to discuss personal issues with a therapist (Castillo-Perez et al., 2010). This simple, self-

administered music therapy makes it incredibly easy for people with MDD to increase their positive affect, as long as music listening sessions are frequent and consistent. However, as MDD is a highly variable disorder, music therapy may not produce the same effects for all patients. Though a therapist is needed in the case of improvisational music therapy, this form provides an additional set of benefits.

Improvisational music therapy possesses distinct characteristics that may ultimately reveal it to be the most effective method of music therapy; however, much research is needed in this area to confirm such a claim. As previously discussed, this therapeutic program is unique in that it incorporates physical movement. The depression-reducing effects of physical activity in combination with those produced by musically-activating the reward system may lead to a more significant decrease in MDD symptoms than either one can achieve alone. Additionally, incorporating more traditional psychotherapy measures into music therapy adds another dimension of beneficial effects. Psychotherapy has proven successful in encouraging patients with MDD to verbally communicate their thoughts and feelings so as to more adequately address them. Using improvisational music therapy integrates the verbal conversation aspect of psychotherapy with the nonverbal emotional expression of music-making into a single therapeutic process (Maratos et al., 2011). In so doing, this suggests that the power of improvisational music therapy to alleviate symptoms of MDD could be greater than either music therapy or psychotherapy individually. Using these criteria, currently improvisational music therapy can be seen as the most successful treatment method for reducing symptoms of MDD.

While there are many forms of music therapy available today, all likely succeed in alleviating symptoms of MDD by activating the neural reward circuit. However, most music therapists and researchers who investigate the field do not approach music therapy with the goal of maximizing reward circuit activation; doing so may result in dramatic improvements in treatment outcomes. Knowledge about the effectiveness of music in alleviating symptoms of MDD is becoming widespread, but oftentimes those who practice music therapy are unaware of the neural mechanisms underlying these benefits, mainly that music activates the reward system and increases dopamine levels throughout the brain. While improvisational music therapy may be the most effective form of music therapy, it could be modified so as to maximize reward circuit activation and thus lead to an even more successful treatment method. One way to utilize this information might be to tailor the music to the preferences of the individuals, for example using the patient's choice of musical instruments or playing certain types of music based on the patient's music interests during improvisational music therapy sessions. This may be an effective way to develop subjective, nonconscious connections between patient and therapist that often underlie successful relationships. The main aim of any therapy for MDD is to produce a decrease in depressive symptoms, though in the case of music therapy, further

research is needed to clearly demonstrate its long term effects in reducing these symptoms. Because this effect is likely achieved mainly through activation of the brain's reward system, approaching music therapy from this standpoint will result in improved methodology, organization, and outcomes for a treatment that has initially proven remarkably successful in alleviating symptoms of MDD.

Conclusion

This paper has demonstrated that the concepts of music, reward, and depression are intimately related. Listening to pleasant music has been shown to activate many of the same brain regions that are associated with other types of reward processing, mainly the VTA, nucleus accumbens, prefrontal cortex, and ACC (Blood & Zatorre, 2001; Menon & Levitin, 2005; Salimpoor et al., 2011). Because MDD is a disorder associated with reward system dysfunction and abnormal dopamine activity, music has begun to be explored as a treatment which specifically targets this circuit to reduce symptoms. The field of music therapy, and improvisational music therapy in particular, initially seems to be effective in alleviating depressive symptoms. This is not to say that music therapy can completely replace more traditional forms of psychotherapy or medication, but it should perhaps be used as a complement to these other treatment methods. While research has not yet explored specifically whether active music-making using instruments and/or singing activates the neural reward system, if such an fMRI study were to be conducted it would likely find increased activation of the VTA, nucleus accumbens, ACC, and medial prefrontal cortex. These regions are all considered major components of reward processing in the brain. Because listening to pleasant music activates the brain's reward pathway and improvisational music therapy reduces the symptom of anhedonia that characterizes MDD, the inference is that music-making also has the ability to act as a reward. This may contribute to long-term changes if used in a therapeutic manner, although the parameters (i.e. optimal session duration, number of sessions, patient group, etc.) for such a successful treatment are currently entirely unexplored. Such lasting improvements could include increased positive affect, decreased anhedonia, and a renewed sense of joy from activities that used to elicit feelings of pleasure before the onset of MDD. If improvisational music therapy results in reward system activation, this would largely explain why it is so successful in reducing symptoms of MDD and increasing positive affect.

Future directions in this area of research could include studies investigating patterns of neural activation while participants play music using various instruments, sing, or a combination of music-making and singing. Studies could also examine brain activation of reward-related areas while playing music selected by participants in the background and simultaneously actively playing a musical instrument. Though it would be impossible for some instruments to be played during an fMRI, using small, simple instruments, such as a recorder or a single drum, is plausible. Such research would provide a clearer

picture of how effective these topics for future directions are in activating the neural reward circuit.

Additionally, the population of people with MDD is a highly heterogenous group; individuals display variable symptoms and oftentimes have been diagnosed with a comorbid mental disorder, such as anxiety (Treadway & Zald, 2011). Thus, improvisational music therapy may not be as effective for some people with MDD as it is for others. However, taking a patient's comorbid disorder or their specific symptoms into consideration and incorporating that information into music therapy sessions could improve their efficacy across the MDD patient group as a whole. This is an area of research which has been entirely unexplored and studies investigating the success of tailoring improvisational music therapy sessions to the needs of individual patients would contribute greatly to improvements in the field.

While music therapy certainly can be beneficial for people with MDD, it may also prove effective for other psychiatric disorders including bipolar disorder, schizophrenia, generalized anxiety disorder, and even Parkinson's disease; all of these disorders involve periods of low mood and anhedonia in addition to reward system malfunction and/or abnormal dopamine activity. Currently, music therapy is also being explored as a complementary treatment for Alzheimer's patients (Fang, Ye, Huangfu, & Calimag, 2017). Preliminary research suggests that music therapy promotes positive affect and reduces the cognitive decline that is the hallmark of Alzheimer's disease and does so through music that creates constructive, personal associations (Fang et al., 2017). People with MDD can also exhibit decreased cognitive abilities, such as an inability to concentrate and increased forgetfulness, which might be another connection between MDD and music therapy as an effective treatment. However, the importance of the neural reward circuit to the success of music therapy remains largely unacknowledged. As music and music-making begin to be viewed as effective tools for alleviating symptoms directly as a result of their ability to activate the brain's reward system, music therapy will have the potential to become a mainstream treatment method not only for MDD, but also for other psychiatric and neurological disorders as well.

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