False Memory and Borderline Personality Features

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Abstract

Borderline Personality Disorder (BPD) is a mental disorder characterized by significant impairment in intrapersonal and interpersonal functioning, as well as patterns of personality pathology. Memory deficits are not recognized as a core symptom of BPD, but individuals with BPD symptoms have long been suspected to have inaccurate perceptions, disturbed memory processes, and an increased tendency to develop false memories. In the present study, we examined whether there was an association between BPD features and the production of false memories in the Deese-Roediger-McDermott (DRM) paradigm—a laboratory-based procedure that is frequently used to investigate false memory. We also compared the traditional categorical BPD criteria (DSM-5 Section II) with the alternative model of personality disorders BPD criteria (DSM-5 Section III) in predicting memory performance. A total of 298 university students completed the McLean Screening Instrument for Borderline Personality Disorder, SCID-II Personality Questionnaire, Borderline Personality Disorder Impairment Scale, Personality Inventory for DSM-5, Beck Depression Inventory, Dissociative Experiences Scale, and Traumatic Life Events Questionnaire. Participants were also tested using both traditional DRM word lists as well as word lists that were specifically associated with BPD features. Using the traditional diagnosis of BPD, BPD features were correlated with higher false memory for positive information; in the alternative model of BPD, identity impairment and anxiousness were correlated with the overall false memory score. We also found that trauma and dissociation mediated the relation between BPD and false memory. These findings are discussed in terms of how the consequences of trauma, such as dissociation and identity disturbance, are associated with false memory. Whether false memory rates are higher in a clinical population of BPD patients than in non-clinical volunteers remains to be determined.

Keywords Borderline personality disorder, Alternative model of personality disorders, False memory, DRM paradigm

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Borderline personality disorder (BPD) is a severe psychiatric condition characterized by a wide range of psychosocial impairments and psychopathological symptoms such as affective and behavioral instability, severe interpersonal problems, cognitive distortions, and identity diffusion (American Psychiatric Association, 2013). Decades of criticism about the diagnostic construct and categorical model of personality disorders has led to the development of an alternative model for the assessment and diagnosis of personality disorders, including BPD (Bach et al., 2016). The Alternative DSM-5 Model of Personality Disorders (AMPD; APA, 2013) is grounded in personality trait studies (e.g., Morey et al., 2013; Pocnet et al., 2018); is focused on dimensional core

features of personality disorders; and considers personality pathology on a continuum, rather than as an all-or-none phenomenon (Millon, 2011). This dimensional system was recommended to preserve continuity in the clinical setting and to address the existing shortcomings of the categorical approach to personality disorders (Reichborn-Kjennerud et al., 2017; Rounsaville et al., 2002; Widiger et al., 2007; see Krueger & Markon, 2014, for further details).

In the AMPD, BPD is defined based on two primarily dimensional criteria. Criterion A involves impairment in the functioning of the self (i.e., identity and self-directedness) and interpersonal relationships (i.e., empathy and intimacy). Criterion B is a pattern of maladaptive personality traits that include anxiousness,

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emotional lability, separation insecurity, hostility, depressivity, impulsivity, and risk-taking (DSM-5; APA, 2013). In the current study, we examined whether there was a potential association between BPD, both as traditionally operationalized and as defined by the AMPD, and false memory as measured through the Deese-Roediger-McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995).

Reasons to Suspect False Memory Susceptibility in BPD Symptoms

Although memory deficits are not recognized as a core symptom of BPD (Comtois et al., 2003; Fertuck et al., 2012), individuals with BPD symptoms have long been suspected of having inaccurate perception, disturbed memory processes, and an increased tendency to develop false memories1 (Bailey & Shriver, 1999; Ruocco & Bahl, 2014; Schilling et al., 2013). To date, several studies have focused on various neuropsychological factors that might contribute to memory impairment in individuals with borderline personality traits. For example, Carcone et al. (2020) suggest that memory performance and encoding-related activation in the hippocampus is disrupted in BPD individuals. Some researchers have found that cognitive deficit in BPD individuals has a negative impact on attention, working memory, learning and episodic memory (Hagenhoff et al., 2013; Ruocco, 2005; Stevens et al., 2004), and others have suggested that sustained attention increases false memory susceptibility (Kiat et al., 2018).

