Distribution Agreement

Brooke Holsinger April 10, 2024

Exploring the Role of Emotion Processing in Face Memory in Dissociation

by

Brooke Holsinger

Alexandra O. Cohen
Adviser

Department of Psychology

Alexandra O. Cohen

Adviser

Negar Fani

Committee Member

Patricia A. Brennan

Committee Member

2024

Exploring the Role of Emotion Processing in Face Memory in Dissociation

By

Brooke Holsinger

Alexandra O. Cohen

Adviser

An abstract of
a thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
Bachelor of Science with Honors

Department of Psychology

2024

Abstract

Exploring the Role of Emotion Processing in Face Memory in Dissociation
By Brooke Holsinger

Research has found that greater dissociation relates to both reduced brain activity and physiological responses for emotional content, as well as worse accuracy in identifying angry and fearful faces. Studies also suggest that emotional memory is impaired in dissociative populations. Given that emotion plays a major role in modulating memory formation, deficits in emotion processing in those with greater dissociation may then affect memory for faces, which are a consistent source of emotional content experienced in individuals' daily lives. In this study, we investigated the relationships between dissociation, emotion processing, and face memory in an existing sample of 157 women aged 18-62. Dissociation, facial emotion recognition, face memory, word memory, attention, and childhood abuse were assessed. Results indicated no significant associations between dissociation and emotion recognition accuracy or reaction time for any emotions, as well as no association with face memory. However, we found marginally significant associations between dissociation and word memory and between attention and emotion recognition accuracy, irrespective of dissociation. Greater dissociation related to worse word memory, and worse attention scores related to worse emotion recognition accuracy. These findings suggest that dissociation may not have a significant impact on emotion processing or face memory, but it may relate to impairments in verbal memory.

Exploring the Role of Emotion Processing in Face Memory in Dissociation

By

Brooke Holsinger

Alexandra O. Cohen

Adviser

A thesis submitted to the Faculty of Emory College of Arts and Sciences
of Emory University in partial fulfillment
of the requirements of the degree of
Bachelor of Science with Honors

Department of Psychology

2024

Acknowledgements

Thank you to Dr. Ali Cohen for giving me the opportunity to do a thesis and providing me the freedom to choose a topic that interests me. Thank you for taking the time to consistently provide amazing guidance and support throughout the development of my thesis.

Thank you to Dr. Negar Fani for providing support and feedback as I developed this project and for being a committee member, and to her and the Grady Trauma Project for allowing me to use their data.

Thank you to Dr. Patricia Brennan for also giving feedback as I built my thesis and for being a committee member.

Thank you to my family and friends for the constant support throughout this process.

Table of Contents

List of Tables i

List of Figures ii

Introduction 1

Methods 7

Results 14

Discussion 16

References 28

Appendices 39

List of Tables

Table 1: Characteristics of Scores for All Measures 39

Table 2: Linear Mixed-Effects Model Results for the Interaction Effect of Dissociation Score and Attention on Emotion Recognition Accuracy for each Emotion Compared to Neutral … 40

Table 3: Linear Mixed-Effects Model Results for Emotion Recognition Reaction Time as a Function of Dissociation Score for each Emotion Compared to Neutral 41

List of Figures

Figure 1: Emotion Recognition Accuracy Score as a Function of Dissociation Score for each Emotion Compared to Neutral 42

Figure 2: Emotion Recognition Reaction Time as a Function of Dissociation Score for each Emotion Compared to Neutral 43

Figure 3: Relationship Between Dissociation and Word Memory 44

Figure 4: Relationship Between Childhood Abuse and Dissociation 45

Introduction

Dissociation is often defined as a feeling of disconnect within a person's perceptions, memory, and identity. Dissociative experiences can manifest in a range of ways, from mundane, occasional moments of detachment from one's surroundings to the development of multiple distinct identities within one person. Some theories suggest that dissociation is a result of problems in integrating information within the brain, leading to difficulty in controlling mental processes (Lynn & Rhue, 1994). Pathological dissociation tends to develop as a result of trauma, such as abuse and neglect (Nijenhuis et al., 1998). Those with dissociative disorders experience disruptions in cognitive functioning, including feelings of disconnect from oneself and their surroundings in depersonalization-derealization disorder (DPDR) and gaps in memory in dissociative amnesia (DA). Dissociative disorders impact 2% of the population, but rates are even higher in some clinical populations, with 30% of war veterans with post-traumatic stress disorder (PTSD) and 60% of patients with unipolar depression meeting clinical criteria for dissociative disorders (Hunter, Sierra, & David, 2004). Even in the general population, up to 74% of people will experience an episode of depersonalization or derealization in their lifetime (Hunter, Sierra, & David, 2004). Still, little research has been dedicated toward understanding dissociation's impact on cognition.

Emotion Processing in Dissociation

Studies suggest that dissociation affects a person's ability to properly process emotions. DPDR patients report struggling with feeling emotions during dissociative experiences to varying degrees—some with complete inability to experience emotion and others struggling to perceive and process the emotional content in emotional stimuli (Sierra & Berrios, 1998). One study looking at how DPDR patients respond to emotional stimuli found that they rated aversive pictures as less arousing compared to controls (Sierra et al., 2002). These findings were reflected when testing their responses to emotional faces as well, with DPDR patients showing both less extreme emotional ratings for faces of disgust (Sierra et al., 2006) and reduced sensitivity in detecting anger in facial expressions compared to controls (Montagne et al., 2007). Research looking into emotion recognition in patients with DID found deficits in processing for those with greater dissociative symptoms as well. Integration, which is the process of developing increased ownership of one's mental and bodily experiences in DID, is associated with improvements in DID symptoms (van der Hart et al., 2006). DID patients with less integration were found to have worse accuracy in identifying angry and fearful faces compared to those showing greater integration (Lebois et al., 2020). These findings suggest that greater experiences of dissociation relate to difficulties in explicitly processing emotional expressions in faces.

Differences in physiological responses and brain activity for emotional content have also been found in those with greater dissociation. DPDR patients show reduced autonomic responses to negative emotional stimuli in skin conductance studies (Sierra, Senior, et al., 2002). fMRI studies found that when looking at emotional content, DPDR patients showed decreased activity in the amygdala and anterior insula, which are both regions involved in the conscious experience of emotions (Lemche et al., 2008; Craig, 2009). Another study found no differences in neural activity during encoding for emotional compared to neutral material, whereas controls showed significant differences (Medford et al., 2006). These findings suggest that greater dissociation may relate to reduced autonomic responses and brain activity for regions involved in feeling emotions. These differences can also be reflected in response time, as research has found that response times vary as a function of emotional valence and that physiological arousal mediates this relationship (Ihssen & Keil, 2013). Studies assessing emotion processing in dissociation using the flanker task found that DID patients had slower response times for emotionally negative words compared to neutral, but this difference was not present in controls or depressive patients (Dorahy, Middleton, & Irwin, 2005). These results may indicate implicit differences in processing emotionally negative content in dissociation that are reflected in slower reaction times.

Explicit and implicit functions in emotion processing likely inform one another, as people draw from implicit mental processes to form explicit judgements (Gawronski & Bodenhausen, 2014). However, dissociative patients are still able to consciously recognize the emotional valence of stimuli, even if they do not feel the proper physiological response to it. One study tested the extent to which DPDR patients experience cognitive empathy, the ability to understand someone's emotional state, and affective empathy, the ability to experience an emotional response. The results showed that DPDR patients had intact cognitive empathy but impaired affective empathy (Lawrence et al., 2007). Another study looking at differences in explicit and implicit emotional memory across identity states in DID found poorer performance in recalling explicit but not implicit information, suggesting impairments related to emotion may not arise until later stages of processing (Elzinga, Phaf, Ardon, & Van Dyck, 2003). Thus, dissociative patients may process emotions explicitly and implicitly in differing ways.

The experience of childhood abuse, which is one of the main forms of trauma that leads to greater experiences of dissociation, is related to differences in facial emotion processing as well (Lipschitz et al., 1996). Research has found worse accuracy in identifying negative facial expressions (Turgeon, et al., 2020) along with happy faces (Veague et al., 2014) in abused populations. Several studies have found worse accuracy for anger and fear in those who both experienced childhood abuse and are diagnosed with a mental disorder (Kirkham & Levita, 2019; Suzuki et al., 2015; Brüne et al., 2013). Reaction times, however, tend to be faster for individuals who experienced childhood abuse for angry and fearful faces, suggesting greater reactivity towards threat (Bérubé, Turgeon, Blais, & Fiset, 2023). As a result, this effect of childhood abuse on emotion processing may influence processing in dissociative populations.

Face Memory in Dissociation

Given the amnesic experiences that exist in dissociation, as well as the apparent cognitive deficits, research has looked into memory performance for several different types of memory in dissociation. Results have been mixed throughout these studies. Some have suggested worse performance in verbal, visual, and short-term memory, whereas others have found no differences across dissociation level, and even enhanced short-term memory in dissociative patients (Parlar et al., 2016; Özdemir, Güzel Özdemir, Boysan, & Yilmaz, 2015; Elzinga et al., 2007; Stein, Hanna, Vaerum, & Koverola, 1999). Memory gaps in dissociative disorders tend to relate to highly emotional experiences, indicating that emotion may have a distinct impact on memory within dissociation. Two studies looking at the effect of emotion on word memory found impaired recall for negatively emotional words in those with greater dissociation, and one found worse performance for positively emotional words as well (DePrince & Freyd, 1999, Holtgraves & Stockdale, 1997). Greater dissociation also relates to increased errors in negatively emotional memory (Devilly et al, 2007; Candel, Merckelbach, &

Kuijpers, 2003) as well as memory fragmentation when recalling an emotional video (Giesbrecht, Merckelbach, van Oorsouw, & Simeon, 2010). Taken together, these findings suggest that memory is likely impacted in dissociation, particularly for emotional content.

Memory for emotional and neutral faces has yet to be investigated in dissociation. In the general population, emotion plays a major role in memory, as memory is typically enhanced for emotionally positive and negative material over neutral material (Tyng et al., 2017). These effects are the result of brain regions involved in emotion processing, like the amygdala, modulating memory systems (Clark, 1995). Given the deficits in emotion processing that exist in dissociation, this effect of emotion may not lead to the same enhancements in memory involving emotion processing. This suggests that differences in facial emotion processing may relate to differences in face memory, as studies have found a positive correlation between emotion recognition and face memory for both emotional and neutral faces (Rhodes et al., 2015; Ventura, Wood, Jimenez, & Hellemann, 2013).

Facial emotion processing is incredibly important, as it helps inform how a person chooses to interact with others. Facial expressions are one of the main ways through which people communicate information, so impairments in emotion processing can lead to difficulty in social functioning (Chanes, Wormwood, Betz, & Barrett, 2018). Studies also suggest that, given their important emotional significance, people are consistently processing the emotional content of faces, even when no emotion is present (Albohn, Brandenburg, & Adams, 2019). Specifically, people are prone to interpreting neutral faces as having slight negative valence (Adams et al., 2013), and this tendency is enhanced in populations with greater experiences of abuse (Pfaltz et al., 2019). Face memory is also important in guiding how people approach social situations, as poor face memory is associated with increased social anxiety and social inhibition (Avery et al., 2015). As a result, these impairments may be present in dissociative populations, but research has yet to investigate associations between dissociation, emotion processing, and face memory.

Attention

Attention plays a major role in cognition, as it is the lens through which people process stimuli. Difficulties in attention can have a severe impact on general processing (Kida, Tanaka, & Kakigi, 2017). Problems with attentional control are prevalent in dissociative disorders, and some studies have found impairments in performance on attentional tasks for those with higher dissociation (DePrince & Freyd, 1999; Freyd et al, 1998). Research looking at relations between emotion recognition and attention in attention deficit/hyperactivity disorder (ADHD) also supports the effect of attention on emotion recognition accuracy and reaction time (Olaya-Galindo, Vargas-Cifuentes, Vélez Van-Meerbeke, & Talero-Gutiérrez, 2023; Baran, Yargıç, Oflaz, & Büyükgök, 2015). Memory and attention are heavily linked, as some form of attention is required to create declarative memories (Cowan, 1998). Attention is also related to task performance, so poorer attention may lead to worse general performance on cognitive tasks (Kida, Tanaka, & Kakigi, 2017). Thus, attention should be considered as well when assessing these relationships.

The Present Study

Together, these findings indicate that greater dissociative experiences may relate to deficits in explicitly identifying facial emotions and implicit changes in how emotional content is processed. Because of the role emotion plays in modulating memory, these differences may then impact memory for faces, as studies suggest that people consistently process the emotional content in faces and that emotional memory is impaired in those with greater dissociation. These relationships may be impacted by other factors as well, such as attention and the experience of childhood abuse, as both have been found to be related to dissociation and differences in emotion processing. Face processing and face memory are a major part of daily life, so impairments can lead to problems with social functioning. Thus, it is important to understand how these processes may be affected in dissociative populations.

The goal of this study was to examine how dissociation may impact the ability to process emotional facial expressions, and in turn how differences in processing may impact memory for faces. To do this, we investigated how dissociation related to differences in how emotional facial expressions were both explicitly and implicitly processed. Explicit emotion processing consisted of explicit reports of facial emotion recognition, measured through accuracy scores, and implicit emotion processing looked at implicit changes in emotion recognition, measured through reaction time. We then looked at the association between dissociation and face memory, with the goal of examining whether their relationship was mediated by differences in explicit and implicit emotional processing. We hypothesized that: (1) greater dissociation would relate to worse accuracy and slower reaction times in emotion recognition, particularly for angry and fearful faces, (2) greater dissociation would relate to worse memory for neutral faces but not neutral words, (3) emotion recognition accuracy and reaction time would mediate the relationship between greater dissociation and worse memory for neutral faces.

Methods

Participants

In this study, we used existing data collected at the Grady Trauma Center in Atlanta, Georgia from 2012-2015 by Dr. Negar Fani and team (Fani et al., 2019). Participants consisted of 157 women aged 18-62 years who all had experienced trauma. 156 of the women were Black, and 1 was White. To participate, individuals were required to understand English and be willing to provide informed consent. Participants were recruited from an NIH funded study examining genetic and environmental risk for posttraumatic psychopathology. They were approached at random by trained staff in publicly funded medical clinics serving low-income individuals in inner-city Atlanta, Georgia. Participants had an average monthly income of $1,000-$2,000. The initial dataset contained 244 participants, but exclusions were made for those who did not have sufficient data for the present analyses. 40 individuals were removed for not having dissociation data, and 45 individuals were removed for not having emotion recognition and face memory data. We also excluded 2 participants who had extreme outlier scores of +/- 4 standard deviations from the mean on the attention and emotion recognition reaction time measures (see Measures for description).

Procedure

Data were collected through interviews that took about 2 hours to complete and were conducted by trained research assistants. Participants answered questionnaires measuring trauma exposure, childhood maltreatment, PTSD, depression, dissociation, emotion regulation, and more. In a separate visit, they also performed tasks from the Penn Computerized Neurocognitive Battery (CNB; Gur et al., 2010), which assessed various cognitive abilities (see Table 1 for characteristics of participants' scores on all measures). Participants were compensated with money for all study visits. For this study, only a subset of the initial dataset was used, which is detailed under participants.

Measures

Dissociation

Dissociation was measured using the Multiscale Dissociation Inventory (MDI; Briere, 2002). Studies assessing the MDI have found it to be reliable and have strong convergent and discriminant validity (Jeffiers et al., 2023). This scale measured dissociation continuously based on self-reported responses to how often different statements applied to participants in the past month (e.g., “Your body feeling like it was someone else’s,” 1 = never, 5 = very often). Six components of dissociation, which were identified using exploratory structural equation modeling, were measured separately within the questionnaire: disengagement, depersonalization, derealization, emotional constriction, memory disturbance, identity dissociation (Jeffiers et al., 2023). Higher scores on the MDI represented greater experiences of dissociation.

We also created an altered dissociation measure by summing the scores from three subsections of the MDI: depersonalization, derealization, and emotional constriction. These components are associated with reduced emotional responses to emotional content (Sierra & David, 2011), so this altered score aimed to better isolate the deficits in emotion processing in dissociation. This measure was calculated by adding up individual scores on each of these subsections and combining them into a single score. Higher altered MDI scores represented greater experiences of depersonalization, derealization, and emotional constriction in dissociation.

Childhood Abuse

Childhood trauma was measured using the Childhood Trauma Questionnaire (CTQ; Bernstein, 1994), which assessed childhood abuse and mistreatment continuously based on self-reported responses to how true different statements felt to participants when they were children (e.g., "I thought my parents wished I had never been born," 1 = never true, 5 = always true). The CTQ has been found to have high criterion validity (Bernstein et al., 2003). The scale measured five components of childhood trauma separately, which were determined using exploratory factor analysis: sexual abuse, physical abuse, emotional abuse, emotional neglect, and physical neglect. We combined the scores on the sexual abuse, physical abuse, and emotional abuse sections in order to isolate childhood abuse. Higher scores on this measure represented greater experiences of childhood abuse.

Penn Computerized Neurocognitive Battery (CNB)

The following measures used tasks from the CNB, which is made up of several cognitive tasks assessing executive functioning, declarative memory, complex cognitive processing, social cognition, and processing speed. Studies have been conducted to assess the reliability and validity of these measures, and results have found all tasks to have moderate to high reliability and construct validity (Gur et al., 2010).

Explicit Emotion Processing. In the present study, we defined explicit emotion processing as the participants' explicit identifications of emotions conveyed by facial expressions, here measured by assessing accuracy on the Penn Emotion Recognition Task (ER40; Gur et al., 2002). In this task, participants were shown 40 faces and were required to choose which emotion was being expressed based on five options: happy, sad, anger, fear, and no emotion. For each emotion, half of the expressions were of mild intensity and half were of extreme intensity. We looked at differences in accuracy scores between different emotions. Higher accuracy scores in this task were interpreted as better explicit emotion processing.

Implicit Emotion Processing. In the present study, we defined implicit emotion processing as implicit changes in emotion recognition, which were measured by assessing reaction times for correct responses on the ER40. Reaction times reflected how long participants spent interpreting the facial expressions and selecting their response. We looked at differences in reaction time between different emotions. Longer average reaction times were interpreted as slower implicit emotion processing.

Face Memory. Face memory was measured using the Penn Facial Memory Test (CPF; Gur et al., 2001). In this task, participants were shown 20 neutral faces, then shown 40 neutral faces (20 new, 20 old) and asked if they had seen them before ("definitely yes", "probably yes", "probably no", "definitely no"). Distractor faces were matched by age, gender, and ethnicity. Participants were assessed immediately after initial presentation. Accuracy scores were calculated using corrected recognition, where true positives were subtracted by false positives. Higher accuracy scores represented better memory for faces.

Word Memory. Word memory was measured using the Penn Word Memory Test (CPW; Gur et al., 2001). In this task, participants were shown neutral 20 words, then shown 40 words (20 new, 20 old) and asked if they had seen them before ("definitely yes", "probably yes", "probably no", "definitely no"). Distractor words were matched by frequency, length, imaginability, and concreteness. Participants were assessed immediately after initial presentation. Accuracy scores were calculated using corrected recognition, where true positives were subtracted by false positives. Higher accuracy scores represented better memory for words. Results were used as a control to discriminate face memory from other types of memory, such as word memory.