In another line of research, for example, Bailey and Shriver (1999) surveyed clinical psychologists about the likelihood that BPD patients tend to misremember prior events. Based on their clinical observations, the psychologists believed that, compared to other kinds of patients, individuals with BPD were more likely to misinterpret or misremember their perceptions and interpersonal interactions. On the basis of their data, Bailey and Shriver argued that some BPD symptoms (e.g., transient, stress-related paranoid ideation or severe dissociative symptoms) make the encoding and objective reporting of events difficult.

In addition to clinicians' experience, there are also other reasons that might lead us to suspect that individuals with BPD might have altered memory processing. Figure 1 provides a list of variables that are associated with BPD. For example, individuals with BPD display dissociative symptoms (Van den Broeck et al., 2012), attention deficits (Ruocco & Direkoglu, 2013), emotion dysregulation (Mensebach et al., 2009), and identity impairment (Bech et al., 2015). Individuals with BPD also typically have experienced trauma (Laporte et al., 2011) that can result in posttraumatic stress disorder (PTSD; Pagura et al., 2010) and

depression (Van den Broeck et al., 2012). As we will outline below, many of these same variables have also been shown to interfere with memory.

Considering Figure 1 more carefully, more than 70% of BPD patients have experienced early childhood trauma (Laporte et al., 2011) and 46–56% of them also have PTSD (Lieb et al., 2004; Pagura et al., 2010). Given this high co-morbidity, some authors have proposed including BPD in the list of 'trauma-related disorders' (Van Dijke, 2012) and some view PTSD and trauma-related disorders as a disorder of memory (Brewin, 2014; McNally, 2005), emphasizing the importance of memory in the maintenance of psychopathology. Based on Otgaar et al. (2017), one prediction would be that PTSD, or a trauma history can make individuals more vulnerable to the creation of false memories (Howe & Malone, 2011; Otgaar et al., 2017).

A common form of trauma experienced by individuals with BPD is childhood sexual abuse (CSA), which has been estimated to have occurred in approximately 70% of individuals with BPD (Perry & Herman, 1993), and a history of childhood sexual abuse has been associated with higher rates of false memory. For example, Goodman et al. (2011) examined false memories in adolescent and adult participants who were sexually abused as children and control participants who did not have a documented history of child sexual abuse. Participants completed age-appropriate measures of PTSD and were then presented with DRM word lists that contained CSA-related words (e.g., sex), positive (e.g., happy), neutral (e.g., window), and negative (e.g., kill) words. After the presentation of each list, participants were asked to recall and recognize the words on the list. In free recall, the CSA lists and negative lists evoked the highest number of false memories across all participants. However, for recognition, the opposite effect was found; CSA lists produced the lowest number of false memories. In addition, participants with a history of CSA and PTSD produced more false memories than did participants with PTSD or a history of CSA alone.

In addition to trauma, up to 75% of BPD patients also suffer from dissociative symptoms, with disturbances in perception and cognition, including memory (Beblo et al., 2014; Vermetten & Spiegel, 2014). It has been argued that dissociation is correlated with increased false memories and may impede the encoding and retrieval of events (Bailey & Shriver, 1999). Moreover, the lifetime prevalence rates of depressive and anxiety disorders in BPD patients is estimated to be 85% (Distel et al., 2016), and even after treatment, 61% of BPD patients meet the criteria for major depression (Zanarini et al., 2004). BPD patients also ruminate (Smith et al., 2006), and the existing literature shows that both depression severity and

rumination are negatively related to memory specificity in BPD patients. These findings suggest that the more severe an individual's depressive symptoms, and the more that individual ruminates, the less capable they are of retrieving specific autobiographical memories (Van den Broeck et al., 2012) and the more readily they generate negative false memories (Howe et al., 2009).