Attention. We measured attention using the Penn Continuous Performance Test – Number and Letter version (PCPT-nl; Kurtz, Ragland, Bilker, Gur, & Gur, 2001). In this task, vertical and horizontal lines were continuously flashed on the screen in differing positions, and participants were told to press a button when the lines formed a complete number or letter. We measured attention using accuracy scores for true positives, with better accuracy representing better attention.

Analysis

Analyses were separated into three parts in order to establish initial relationships between dissociation, emotion processing, and memory that were prerequisites for a mediation analysis of interest. For all analyses, p-values of <.05 were considered statistically significant. Attention was included as a covariate of no interest in all analyses, and if its effects were significant, then we modeled the interaction effects. All continuous predictors were z-scored before entering them into analyses.

Dissociation and Emotion Processing

We ran two linear mixed-effects models to assess the relationship between dissociation and explicit and implicit emotion processing, separately. For explicit emotion processing, we assessed whether there was an interaction between dissociation score and emotion type on emotion recognition accuracy. For implicit emotion processing, we assessed whether there was an interaction between dissociation score and emotion type on emotion recognition reaction times. In each model, dissociation scores were treated as between-subject fixed-effects, and the emotion type categorical variable was treated as within-subject fixed-effects. Emotion type consisted of neutral, happy, sad, angry, and fearful faces, with neutral faces serving as the baseline reference level in the model. We modeled a random intercept for each participant, accounting for participant-level variability.

Dissociation and Face Memory

We ran a simple linear regression analysis between dissociation score and face memory score to determine if they were associated. As a control, we also ran a simple linear regression analysis between dissociation score and word memory score to discriminate face memory from other forms of memory.

Emotion Processing as a Mediator for Dissociation and Face Memory

If the previous analyses had established an association between dissociation and face memory, as well as dissociation and emotion processing, then we would use multiple mediation analyses with emotion recognition accuracy and/or emotion recognition reaction time as the mediator to assess its impact on the relationship between dissociation score and face memory score. However, the assumptions for mediation analyses were not met, so we could not move forward with these analyses.

Exploratory Analyses

Because depersonalization, derealization, and emotional constriction are the main components of dissociation associated with reduced sensitivity to emotional content (Sierra & David, 2011), we created a new dissociation variable that consisted of participants' scores on those subsections of the MDI to better capture the effect of emotional numbing. We then reran the same analyses previously described using this edited measure of dissociation. Findings did not differ from those using the full MDI score, so results will not be reported.

We also looked at how childhood abuse related to dissociation and emotion processing, with the goal of seeing whether childhood abuse mediated a relationship between dissociation and emotion processing. We explored these relationships because literature suggests that childhood abuse is related to increased dissociative symptoms (Lipschitz et al., 1996), worse accuracy in emotion recognition for angry and fearful faces (Kirkham & Levita, 2019), and faster reaction times in emotion recognition for angry and fearful faces (Bérubé, Turgeon, Blais, & Fiset, 2023). We ran a simple linear regression analysis between dissociation and childhood abuse to determine if they were associated, as has been reported previously. We then ran two linear mixed-effects models to look at the relationship between childhood abuse and explicit and implicit emotion processing. For explicit emotion processing, we looked at the interaction between childhood abuse score and emotion type on emotion recognition accuracy. For implicit emotion processing, we looked at the interaction between childhood abuse score and emotion type on emotion recognition reaction times. If these analyses established a relationship between dissociation and childhood abuse, as well as childhood abuse and emotion processing, we would then use mediation analyses with childhood abuse as the mediator to assess its impact on dissociation and emotion recognition accuracy and/or reaction time. Although a significant relationship was found between childhood abuse and dissociation, all other analyses were not statistically significant, so we were unable to run the mediation analysis.

Results

Dissociation and Explicit Emotion Processing

To investigate how dissociation level and emotion type related to explicit emotion processing, we first used a linear mixed-effects model to look at emotion recognition accuracy as a function of dissociation score and emotion type while also controlling for attention. Results showed a significant difference in accuracy score across participants for all emotions relative to neutral (all ps $< .01$; see Table 2), with happy faces having better emotion recognition accuracy scores compared to neutral faces, and angry, sad, and fearful faces having worse accuracy scores. However, the model did not show any significant associations between dissociation and emotion recognition accuracy for any emotions (see Figure 1). We did find a robust effect of attention on emotion recognition accuracy ($\beta = .22$, $SE = .055$, $p < .0001$), so we treated attention as a covariate of interest and modeled its interaction effects with dissociation and emotion recognition accuracy. Results for main effects were the same as our previous analysis, but all other associations were not statistically significant (all ps $> .11$).

Dissociation and Implicit Emotion Processing

To look at how dissociation level and emotion type may relate to implicit emotion processing, we ran a linear mixed-effects model looking at emotion recognition reaction times as a function of dissociation score and emotion type, again controlling for attention. We found a significant difference in emotion recognition reaction time for happy and fearful faces relative to neutral faces (all ps $< .0001$), and a marginally significant difference for angry faces relative to neutral ($p = .085$; see Table 3). Fearful and angry faces had slower reaction times compared to neutral, whereas happy faces had faster reaction times. We did not, however, find any significant associations between dissociation score and emotion recognition reaction time for any emotion relative to neutral (all ps > .56, see Figure 2). Attention also did not have a significant effect on emotion recognition reaction time (β = -7.98, SE = 6.53, p = .22).

Dissociation and Face Memory

We then examined how dissociation score may relate to memory for faces, including attention again as a covariate. We did not find a significant association between dissociation and face memory (β = .086, SE = .49, p = .86) or between attention and face memory (β = .022, SE = .050, p = .66).

We also conducted a control neutral memory analysis using word memory in place of face memory. While no relationship was found between dissociation and face memory, results showed a marginally significant association between dissociation and word memory (β = -.81, SE = .41, p = .051), with greater dissociation relating to worse memory for words (see Figure 3). Attention did not have a significant effect on word memory (β = -.014, SE = .043, p = .74).

Dissociation and Childhood Abuse

We also conducted exploratory analyses on the relations between childhood abuse, dissociation, emotion processing, and attention. Based on previous literature, we anticipated that there should be a robust relationship between childhood abuse and dissociation. Indeed, we found a significant relationship between the two (β = .14, SE = .044, p = .0013), with greater childhood abuse relating to higher dissociation (see Figure 4). All other analyses involving emotion processing measures were not statistically significant.

Discussion

The goal of this study was to explore how dissociation may impact the processing of emotional expressions in faces and how that in turn may impact memory for faces. Results did not show any statistically significant relations between dissociation and emotion processing. We also did not find a statistically significant association between dissociation and memory for faces. These findings suggest that dissociation may not have a significant effect on the processing of facial emotions or memory for faces.

Explicit Emotion Processing

In assessing the relationship between dissociation and explicit emotion processing, our prediction that greater dissociation would be associated with worse emotion recognition accuracy, particularly for angry and fearful faces compared to neutral, was not supported. We did find significant differences in accuracy across individuals for all emotions compared to neutral, as happy faces had greater accuracy scores compared to neutral faces, and sad, angry, and fearful faces had worse accuracy. These results may reflect an asymmetry in the number of positively valanced expressions compared to negatively valanced expressions in the task. Happy was the only positive emotion displayed, whereas the negatively valanced emotions consisted of sad, anger, and fearful faces. Because there were a greater number of negatively valanced options, faces displaying anger, fear, or sadness were likely easier to mistake with one of the other negatively valanced emotions. This has been supported in previous literature, with happiness being easier to detect compared to negative emotions (Wagner et al., 2014). Thus, our findings for the main effect of emotion type match those of previous studies.

When looking at the effect of dissociation on emotion recognition accuracy, we did not find a statistically significant difference in emotion recognition accuracy across dissociation score for any emotions. This suggests that dissociative symptoms may not significantly impact an individual's ability to explicitly identify emotional facial expressions. Still, given past studies have found an effect of dissociative symptoms on emotion processing for angry and fearful faces, it is possible that there is an effect that we were unable to detect within our sample. The impact of dissociation on processing fearful faces is less supported in literature, as other studies have failed to find a significant effect (Montagne et al., 2007), so this relationship may be smaller than that of angry faces and thus harder to identify. The absence of significant results for angry faces is more surprising, but it is possible that other factors we did not account for may have impacted our findings. Our study did not look at measures of anxiety within our sample, but past research has found greater sensitization towards threatening stimuli for increased anxiety symptoms. Specifically, evidence suggests that individuals with higher trait anxiety are more sensitive towards identifying angry faces compared to other expressions (Kang et al., 2019) and that increased state anxiety leads to a bias towards perceiving anger in emotional expressions (Dyer et al., 2022). Increased dissociation is highly related to greater anxiety symptoms (Černis et al., 2021), so it is possible that the arousing effects of anxiety for angry faces may have impacted our ability to detect any emotionally suppressive effects of dissociation.

Implicit Emotion Processing

When looking at how dissociation may impact implicit emotion processing, we did not find support for our hypothesis that greater dissociation would be associated with slower emotion recognition reaction time, particularly for angry and fearful faces compared to neutral. Results looking across all individuals showed significant differences in reaction time for happy and fearful faces compared to neutral, and a marginally significant difference for angry faces compared to neutral. Happy faces had faster reaction times compared to neutral faces, whereas fearful and angry faces had slower reaction times. Similar to emotion recognition accuracy, these differences in reaction times may loosely reflect the difficulty in identifying each emotion related to the distribution of emotions by valence. Past studies measuring reaction time for facial expressions have found similar results, with happiness tending to have faster average reaction times and fear having slower reaction times (Palermo & Coltheart, 2004; Russell, 1994; Feyereisen, Malet, & Martin, 1986).