Despite the logic of the argument for a relation between history of trauma, dissociative experiences, and depressive symptoms and false memories, the research findings regarding false memory susceptibility in these conditions has been inconsistent (see online supplement for a summary of studies that have investigated the link between false memories and BPD-related symptomology). In some studies, researchers have reported a link between heightened levels of false memories and PTSD (e.g., Moradi et al., 2015), depression (e.g., Joormann et al., 2009), dissociative experiences (e.g., Dehon et al., 2008), while in other studies, they have not (e.g., Dasse et al., 2015). Another strategy to establish a link between psychopathology and false memory has been to identify disorders that are characterized by emotion dysregulation and deficits in emotional memory retrieval (e.g., BPD, antisocial and psychopathy personality disorders). When individuals with these disorders have been asked about their emotionally negative memories, they have been shown to display less automatic associative activation in their knowledge base than do individuals without these disorders (for review, see Otgaar et al., 2017).

DRM False Memory and BPD Symptoms
One of the most frequently-used paradigms to investigate spontaneous false memories is the Deese/Roediger–McDermott (DRM) paradigm (Deese, 1959; Roediger & McDermott, 1995). In this paradigm, participants are presented with lists of words (e.g., bed, rest, pillow, night, etc.) that are all semantically linked to a non-presented critical lure word (e.g., sleep). The typical outcome during a subsequent memory test is that participants often falsely recall and/or recognize the non-presented critical lure word. More specifically, false recall or recognition may occur when participants confuse internally-generated items (critical lure words) with externally-presented items (studied words). Activation (during encoding) and reactivation (during retrieval) of the critical lure word enhance its familiarity, leading to a heightened vulnerability to DRM-induced false memories (Peters et al., 2008).

More recently, there has been a growing interest in studying the effect of emotions in evoking false memories. In this line of research, researchers have constructed thematic DRM word lists, such as

depression-relevant, trauma-relevant, and delusion-relevant word lists to study trait-congruent false memories (e.g., Dovidio & Gaertner, 2000; Howe & Malone, 2011; Goodman et al., 2011). In these studies, researchers have examined the extent to which the formation of false memories is influenced by one's past experiences (e.g., traumatic experiences), or one's mental condition (e.g., depressive symptoms). For example, Brennen et al. (2007) found that participants with a history of trauma had significantly higher false memory for trauma-relevant word lists than did a comparison group without a history of trauma. In a similar study, Howe and Malone (2011) found that participants with depression had significantly higher false memory for depression-relevant word lists than did a control group (see online supplementary materials for more details). Hence, it is important to examine how false memory phenomena in individuals with features of BPD might be influenced by emotional stimuli that are related to their past experiences or psychopathology.

Research regarding the susceptibility of BPD patients to false memory errors in the DRM paradigm is scarce. In one study, Schilling et al. (2013) examined false memory susceptibility in individuals with BPD using a visual version of the DRM paradigm. Participants diagnosed with BPD and control participants were shown two black and white images and asked to remember as many details as possible from the images. One image depicted a beach scene (a positive image), while the other depicted a surveillance scene (a negative image). The images were later presented with additional details added to them (e.g., a towel where there previously was no towel). Participants were asked whether certain details were old or new, and to rate the level of confidence they had for the decision of whether a detail was old or new. Individuals with BPD and controls showed similar rates of false memories (i.e., remembering a detail that was not previously in the image), however, individuals with BPD were more confident when falsely deciding that details were new. Although Schilling et al.'s findings are interesting, they did not consider the AMPD perspective; they used clinical samples of BPD patients and were exclusively reliant on group comparisons between BPD individuals and healthy controls. As such, this study did not address the question of whether a particular BPD-relevant trait or form of personality impairment might be related to false memory creation. Moreover, Schilling et al. only used positive and negative stimuli; although emotionally valanced, these stimuli are not related to BPD psychopathology. Thus, they did not address the question of whether BPD individuals are more prone to false memory when they encounter information that maps onto the psychopathology. To the best of our

knowledge, there has been no other research on false memory susceptibility in individuals with BPD using the DRM or any other false memory paradigm.