The effect of dissociation on emotion recognition reaction time across emotion type, however, was not significant for any emotions. This suggests that dissociation is not associated with implicit differences in emotion processing that would affect reaction time. Although past studies have found implicit differences in how individuals with greater dissociation process emotional stimuli, these changes may not have an effect on response time, as few studies have investigated this relationship. Similar to explicit emotion processing, enhanced reactivity towards threat-related stimuli in other disorders like anxiety and PTSD, which we did not look at in our sample, may have also impacted our ability to find an effect on reaction time within dissociation. Specifically, social anxiety is related to faster responses for fearful faces (Fujihara, Guo, & Liu, 2023), and those with PTSD tend to have faster reaction times towards fearful and angry faces (Masten et al., 2008; Ashley & Swick, 2019). Greater dissociation is related to increased symptoms of both anxiety and PTSD (Černis et al., 2021), so the increased vigilance to threat within these disorders could have conflicted with the emotional numbing within dissociation.

Memory

We then tested how dissociation may affect memory, and we hypothesized that greater dissociation would relate to worse memory for neutral faces. Our hypothesis was not supported, as there was not a significant association between dissociation and memory for neutral faces. Given we did not find an effect of dissociation on emotion processing, it makes sense that we then would not see any deficits in memory for faces. Thus, this may be further support that there is no link between dissociation and face memory related to emotion processing. However, since past studies have found differences in emotion processing in dissociation, it is also possible that, while people do consistently process the emotional content in faces, the emotion interpreted in neutral faces may not be strong enough to lead to any differences in memory related to dissociation. This has not been studied within dissociation until now, so while our findings provide some insight, they are hard to properly interpret without further research. Also, very few studies have looked at associations between dissociation and face memory, including memory for emotional faces, so it remains unclear how facial emotions may impact face memory in dissociation.

As a control, we also looked at the relationship between dissociation and neutral word memory. Results were very close to significant ($p = .051$), such that higher dissociation related to worse memory for neutral words. This suggests that, for unemotional words and faces, dissociation may be differentially associated with word memory compared to face memory, with greater dissociation relating to worse word memory but not face memory. Because we anticipated an effect of emotion on the processing of neutral faces over neutral words, this was contrary to what we expected. However, since findings for the effect of dissociation on memory are mixed, the results are not surprising. While face memory has not been heavily studied within dissociation, a greater effect of dissociation on verbal memory over visual memory has been supported in past research (Özdemir, Güzel Özdemir, Boysan, & Yilmaz, 2015). One paper suggests that the differences in hemispheric lateralization may explain findings of greater impairment in verbal memory over visual memory in dissociation, as verbal memory is left-lateralized and visual memory is right-lateralized (Shenoy, Sharma, & Agrawal, 2019). A study looking at brain activity using electroencephalography found deficits in connectivity between hemispheres as well as increased left hemispheric lateralization in individuals with high dissociation compared to controls (Ashworth, Ciorciari, & Stough 2008). Given how impaired integration and cognitive connectivity leads to memory lapses (Nijenhuis, Spinhoven, van der Hart, & Vanderlinden, 1998), these differences may result in a differential effect of dissociative experiences on verbal memory compared to visual memory. Research has found that face memory is also right-lateralized and is highly related to visual memory but not verbal memory (Rossion & Lochy, 2022; Woodhead & Baddeley, 1981), so this theory may explain our findings of an association between dissociation and word memory but not face memory.

Attention

Throughout our analyses, we included attention as a covariate to explore how it may influence our findings, as attention is related to dissociation, emotion processing, and memory, as well as general task performance. For emotion processing, attention had a robust effect on emotion recognition accuracy but not reaction time, with greater attention being associated with worse accuracy. This relationship may indicate that differences in attentional ability affected participants' accuracy on this task, meaning attention likely plays an important role in properly recognizing emotional expressions. These results are supported by literature looking at associations between emotion recognition accuracy and attention in ADHD (Olaya-Galindo, Vargas-Cifuentes, Vélez Van-Meerbeke, & Talero-Gutiérrez, 2023; Bisch et al., 2016; Baran, Yargıç, Oflaz, & Büyükgök, 2015). However, the potential effect of attention does not seem to influence reaction time for any emotions. While several studies looking at this relationship in ADHD report an effect of attention on reaction time (Olaya-Galindo, Vargas-Cifuentes, Vélez Van-Meerbeke, & Talero-Gutiérrez, 2023; Baran, Yargıç, Oflaz, & Büyükgök, 2015), some have also found no differences across groups (Bisch et al., 2016; Berggren, Engström, & Bölte, 2016). This may then explain why we see an effect on emotion recognition accuracy but not reaction time.

When we modeled the interaction effects between dissociation, attention, and emotion recognition accuracy to further explore the effect of attention, we did not find any statistically significant associations. Thus, the variation in dissociation score does not seem to be differentially associated with emotion recognition accuracy for any emotions based on attention. Some studies have found a greater effect of attention in accuracy for some emotions over others, but there is no trend in these findings for any specific emotions. Studies have also found mixed results for the association between dissociation and attention, with evidence supporting worse attention in higher dissociation (Freyd et al., 1998) as well as no differences across dissociation level (Özdemir, Güzel Özdemir, Boysan, & Yilmaz, 2015). Due to the mixed findings, it makes sense we did not see an increased interaction between dissociation and attention for any specific emotions.

Attention also was not significantly associated with memory for neutral faces or words. Given the association between attention and emotion recognition accuracy, as well as the intimate link between attention and memory, these results are unexpected. Still, they indicate that memory performance in these tasks may not have been influenced by differences in attention. This could be because the memory tasks were more engaging, as they require increased effort, with participants having to memorize stimuli during encoding and access those memories during retrieval. Consequently, they may have had an easier time paying attention during that task compared to in the PCPT-nl, which only had them respond when certain configurations of lines were presented. Compared to the memory tasks, the ER40 may have also been less engaging, as less effort is required to look at a face and identify the expression. This may have influenced results, leading to a significant effect of attention on emotion recognition accuracy but not memory. However, because attention was assessed in a separate task from each measure, it is difficult to determine the true effect of attention within each of these tasks.

Exploratory Analyses

We conducted several exploratory analyses as well in order to test hypotheses outside of our main questions. For our first set of exploratory analyses, we reran our main analyses using an altered MDI score made up of scores for depersonalization, derealization, and emotional constriction, which are the components of dissociation related to emotional numbing. Our goal was to better isolate this effect of emotional numbing within dissociation to see if greater altered dissociation scores would be associated with worse emotion processing and face memory. Results for these analyses did not differ from those using the full MDI dissociation score, so these specific components do not seem to have a separate association with emotion processing compared to those measured within the full dissociation score. The

MDI has been found to have high internal consistency across subscales (Jeffiers et al., 2023), so consistent with that, our results suggest that these three components do not vary greatly from the other three within dissociation.

Our second set of analyses looked at how childhood abuse is associated with dissociation and emotion processing. We wanted to see if the experience of childhood abuse played a role in facial emotion processing, as well as if it may impact the relationship between dissociation and emotion processing. We did find a significant effect of childhood abuse on dissociation, such that greater abuse related to greater dissociation. This is consistent with current literature, as childhood abuse is one of the main factors that leads to increased dissociation (Lipschitz et al., 1996). Our hypotheses that greater childhood abuse would relate to worse emotion recognition accuracy but faster emotion recognition reaction time for emotionally negative faces, however, were not supported, as both analyses did not show any significant results. Thus, we did not find evidence that the experience of childhood abuse influenced emotion processing. As discussed previously, the activating effects of anxiety may have impaired our ability to detect any impairments on emotion recognition accuracy within populations with greater childhood abuse and dissociation (Dyer et al., 2022; Kang et al., 2019). For reaction time, we may not have been able to detect an effect of childhood abuse because many participants in our sample have PTSD. Like childhood abuse, PTSD also has an activating effect for threatening stimuli (Masten et al., 2008; Ashley & Swick, 2019), so it may have been harder to detect an effect of childhood abuse since there is likely increased sensitivity to threat within much of the population.

Limitations

Our study had several limitations that may have prevented us from properly addressing our questions. First, our sample is made up almost entirely of Black women aged 18-62 with a wide range of psychopathology and high rates of trauma and adversity. These factors may have influenced results for many of the measures we examined within this study, but we did not take them into account into our analyses. Specifically, increased rates of trauma exposure, post-traumatic stress symptoms, anxiety, and depression relate to elevated dissociative symptoms (Černis et al., 2021). Studies have found differential effects of these factors on emotion recognition and attentional bias towards threat compared to those of dissociation, so it is likely that they impacted our findings (Ashley & Swick, 2019; Kang et al., 2019; Powers et al., 2017; Dalili, Penton-Voak, Harmer, & Munafò, 2015; Fani et al., 2012; Fani, Bradley-Davino, Ressler, & McClure-Tone, 2011). Also, little variance in dissociation score within our sample may have affected our ability to see an effect of dissociation. Scores for only 18 out of 157 participants (11.5%) passed the MDI threshold for clinical significance for a dissociative disorder (Bierre, 2002). Thus, we may not have had enough power to detect any deficits present in those with higher dissociation. We also were unable to look at memory for emotional faces, as the existing dataset did not contain a measure for this. Because worse performance has been found in other forms of emotional memory for individuals with greater dissociation, it would make sense that emotional face memory may have a similar effect. However, since this relationship has yet to be examined, we do not know whether there is a deficit in emotional face memory in dissociation. If a relationship does not exist, then this may explain our lack of significant results between dissociation and neutral face memory, but since we could not examine emotional face memory, it remains unclear.