Aims and Hypotheses

The goals of the present research were four-fold. First, we examined whether individuals who score high on traditional BPD scales (i.e., MSI-BPD and SCID-II) are more prone to producing false memories. In this study, we used the term "false memory" to describe the kind of memory errors produced by the DRM paradigm. Second, because there is a clear need to compare the utility of the dimensional approach with the categorical approach to operationalizing BPD (Trull & Durrett, 2005), we also compared the relation between the traditional and AMPD operationalization of BPD with respect to the production of false memory. It is noteworthy that while the categorical approach considers BPD as a whole, the alternative model of BPD with its dimensional traits allows for a finer-grained analysis of the relation between core dimensional impairments in BPD personality functioning and pathological personality traits, and memory. Third, because previous studies have shown that individuals are more susceptible to false memories when the theme of the material maps onto their psychopathology-related knowledge base (e.g., trauma-related, depression-related; McNally, 2005), we examined whether individuals who score high on the BPD scales are more prone to producing false memory for information that is more related to BPD symptomology (e.g., trauma-related) than for the information that is not related to BPD symptomology. Finally, because previous studies have suggested a link between BPD-related variables (i.e., trauma, dissociation, and depression) and false memory susceptibility, we examined whether BPD indirectly predicts the creation of false memory through the mediating role of particular BPD-related symptoms (i.e., depression, traumatic experiences, and dissociation).

Building on the extant research base, we tested four hypotheses. Specifically, we hypothesized that:

1. Individuals with higher scores on the BPD scale are more prone to producing false memories than are participants with lower scores;
2. Certain constituent traits of BPD are more related to false memory than are others;
3. BPD features are more correlated with false memory for BPD-related information than for information that is not related to BPD symptomology; and
4. BPD is indirectly associated with false memories through the mediating role of

depression, traumatic experiences, and dissociation.

Method

In the present study, we conducted three independent experiments to examine false memory susceptibility in BPD. First, we conducted two preliminary experiments to construct BPD-related DRM word lists that were consistent with the clinical description of BPD (see Online Supplementary materials for more details on how we constructed the BPD-related wordlists). Having compiled BPD-related wordlists, we then conducted the main experiment in which we examined false memory in BPD for these word lists as well as for more standard word lists that are commonly used in the DRM paradigm (see Appendix for the full list of wordlists). Below, we describe the methodology for the main experiment; the details of the two preliminary experiments that we conducted to develop the BPD-related word lists are available as online supplementary materials.

Participants

A total of 300 undergraduate students at a large public university were recruited for this experiment via an online recruitment database. All participants were required to be students studying at the University of Otago, 18-years old or older, and native speakers of English: two participants were excluded from the experiment because they did not meet the second criterion. The final sample (N = 298)2 consisted of 211 females (M age = 21.22 years; SD = 3.12) and 87 males (M age = 21.55 years; SD = 3.80); no participants identified as gender-diverse. Participants identified as New Zealand European (66.4%), Māori (4.7%), Asian (13.8%), or "Other" (19.8%), which included those of other European descent. Using embedded validity indicators, no participants were excluded from the experiment due to suspected random or noncontent-based responding. All participants provided written, informed consent and were tested individually in person using online Qualtrics (www.qualtrics.com) and E-Prime (Psychology Software Tools, Inc., 2012) software. They were reimbursed $40 NZD for their time. The research was reviewed and approved by the University's Human Ethics Committee (Health).

Self-Report Measures

Descriptive statistics for each scale score appear in Tables 1 and 2.

McLean Screening Instrument for Borderline Personality Disorder (MSI-BPD). The MSI-BPD (Zanarini et al., 2003) is a 10-item yes/no questionnaire designed to assess the symptoms of borderline

personality disorder. Responses are summed to create an overall score ranging from 0–10 with higher scores indicating a greater experience of symptoms of borderline personality disorder. Although the MSI-BPD is as a continuous measure, a cut-off score of 7 has been used to identify individuals experiencing significant subthreshold symptoms of BPD (Zanarini et al., 2003). The MSI-BPD is frequently used in research and has good psychometric properties. Reliability analysis (Cronbach's α) indicated adequate internal consistency (α = .74).

SCID-II Personality Questionnaire (SCID-II). The SCID-II (First et al., 1997) is a 119-item true/false questionnaire designed to assess 10 personality disorders according to the DSM-IV diagnostic criteria. In the current study, only the BPD scale from the SCID-II was used; the BPD scale consists of 15 items and was initially designed as a screening device (Carey, 1994) for BPD based on the DSM-IV (APA, 1994). Responses are summed to create an overall score ranging from 0–15 with higher scores indicating a greater experience of symptoms of BPD. A cut-off score of 6 or greater is frequently used to identify individuals experiencing significant sub-threshold symptoms of BPD (van Alebeek et al., 2015). Reliability analysis (Cronbach's α) indicated adequate internal consistency for the BPD sub-scale (α = .79).