Implications and Future Directions

Our findings suggest that those with greater dissociation may not struggle with emotion processing or memory for faces. Still, past research indicates that there could be smaller effects that we were unable to detect in our sample. Relations between dissociation, emotion processing, and face memory should be further explored, as few studies have looked into how dissociation can impact affective and cognitive mechanisms. By increasing our understanding of these deficits in dissociation, clinicians can improve interventions that alleviate the impact of dissociation on daily functioning. Future studies should explore the effect of dissociation on emotion processing and emotional face memory in populations with clinically significant dissociative disorders compared to controls. The effects of other factors that may impact cognitive performance, emotion processing, and vigilance towards threat should also be investigated, such as age, trauma exposure, PTSD, anxiety, and depression. Measuring physiological responses or brain activity during the emotion recognition and face memory tasks would also be ideal, as this would help more accurately assess implicit changes in processing. Studies should also look at associations between dissociation, emotion processing, and emotional face memory since this relationship remains unclear.

Conclusion

In conclusion, the purpose of our study was to examine the relationships between dissociation, emotion processing, and face memory. We were unable to detect any associations between dissociation and explicit or implicit emotion processing, so deficits may not be present in those with higher dissociation. We also did not find a relationship between dissociation and face memory, but dissociation and word memory were marginally associated, indicating a possible effect of dissociation on verbal memory. Future studies should examine these associations in clinical populations and include a measure for emotional face memory.

References

Albohn, D. N., Brandenburg, J. C., & Adams, R. B. (2019). Perceiving emotion in the "neutral" face: A powerful mechanism of person perception. In *The Social Nature of Emotion Expression: What Emotions Can Tell Us About the World* (pp. 25-47). Springer International Publishing.

Ashley, V., & Swick, D. (2019). Angry and Fearful Face Conflict Effects in Post-traumatic Stress Disorder. *Frontiers in psychology*, *10*, 136. https://doi.org/10.3389/fpsyg.2019.00136

Ashworth, J., Ciorciari, J., & Stough, C. (2008). Psychophysiological correlates of dissociation, handedness, and hemispheric lateralization. *The Journal of nervous and mental disease*, *196*(5), 411–416. https://doi.org/10.1097/NMD.0b013e31816ff384

Baran Tatar, Z., Yargıç, İ., Oflaz, S., & Büyükgök, D. (2015). Erişkin Dikkat Eksikliği Hiperaktivite Bozukluğunda Duygu Tanımanın Dikkat ve Dürtüsellik Belirtileri ile İlişkisi [The Relationship Between Emotion Recognition and the Symptoms of Attention Deficit and Impulsivity in Adult Patients With Attention Deficit Hyperactivity Disorder]. *Turk psikiyatri dergisi = Turkish journal of psychiatry*, *26*(3), 172–180.

Berggren, S., Engström, A. C., & Bölte, S. (2016). Facial affect recognition in autism, ADHD and typical development. *Cognitive neuropsychiatry*, *21*(3), 213–227. https://doi.org/10.1080/13546805.2016.1171205

Bernstein, D. P., Fink, L., Handelsman, L., & Foote, J. (1994). *Childhood Trauma Questionnaire (CTQ)* [Database record]. APA PsycTests. https://doi.org/10.1037/t02080-000

Bernstein, D. P., Stein, J. A., Newcomb, M. D., Walker, E., Pogge, D., Ahluvalia, T., Stokes, J., Handelsman, L., Medrano, M., Desmond, D., & Zule, W. (2003). Development and validation of a brief screening version of the Childhood Trauma Questionnaire. *Child abuse & neglect*, *27*(2), 169–190. https://doi.org/10.1016/s0145-2134(02)00541-0

Bérubé, A., Turgeon, J., Blais, C., & Fiset, D. (2023). Emotion Recognition in Adults With a History of Childhood Maltreatment: A Systematic Review. *Trauma, Violence, & Abuse, 24*(1), 278-294. https://doi.org/10.1177/15248380211029403

Bisch, J., Kreifelts, B., Bretscher, J., Wildgruber, D., Fallgatter, A., & Ethofer, T. (2016). Emotion perception in adult attention-deficit hyperactivity disorder. *Journal of neural transmission (Vienna, Austria : 1996)*, *123*(8), 961–970. https://doi.org/10.1007/s00702-016-1513-x

Briere, J. (2002). *Multiscale dissociation inventory professional manual.* Psychological Assessment Resources.

Brüne M., Ebert A., Kolb M., Tas C., Edel M. A., Roser P. (2013). Oxytocin influences avoidant reactions to social threat in adults with borderline personality disorder. *Human Psychopharmacoly*, *28*(6), 552–561. https://doi.org/10.1002/hup.2343

Byrne, A., & Eysenck, M. W. (1995). Trait anxiety, anxious mood, and threat detection. *Cognition and Emotion, 9*(6), 549–562. https://doi.org/10.1080/02699939508408982

Candel, I., Merckelbach, H., & Kuijpers, M. (2003). Dissociative experiences are related to commissions in emotional memory. *Behaviour research and therapy, 41*(6), 719–725. https://doi.org/10.1016/s0005-7967(03)00016-0

Černis, E., Evans, R., Ehlers, A., & Freeman, D. (2021). Dissociation in relation to other mental health conditions: An exploration using network analysis. *Journal of psychiatric research*, *136*, 460–467. https://doi.org/10.1016/j.jpsychires.2020.08.023

Chanes, L., Wormwood, J. B., Betz, N., & Barrett, L. F. (2018). Facial expression predictions as drivers of social perception. *Journal of Personality and Social Psychology, 114*(3), 380–396. https://doi.org/10.1037/pspa0000108

Clark G. A. (1995). Emotional learning. Fear and loathing in the amygdala. *Current biology : CB, 5*(3), 246–248. https://doi.org/10.1016/s0960-9822(95)00050-9

Connolly, H. L., Lefevre, C. E., Young, A. W., & Lewis, G. J. (2019). Sex differences in emotion recognition: Evidence for a small overall female superiority on facial disgust. *Emotion, 19*(3), 455–464. https://doi.org/10.1037/emo0000446

Cowan, N. (1998). *Attention and Memory: An Integrated Framework*. Oxford Psychology Series. https://doi.org/10.1093/acprof:oso/9780195119107.003.0006

Dalili, M. N., Penton-Voak, I. S., Harmer, C. J., & Munafò, M. R. (2015). Meta-analysis of emotion recognition deficits in major depressive disorder. *Psychological medicine*, *45*(6), 1135–1144. https://doi.org/10.1017/S0033291714002591

Devilly, G. J., Ciorciari, J., Piesse, A., Sherwell, S., Zammit, S., Cook, F., & Turton, C. (2007). Dissociative Tendencies and Memory Performance on Directed-Forgetting Tasks. *Psychological Science, 18*(3), 212-217. https://doi-org.proxy.library.emory.edu/10.1111/j.1467-9280.2007.01875.x

DePrince, A. P., & Freyd, J. J. (1999). Dissociative tendencies, attention, and memory. *Psychological Science, 10*(5), 449–452. https://doi.org/10.1111/1467-9280.00185

DePrince, A. P., & Freyd, J. J. (2001). Memory and dissociative tendencies: The roles of attentional context and word meaning in a directed forgetting task. *Journal of Trauma & Dissociation, 2*(2), 67–82. https://doi.org/10.1300/J229v02n02_06

Dorahy, M. J., Middleton, W., & Irwin, H. J. (2005). The effect of emotional context on cognitive inhibition and attentional processing in dissociative identity disorder. *Behaviour research and therapy*, *43*(5), 555–568. https://doi.org/10.1016/j.brat.2004.03.011

Dyer, M. L., Attwood, A. S., Penton-Voak, I. S., & Munafò, M. R. (2022). The role of state and trait anxiety in the processing of facial expressions of emotion. *Royal Society open science*, *9*(1), 210056. https://doi.org/10.1098/rsos.210056

Elzinga, B. M., Ardon, A. M., Heijnis, M. K., De Ruiter, M. B., Van Dyck, R., & Veltman, D. J. (2007). Neural correlates of enhanced working-memory performance in dissociative disorder: a functional MRI study. *Psychological medicine*, *37*(2), 235–245. https://doi.org/10.1017/S0033291706008932

Elzinga, B. M., Phaf, R. H., Ardon, A. M., & van Dyck, R. (2003). Directed forgetting between, but not within, dissociative personality states. *Journal of Abnormal Psychology, 112*(2), 237–243. https://doi.org/10.1037/0021-843X.112.2.237

Fani, N., Bradley-Davino, B., Ressler, K. J., & McClure-Tone, E. B. (2011). Attention bias in adult survivors of childhood maltreatment with and without posttraumatic stress disorder. *Cognitive Therapy and Research, 35*(1), 57–67. https://doi.org/10.1007/s10608-010-9294-2

Fani, N., King, T. Z., Powers, A., Hardy, R. A., Siegle, G. J., Blair, R. J., Surapaneni, S., van Rooij, S., Ressler, K. J., Jovanovic, T., & Bradley, B. (2019). Cognitive and neural facets of dissociation in a traumatized population. *Emotion (Washington, D.C.), 19*(5), 863–875. https://doi.org/10.1037/emo0000466

Fani, N., Tone, E. B., Phifer, J., Norrholm, S. D., Bradley, B., Ressler, K. J., Kamkwalala, A., & Jovanovic, T. (2012). Attention bias toward threat is associated with exaggerated fear expression and impaired extinction in PTSD. *Psychological medicine*, *42*(3), 533–543. https://doi.org/10.1017/S0033291711001565

Feyereisen, P., Malet, C., & Martin, Y. (1986). Is the faster processing of expressions of happiness modality specific? In H. D. Ellis, M. A. Jeeves, F. Newcombe, & A. Young (Eds.), *Aspects of face processing*, 349-355. Boston: Nijhoff.