Borderline Personality Disorder Impairment Scale (BPD-IS). The BPD-IS (Anderson & Sellbom, 2018) is an 11-item self-report rating scale developed to assess BPD impairment according to DSM–5 Section III Criterion A. Based on the Section III model, there are two broad domains (self, interpersonal) and four scales (identity, self-direction, empathy, intimacy) of functional impairment. Accordingly, in each of the four scales, individuals rate their level of functional impairment on several items which represent the four traits of functional impairment included in the DSM–5 Section III model. Participants indicated how much they agreed with 5 items. Each item asks individuals to choose one of five statements of ascending severity ranging from 0 (no impairment) to 4 (extreme impairment). Responses are averaged, with higher scores indicating greater levels of self- and interpersonal impairment (Anderson & Sellbom, 2018). Reliability analysis (Cronbach's α) indicated adequate internal consistency for total score (α = .79). Due to brevity of the items in each subscale, we did not calculate internal consistency for the subscales.

Personality Inventory for DSM-5 Short Form (PID-5-SF). The PID-5-SF (Maples et al., 2015) is a 100-item self-report inventory, that was extracted from the original 220-item PID-5 (Krueger et al., 2012), developed to assess the five DSM–5 Section III personality domains and their respective trait facets found in Criterion B. PID-5-SF covers the 25

personality traits facets as well as the five DSM-5 Section III personality domains (Negative Affectivity, Detachment, Antagonism, Disinhibition, and Psychoticism). Participants are asked to rate the extent to which they agree with each item using a Likert scale ranging from 0 (very false or often false) to 3 (very true or often true). The PID-5 is frequently used in research and has good psychometric properties (e.g., Anderson et al., 2018). Reliability analysis (Cronbach's α) indicated good internal consistency for each trait facet (α's = .80 for hostility and separation insecurity; .84 for impulsivity and risk-taking; and .86 for anxiousness, emotional liability, and depressivity).

Beck Depression Inventory (BDI). The BDI (Beck et al., 1996) is a 21-item questionnaire developed to assess multiple aspects of depression, including cognitive, emotional, behavioral, and physical domains. For each item on the BDI, participants selected from one of four statements. Items were summed to create an overall score ranging from 0-63 with a higher score indicating greater experiences of symptoms of depression. A score of 10 or more is considered indicative of clinically significant levels of depressive symptoms (Beck et al., 1996). Reliability analysis (Cronbach's α) indicated good internal consistency (α = .91).

Dissociative Experiences Scale (DES). The DES (Bernstein & Putnam, 1986) is a 28-item self-report questionnaire developed to measure dissociative experiences. Each item describes a kind of experience that participants may have had. Participants rate their agreement with each item using a 10-point scale (Nev¬er = 0% to Always = 100%). Items are summed to create a total score. The total is multiplied by 10, then divided by 28 to calculate the average score. Studies have shown that a score higher than 15 needs more inves¬tigation to diagnose dissociation, a score higher than 30 indicates the high probability of dissociative disorders and PTSD, and scores over 40 express high probability of dissociative identity disorder (Bernstein & Putnam, 1986). Reliability analysis (Cronbach's α) indicated good internal consistency for the total score (α = .93).

Traumatic Life Events Questionnaire (TLEQ). The TLEQ (Kubany et al., 2000) is a 23-item yes/no questionnaire assigned to assess the history of 22 potentially traumatic events (ranging from physical abuse, being stalked, or robbery involving a weapon, to exposure to warfare) and a 23rd category of "other events" with examples. For every event that was endorsed (e.g., Has anyone threatened to kill you or cause you serious physical harm?), participants were asked to answer questions about whether the particular event happened, the event's frequency (ranging from "never" to "more than 5 times," coded as 6), the severity of the traumatic experience based on DSM-IV

diagnostic criteria (i.e., whether they felt intense fear, helplessness, or horror during the event), and characteristics of the perpetrator (e.g., stranger, relative). Participants' responses on the 22 traumatic events, their frequency and severity were collapsed in the results. In the final item, participants were also asked to nominate the event that caused them the most distress and their age when the event first and last occurred. Regarding the psychometric features of TLEQ, the temporal stability of TLEQ items in previous research using various samples (e.g., university students, Vietnam veterans, and substance users) has been shown to be adequate using kappa coefficients of .40 for most, and .60 or higher for half of the items (Kubany et al., 2000).