Freyd, J.J., Martorello, S., Alvarado, J.S., Hayes, A.E., & Christman, J.C. (1998). Cognitive environments and dissociative tendencies : Performance on the standard Stroop task for high versus low dissociators. *Applied Cognitive Psychology, 12*.

Fujihara, Y., Guo, K., & Liu, C. H. (2023). Relationship between types of anxiety and the ability to recognize facial expressions. *Acta psychologica*, *241*, 104100. https://doi.org/10.1016/j.actpsy.2023.104100

Giesbrecht, T., Merckelbach, H., van Oorsouw, K., & Simeon, D. (2010). Skin conductance and memory fragmentation after exposure to an emotional film clip in depersonalization disorder. *Psychiatry Research, 177*(3), 342–349. https://doi.org/10.1016/j.psychres.2010.03.010

Gur, R. C., Ragland, J. D., Moberg, P. J., Turner, T. H., Bilker, W. B., Kohler, C., Siegel, S. J., & Gur, R. E. (2001). Computerized neurocognitive scanning: I. Methodology and validation in healthy people. *Neuropsychopharmacology: official publication of the American College of Neuropsychopharmacology, 25*(5), 766–776. https://doi.org/10.1016/S0893-133X(01)00278-0

Gur, R. C., Richard, J., Hughett, P., Calkins, M. E., Macy, L., Bilker, W. B., Brensinger, C., & Gur, R. E. (2010). A cognitive neuroscience-based computerized battery for efficient measurement of individual differences: standardization and initial construct validation. *Journal of neuroscience methods, 187*(2), 254–262. https://doi.org/10.1016/j.jneumeth.2009.11.017

Gur, R. C., Sara, R., Hagendoorn, M., Marom, O., Hughett, P., Macy, L., Turner, T., Bajcsy, R., Posner, A., & Gur, R. E. (2002). A method for obtaining 3-dimensional facial expressions and its standardization for use in neurocognitive studies. *Journal of neuroscience methods, 115*(2), 137–143.

Holtgraves, T., & Stockdale, G. (1997). The assessment of dissociative experiences in a non-clinical population: Reliability, validity, and factor structure of the Dissociative Experiences Scale. *Personality and Individual Differences, 22*(5), 699–706. https://doi.org/10.1016/S0191-8869(96)00252-8

Hunter, E. C., Sierra, M., & David, A. S. (2004). The epidemiology of depersonalisation and derealisation. A systematic review. *Social psychiatry and psychiatric epidemiology, 39(1*), 9–18. https://doi.org/10.1007/s00127-004-0701-4

Ihssen, N., & Keil, A. (2013). Accelerative and decelerative effects of hedonic valence and emotional arousal during visual scene processing. *Quarterly Journal of Experimental Psychology, 66*(7), 1276-1301. https://doi.org/10.1080/17470218.2012.737003

Jeffirs, S. M., Petri, J. M., Camden, A. A., Jackson, B. N., & Weathers, F. W. (2023). Psychometric evaluation of the Multiscale Dissociation Inventory (MDI): A replication and extension in two trauma-exposed samples. *European Journal of Trauma & Dissociation, 7*(2), Article 100324. https://doi.org/10.1016/j.ejtd.2023.100324

Kang, W., Kim, G., Kim, H., & Lee, S. H. (2019). The Influence of Anxiety on the Recognition of Facial Emotion Depends on the Emotion Category and Race of the Target Faces. *Experimental neurobiology*, *28*(2), 261–269. https://doi.org/10.5607/en.2019.28.2.261

Kida, T., Tanaka, E., & Kakigi, R. (2017). Attention as a determinant of task performance: From basics to applications. *The Journal of Physical Fitness and Sports Medicine, 6*. 59-64. DOI: 10.7600/jpfsm.6.59.

Kirkham E. J., Levita L. (2019). Early life stress is associated with reduced avoidance of threatening facial expressions. *Development and Psychopathology*, 1–9. https://doi.org/10.1017/S095457941900110X

Kurtz, M. M., Ragland, J. D., Bilker, W., Gur, R. C., & Gur, R. E. (2001). Comparison of the continuous performance test with and without working memory demands in healthy controls and patients with schizophrenia. *Schizophrenia research, 48*(2-3), 307–316. https://doi.org/10.1016/s0920-9964(00)00060-8

Lebois, L. A. M., Palermo, C. A., Scheuer, L. S., Lebois, E. P., Winternitz, S. R., Germine, L., & Kaufman, M. L. (2020). Higher integration scores are associated with facial emotion perception differences in dissociative identity disorder. *Journal of psychiatric research*, *123*, 164–170. https://doi.org/10.1016/j.jpsychires.2020.02.007

Lipschitz, D., Kaplan, M., Sorkenn, J., Chorney, P., & Asnis, G. (1996). Childhood abuse, adult assault, and dissociation. *Comprehensive Psychiatry, 37*(4), 261-266. https://doi.org/10.1016/S0010-440X(96)90005-X

Lynn, S. J., & Rhue, J. W. (Eds.). (1994). *Dissociation: Clinical and theoretical perspectives.* The Guilford Press.

Masten, C. L., Guyer, A. E., Hodgdon, H. B., McClure, E. B., Charney, D. S., Ernst, M., Kaufman, J., Pine, D. S., & Monk, C. S. (2008). Recognition of facial emotions among maltreated children with high rates of post-traumatic stress disorder. *Child abuse & neglect*, *32*(1), 139–153. https://doi.org/10.1016/j.chiabu.2007.09.006

Medford, N., Brierley, B., Brammer, M., Bullmore, E. T., David, A. S., & Phillips, M. L. (2006). Emotional memory in depersonalization disorder: a functional MRI study. *Psychiatry research*, *148*(2-3), 93–102. https://doi.org/10.1016/j.pscychresns.2006.05.007

Montagne, B., Sierra, M., Medford, N., Hunter, E., Baker, D., Kessels, R.P.C., De Haan, E.H.F. and David, A.S. (2007), Emotional memory and perception of emotional faces in patients suffering from depersonalization disorder. *British Journal of Psychology, 98*, 517-527. https://doi.org/10.1348/000712606X160669

Nijenhuis, E. R., Spinhoven, P., van Dyck, R., van der Hart, O., & Vanderlinden, J. (1998). Degree of somatoform and psychological dissociation in dissociative disorder is correlated with reported trauma. *Journal of traumatic stress*, *11*(4), 711–730. https://doi.org/10.1023/A:1024493332751

Olaya-Galindo, M. D., Vargas-Cifuentes, O. A., Vélez Van-Meerbeke, A., & Talero-Gutiérrez, C. (2023). Establishing the Relationship Between Attention Deficit Hyperactivity Disorder and Emotional Facial Expression Recognition Deficit: A Systematic Review. *Journal of Attention Disorders*, *27*(11), 1181-1195. https://doi.org/10.1177/10870547231154901

Özdemir, O., Güzel Özdemir, P., Boysan, M., & Yilmaz, E. (2015). The Relationships Between Dissociation, Attention, and Memory Dysfunction. *Noro psikiyatri arsivi*, *52*(1), 36–41. https://doi.org/10.5152/npa.2015.7390

Palermo, R., & Coltheart, M. (2004). Photographs of facial expression: accuracy, response times, and ratings of intensity. *Behavior research methods, instruments, & computers : a journal of the Psychonomic Society, Inc*, *36*(4), 634–638. https://doi.org/10.3758/bf03206544

Parlar, M., Frewen, P. A., Oremus, C., Lanius, R. A., & McKinnon, M. C. (2016). Dissociative symptoms are associated with reduced neuropsychological performance in patients with recurrent depression and a history of trauma exposure. *European journal of psychotraumatology*, *7*, 29061. https://doi.org/10.3402/ejpt.v7.29061

Powers, A., Fani, N., Carter, S., Cross, D., Cloitre, M., & Bradley, B. (2017). Differential predictors of DSM-5 PTSD and ICD-11 complex PTSD among African American women. *European journal of psychotraumatology*, *8*(1), 1338914. https://doi.org/10.1080/20008198.2017.1338914

Rhodes, G., Pond, S., Burton, N., Kloth, N., Jeffery, L., Bell, J., Ewing, L., Calder, A. J., & Palermo, R. (2015). How distinct is the coding of face identity and expression? Evidence for some common dimensions in face space. *Cognition, 142,* 123–137. https://doi.org/10.1016/j.cognition.2015.05.012

Rossion, B., & Lochy, A. (2022). Is human face recognition lateralized to the right hemisphere due to neural competition with left-lateralized visual word recognition? A critical review.

Brain structure & function, *227*(2), 599–629. https://doi.org/10.1007/s00429-021-02370-0

Russell, J. A. (1994). Is there universal recognition of emotion from facial expression? A review of the cross-cultural studies. *Psychological Bulletin, 115*, 102-141.