Validity indicator. Given that these data were collected on a computer and that none of the measures used in this study had built-in validity indicators, it was important to determine if individuals were responding appropriately to the item content (i.e., not randomly responding). For this reason, we interspersed a series of questions throughout the protocol, to which most individuals should respond in a non-affirmative way, such as "Do you live on Mars?" or "I am allergic to water." None of the participants were excluded based on their responses to the validity indicator questions.

False Memory (DRM) Task: Material and Procedure

We used 12 word lists in the DRM task (3 each for BPD-related, trauma-related, negative, and positive lists). We included two distinct types of thematic wordlists that were related to BPD symptomology (i.e., BPD-related and trauma-related), and two other types of wordlists that were emotionally valenced but were not related to BPD construct (i.e., negative and positive). The BPD-related word lists (e.g., Loneliness, Self-harm) were chosen based on the findings of our preliminary experiment to develop DRM word lists for BPD (see online supplementary materials). Two each of the negative (e.g., Lie, Sick) and positive (e.g., Happy, Nice) lists were taken from Zhang et al. (2017) and one each from Palmer and Dodson (2009); the trauma-related lists (e.g., Rape, Sex) were taken from Goodman et al. (2011). Each word list was 10-words long and the words on each list were shown in the same serial order to all participants. All of the words in each word list were shown in the descending order of their BAS values so that the first word on the list was the one most associated with the critical lure, the second word was the one next-most associated, and so on.

We used E-Prime to present participants with the word lists (120 words in total). Prior to conducting the experiment, the experimenter explained the procedure and then participants completed a neutral-word practice list. The presentation order of the word lists was partially counterbalanced across participants; that is, half of the participants learned the three BPD-related word lists, followed by the three positive lists, the three trauma-related lists, and the three negative word lists, and the other half of the participants learned the word lists in the reverse order (see also Zhang et al., 2017). Each word was presented for 2 seconds on the computer screen and after all of the words in the word list were presented, a message came up warning the participant that the next word list was about to appear. Participants were asked to remember all 12 word lists. Between the learning phase and the test phase, participants completed a 5-minute subtraction exercise.

Following Zhang et al. (2017), the recognition test contained 36 studied words from serial positions 1, 4, and 8 of each word list; and 36 non-studied words. The non-studied words consisted of 12 critical lures and 24 non-related lures that were unrelated to any list words; the positive and negative non-related lures were taken from Brainerd et al. (2010) and the neutral ones were taken from Roediger et al. (2001). The presentation order of the 72 test words was completely random. Participants were asked to make an "Old" decision if they thought a word had been presented in the study phase and to make a "New" decision if they thought a word had not been presented in the study phase. We used the proportion of critical lures that participants falsely recognized (i.e., responded 'Old') as the false recognition rate.

Analytic Strategy

We analysed all of the data using IBM SPSS Statistics 25 (IBM, USA) and Hayes' (2018) PROCESS macro v3.4 for SPSS. For all of the analyses, $p < .05$ was set as the level of significance. The findings of the current study are presented in two major sections. In the first section, we conducted a series of Pearson correlations (r) to examine false memory in 1) BPD as conceptualized by the traditional model (i.e., SCID-II and MSI-BPD), and 2) BPD impairment in personality functioning (i.e., Criterion A in the AMPD), as well as 3) BPD personality traits (i.e., Criterion B in the AMPD), as the aggregate indices of AMPD-BPD. Then, we tested four separate mediation models to examine the indirect effect of BPD symptoms on false memory. To do this, we used Hayes' PROCESS to conduct a series of simple mediation models (Model 4, 10,000 bootstrap resamples); statistical significance for an indirect effect is assumed if zero is not included in the bias-corrected 95% confidence interval for the indirect effect.