Shenoy. A.A., Sharma. R.K., & Agrawal. A (2019). A Role of Memory Functions in Patients with Dissociative Disorder. *International Journal of Indian Psychology, 7*(2), 687-692. DIP:18.01.082/20190702, DOI:10.2525/10702.082

Sierra, M., & Berrios, G. E. (1998). Depersonalization: neurobiological perspectives. *Biological psychiatry*, *44*(9), 898–908. https://doi.org/10.1016/s0006-3223(98)00015-8

Sierra, M., & David, A. S. (2011). Depersonalization: a selective impairment of self-awareness. *Consciousness and cognition*, *20*(1), 99–108. https://doi.org/10.1016/j.concog.2010.10.018

Sierra, M., Senior, C., Dalton, J., et al. (2002) Autonomic Response in Depersonalization Disorder. A*rchives of General Psychiatry, 59*(9), 833–838. doi:10.1001/archpsyc.59.9.833

Sierra, M., Senior, C., Phillips, & M., David, A. (2006) Autonomic response in the perception of disgust and happiness in depersonalization disorder. *Psychiatry Research, 145*(3), 225-231.

Stein, M. B., Hanna, C., Vaerum, V., & Koverola, C. (1999). Memory functioning in adult women traumatized by childhood sexual abuse. *Journal of traumatic stress*, *12*(3), 527–534. https://doi.org/10.1023/A:1024775222098

Suzuki A., Poon L., Kumari V., Cleare A. J. (2015). Fear biases in emotional face processing following childhood trauma as a marker of resilience and vulnerability to depression. *Child Maltreatment*, *20*(4), 240–250. https://doi.org/10.1177/1077559515600781

Turgeon, J., Bérubé, A., Blais, C., Lemieux, A., & Fournier, A. (2020). Recognition of children's emotional facial expressions among mothers reporting a history of childhood maltreatment. *PloS one*, *15*(12), e0243083. https://doi.org/10.1371/journal.pone.0243083

van der Hart O, Nijenhuis ERS, & Steele K (2006). *The Haunted Self: Structural Dissociation and the Treatment of Chronic Traumatization*.

Veague, H. B., & Hooley, J. M. (2014). Enhanced sensitivity and response bias for male anger in women with borderline personality disorder. *Psychiatry research*, *215*(3), 687–693. https://doi.org/10.1016/j.psychres.2013.12.045

Wagner, M. F., Milner, J. S., McCarthy, R. J., Crouch, J. L., McCanne, T. R., & Skowronski, J. J. (2015). Facial emotion recognition accuracy and child physical abuse: An experiment and a meta-analysis. *Psychology of Violence, 5*(2), 154–162. https://doi.org/10.1037/a0036014

Woodhead, M.M., Baddeley, A.D. (1981). Individual differences and memory for faces, pictures, and words. *Memory & Cognition 9*, 368–370 https://doi.org/10.3758/BF03197561

Appendices

Table 1

Characteristics of Scores for all Measures

Measure	*Mean*	*Range*
Dissociation	1.58	1.00 – 3.67
Altered dissociation	1.56	1.00 – 3.80
Childhood abuse	26.3	15 – 73
Emotion recognition accuracy		
No emotion	6.83	0 – 8
Sad	6.08	0 – 8
Happy	7.92	7 – 8
Fear	6.47	0 – 8
Anger	5.07	2 – 8
Emotion recognition reaction time (ms)		
No emotion	2634	839 – 9065
Sad	2553.3	1.5 – 6224
Happy	1885.8	1.5 – 4080
Fear	3347	4 – 10840
Anger	2832	1436 – 8972
Face memory	10.35	-1 – 18
Word memory	14.7	4 – 20
Attention	112.4	67 – 120

Table 2

Linear Mixed-Effects Model Results for the Interaction Effect of Dissociation Score and Attention on Emotion Recognition Accuracy for each Emotion Compared to Neutral

Predictors	*Estimates*	*CI*	*p*
(Intercept)	6.86	6.64 – 7.08	**<0.001**
Sad	-0.71	-1.01 – -0.41	**<0.001**
Happy	1.06	0.76 – 1.36	**<0.001**
Fear	-0.43	-0.72 – -0.13	**0.005**
Anger	-1.78	-2.08 – -1.49	**<0.001**
Dissociation	0.14	-0.08 – 0.36	0.200
Attention	0.28	0.06 – 0.50	**0.013**
Sad x Dissociation	-0.09	-0.39 – 0.20	0.540
Happy x Dissociation	-0.10	-0.40 – 0.20	0.509
Fear x Dissociation	0.06	-0.24 – 0.36	0.693
Anger x Dissociation	-0.19	-0.49 – 0.11	0.212
Sad x Attention	0.15	-0.15 – 0.46	0.319
Happy x Attention	-0.25	-0.55 – 0.06	0.111
Fear x Attention	-0.11	-0.41 – 0.19	0.484
Anger x Attention	-0.09	-0.39 – 0.21	0.569
Dissociation x Attention	0.01	-0.21 – 0.22	0.945
Sad x Dissociation x Attention	0.21	-0.08 – 0.51	0.158
Happy x Dissociation x Attention	-0.03	-0.32 – 0.27	0.862
Fear x Dissociation x Attention	-0.14	-0.44 – 0.15	0.342
Anger x Dissociation x Attention	-0.07	-0.36 – 0.22	0.641

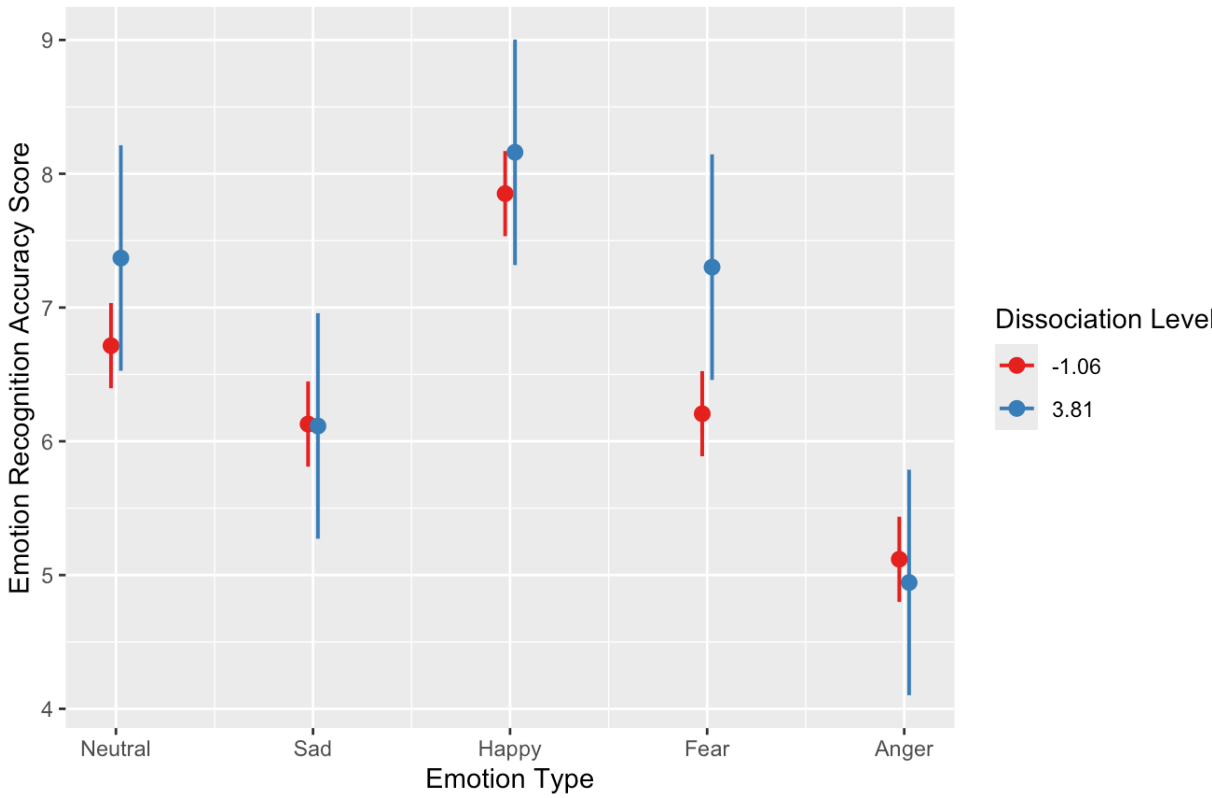
Table 3

Linear Mixed-Effects Model Results for Emotion Recognition Reaction Time as a Function of Dissociation Score for each Emotion Compared to Neutral

Predictors	*Estimates*	*CI*	*p*
(Intercept)	3543.63	2091.86 – 4995.40	**<0.001**
Sad	-73.43	-287.37 – 140.51	0.501
Happy	-756.87	-970.43 – -543.31	**<0.001**
Fear	724.73	510.75 – 938.70	**<0.001**
Anger	187.86	-25.70 – 401.42	0.085
Dissociation	-68.71	-243.03 – 105.62	0.439
Attention	-7.98	-20.79 – 4.83	0.222
Sad x Dissociation	19.36	-192.94 – 231.66	0.858
Happy x Dissociation	62.26	-149.30 – 273.82	0.564
Fear x Dissociation	43.55	-168.07 – 255.18	0.686
Anger x Dissociation	-22.43	-233.99 – 189.13	0.835