Results

The descriptive statistics and correlations between the traditional and AMPD indices of BPD and participants'

Table 1. Zero-order correlations between false memory and traditional/AMPD indices of BPD, and individual difference measures

		Mean (SD)	False Recognition Rates				
			BPD	Trauma	Negative	Positive	Overall
Traditional BPD	SCID-II	4.14 (*3.28*)	.008	.10	.06	.14*	.11
	MSI-BPD	3.21 (*2.47*)	-.002	.08	.08	.13*	.10
AMPD-Criterion A	Identity impairment	1.24 (*0.66*)	.13*	.13*	.09	.08	.15**
	Self-direction	0.90 (*0.96*)	-.06	-.06	-.12*	.08	-.05
	Empathy	0.51 (*0.43*)	.04	.03	.06	.01	.05
	Intimacy	0.66 (*0.59*)	.07	.06	.05	.08	.09
AMPD-Criterion B	Anxiousness	1.31 (*0.85*)	.10	.08	.10	.09	.13*
	Emotional Liability	0.86 (*0.77*)	.02	.08	.06	.10	.10
	Separation Insecurity	1.16 (*0.80*)	.01	.07	.03	.02	.05
	Impulsivity	0.77 (*0.71*)	.10	.05	.03	.07	.09
	Hostility	0.66 (*0.63*)	.05	.02	.05	.05	.06
	Depressivity	0.35 (*0.57*)	.03	.02	.09	.03	.06
	Risk Taking	0.60 (*0.65*)	.06	.01	-.03	-.009	.01
Individual differences measures	Dissociation	17.45 (*11.82*)	.12*	.13*	.05	.12*	.15**
	Trauma	16.56 (*14.52*)	.03	.08	.16**	.11*	.14*
	Depression	8.80 (*8.18*)	.08	.07	.08	.02	.09

Note. Overall false recognition rate is the mean across all 4 word lists; BPD, trauma-related, negative, and positive. Traditional BPD was measured using the SCID-II Personality Questionnaire (SCID-II) and the McLean Screening Instrument for Borderline Personality Disorder (MSI-BPD). AMPD-Criterion A was measured using the Borderline Personality Disorder Impairment Scale (BPD-IS). AMPD-Criterion B was measured using the Personality Inventory for DSM-5 Short Form (PID-5-SF). Dissociation was measured using the Dissociative Experiences Scale (DES). Trauma was measured using the Traumatic Life Events Questionnaire (TLEQ). Depression was measured using the Beck Depression Inventory (BDI).
**Correlations significant at the p < .01 level (2-tailed); *Correlation is significant at the p < .05 level (2-tailed).

false recognition rates are shown in Table 1. With respect to traditional BPD scores, we found a positive relation between false memory for positive word lists and participants' scores on the SCID-II and MSI-BPD. With respect to the AMPD-BPD Criterion A impairment facets, Identity Impairment was correlated with overall false memory in general, and with BPD-related as well as trauma-related false memory, in particular. Examining AMPD-BPD Criterion B, only Anxiousness was correlated with overall false memory. Next, we examined whether BPD symptoms were indirectly associated with false memory through the mediating roles of depression, traumatic experiences, and dissociation. For this purpose, first, we conducted a series of bivariate correlations between participants' false memory and their scores on BPD-related variables including depression, trauma, and dissociation (see Table 1). As shown in Table 1, there were no correlations between depression symptoms and false memory on any type of word list. There was, however, a significant positive correlation between false memory and participants' history of traumatic experiences and dissociation.3

Analysis of Indirect Effects

Next, we examined whether BPD symptoms were indirectly associated with false memory through the mediating roles of dissociation and traumatic experiences (Figure 2). Because depression was not correlated with false memory on any of the word lists, we did not include it in the models. In four separate models, we tested whether BPD (as measured by SCID-II) and false memory on each of the four-word lists was indirectly associated via scores on the measures of dissociation and traumatic experiences. Figure 2 illustrates the hypothesized mediation model of BPD and false memory.