Figure 1

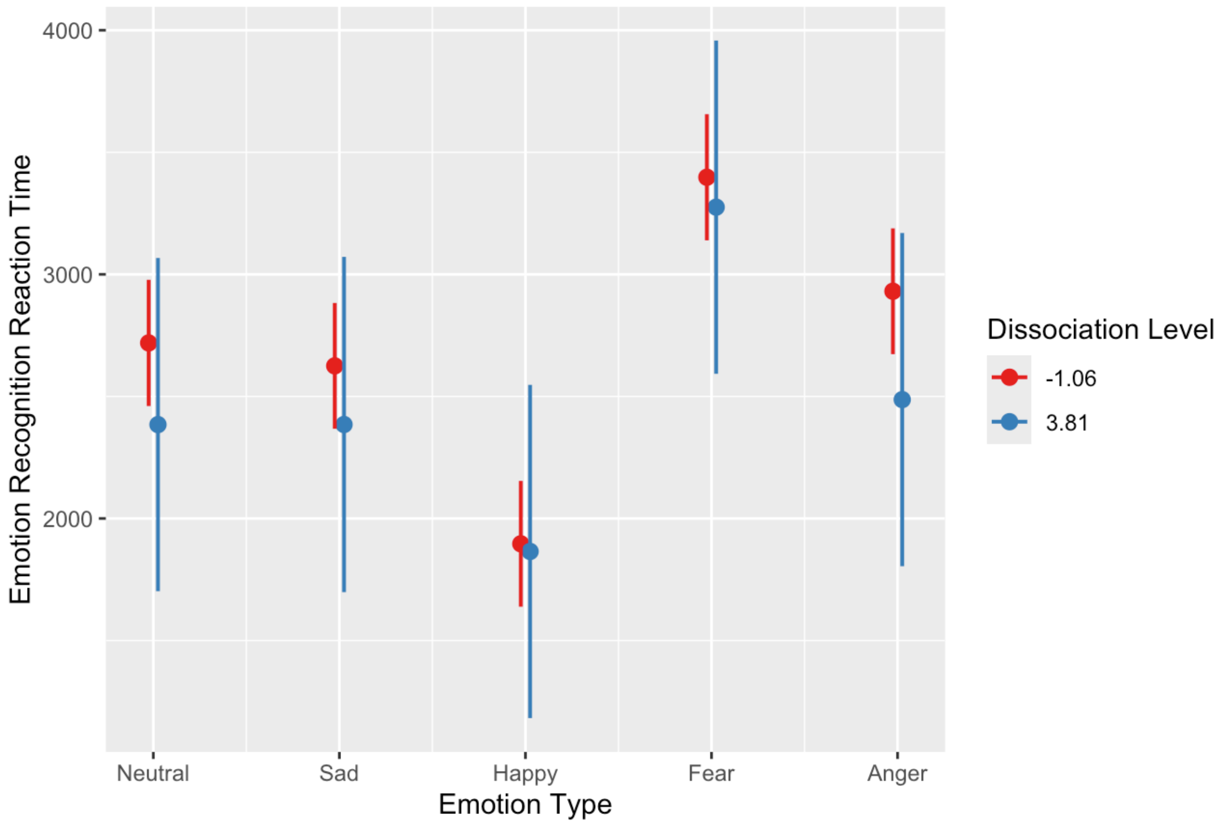
Emotion Recognition Accuracy Score as a Function of Dissociation Score for each Emotion Compared to Neutral



Note. Graph depicts predicted values of emotion recognition accuracy scores for each emotion type, separated into lower dissociation (red) and higher dissociation (blue) from the linear mixed-effects model. Results show no significant differences between higher and lower dissociation scores in emotion recognition accuracy score for any emotions. Error bars represent 95% confidence intervals. Dissociation level values represent standard deviations from the mean. Dissociation was modeled continuously.

Figure 2

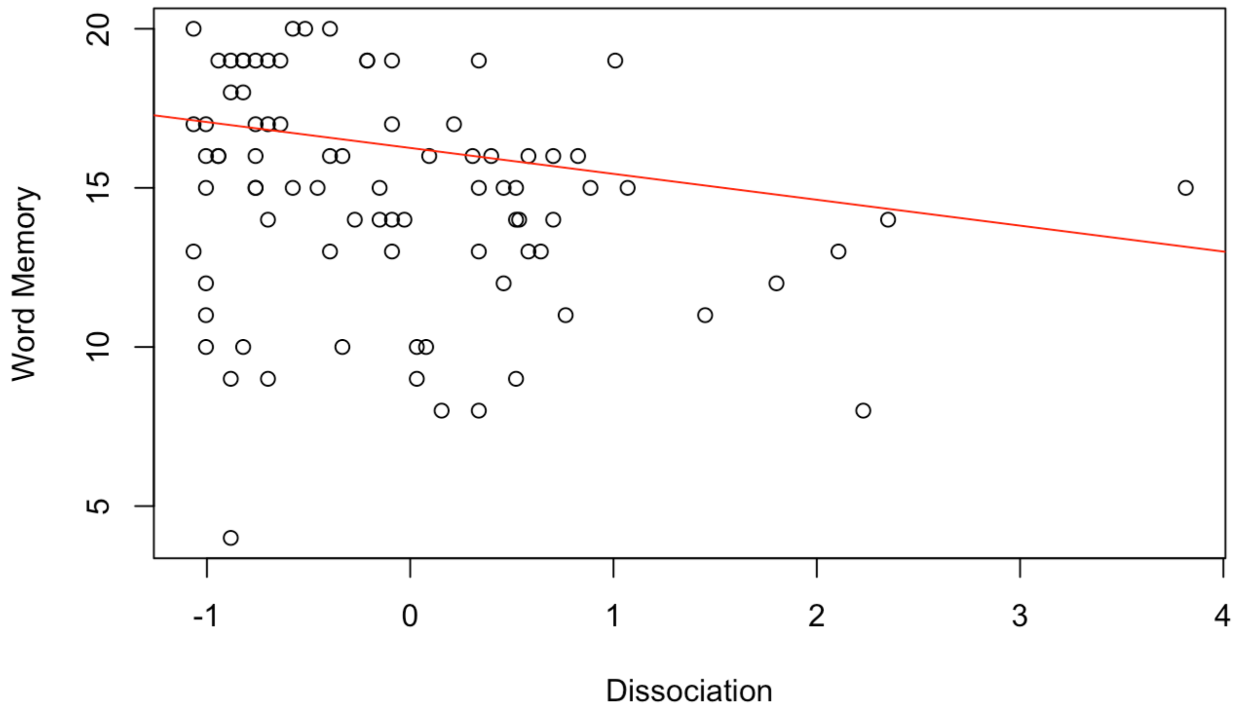
Emotion Recognition Reaction Time as a Function of Dissociation Score for each Emotion Compared to Neutral



Note. Graph depicts predicted values of emotion recognition reaction times in milliseconds for each emotion type, separated into lower dissociation (red) and higher dissociation (blue) from the linear mixed-effects model. Results show no significant differences between higher and lower dissociation scores in emotion recognition reaction time for any emotions. Error bars represent 95% confidence intervals. Dissociation level values represent standard deviations from the mean. Dissociation was modeled continuously.

Figure 3

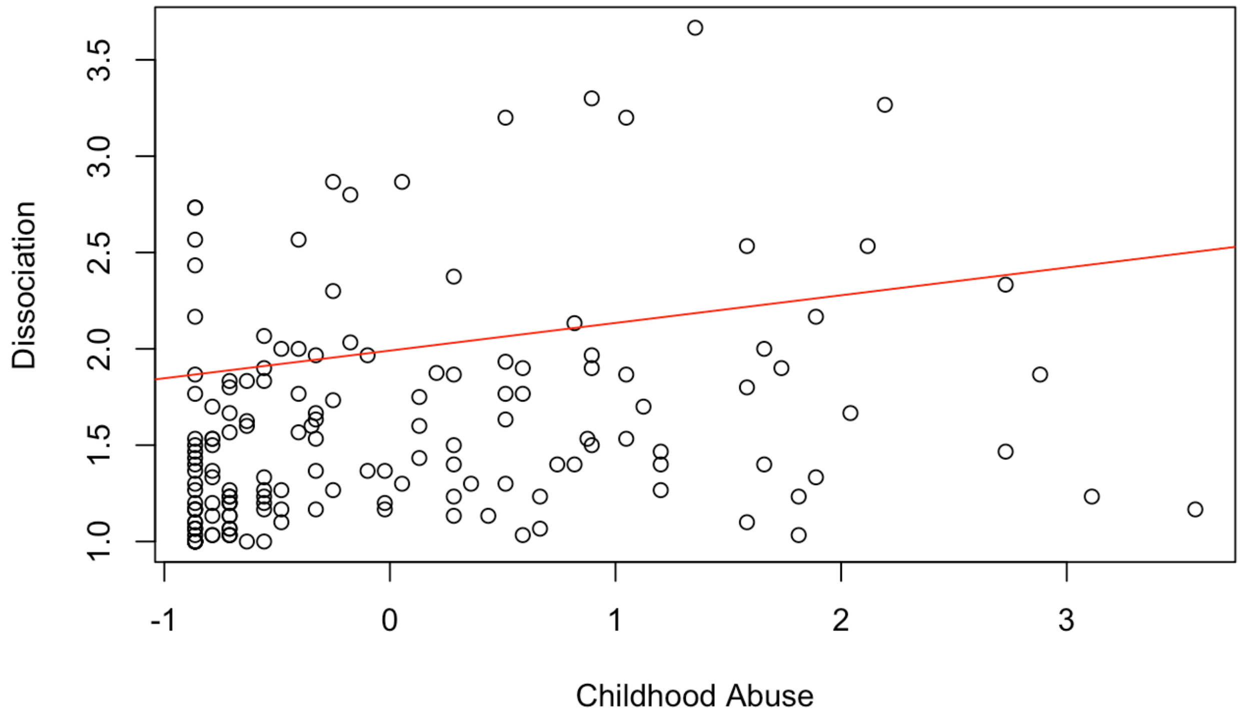
Relationship Between Dissociation and Word Memory



Note. Graph depicts the linear regression results showing the marginally significant association between greater dissociation score and worse word memory with a line of best fit.

Figure 4

Relationship Between Childhood Abuse and Dissociation



Note. Graph depicts the linear regression results showing the significant association between greater childhood abuse score and greater dissociation score with a line of best fit.