Not surprisingly, participants' scores on the SCID-II were a strong predictor of their scores on the dissociation (ß = .50, p < .001) and traumatic experiences (ß = .36, p < .001) scales. Furthermore, dissociation contributed significantly to the prediction of BPD-related false memory (ß = .15, p < .05) and traumatic experiences contributed significantly to the prediction of negative false memory (ß = .16, p < .05). Regarding the indirect effects, we found that the effect of BPD (as measured by SCID-II) on false memory was mediated by dissociation (ß = 0.07, 95% CI = 0.007,

Table 2. Path standardized coefficients, p-values, and 95% confidence intervals for the mediation models

Models 1-4: The mediating effect of dissociation and trauma in the relation between BPD and false memory.	ß	p	95% Bootstrap CI
Model 1: BPD to BPD-related false memory			
Path a_1: BPD → DES	0.50	< .001*	
Path a_2: BPD → Trauma	0.36	< .001*	
Path b_1: DES→ BPD-related false memory	0.15	.02*	
Path b_2: Trauma → BPD-related false memory	0.01	.76	
Total effects (c)	0.008	.88	
Direct effects (c')	-0.07	.27	
Indirect effects:			
• BPD→DES→BPD-related false memory	0.077	-	0.007, 0.151†
• BPD→Trauma→ BPD-related false memory	0.007	-	-0.036, 0.053
Model 2: BPD to trauma-related false memory			
Path b_1: DES→ trauma-related false memory	0.10	.12	
Path b_2: Trauma → trauma-related false memory	0.04	.49	
Total effects (c)	0.10	.07	
Direct effects (c')	0.03	.61	
Indirect effects:			
• BPD→DES→trauma-related false memory	0.05	-	-0.015, 0.125
• BPD→Trauma→ trauma-related false memory	0.03	-	-0.026, 0.068
Model 3: BPD to negative false memory			
Path b_1: DES→ negative false memory	0.01	.81	
Path b_2: Trauma → negative false memory	0.16	.01*	
Total effects (c)	0.06	.29	
Direct effects (c')	-.005	.93	
Indirect effects:			
• BPD→DES→ negative false memory	0.007	-	-0.064, 0.078
• BPD→Trauma→ negative false memory	0.05	-	0.013, 0.110†
Models 1-4: The mediating effect of dissociation and trauma in the relation between BPD and false memory.	Standardized coefficients	p-value	95% Bootstrap CI confidence interval
Model 4: BPD to positive false memory			
Path b_1: DES→ positive false memory	0.06	.36	
Path b_2: Trauma → positive false memory	0.06	.26	
Total effects (c)	0.14	.01*	
Direct effects (c')	0.08	.22	
Indirect effects:			
• BPD→DES→ positive false memory	0.03	-	-0.028, 0.094
• BPD→Trauma→ positive false memory	0.02	-	-0.018, 0.082

Note. *statistically significant at the Bonferroni-corrected value of p < .008; †statistically-significant indirect effect.

Paths a1 and a2 were the same in all of the models. Dissociative Experiences Scale (DES) is the measure of dissociation.

0.151) for BPD-related word lists, and was mediated by traumatic experiences (ß = 0.05, 95% CI = 0.013, 0.110) for negative word lists. Table 2 shows the path standardized coefficients, p-values, and confidence intervals for mediation models.

Discussion

Many researchers and clinicians argue that memory impairment is often a consequence of BPD-related symptoms. However, to the best of our knowledge, there has been no prior research on false memory susceptibility in individuals with BPD symptoms using the standard DRM paradigm, a task that is known to elicit a high rate of false memory (cf. Schilling et al.,

2013 who used a visual-imagery version of the DRM paradigm). Here, we predicted that participants who scored high on the traditional BPD scale would be more prone to producing false memories. We found that the magnitude of the correlations between measures of BPD and DRM false memory were positive, albeit small. These small correlations are typically observed in personality and performance studies (e.g., Zhu et al., 2010), and our study is additionally novel because of the inclusion of the AMPD-BPD.

First, we predicted that individuals with higher scores on the BPD scale are more prone to producing DRM false memories than are participants with lower scores. Using scores on the SCID-II and MSI-BPD which measure traditional BPD, we found that participants with higher features of BPD had difficulty

Figure 1. A diagrammatic outline of the characteristics of BPD that might lead individuals with BPD to have heightened vulnerability to memory distortion
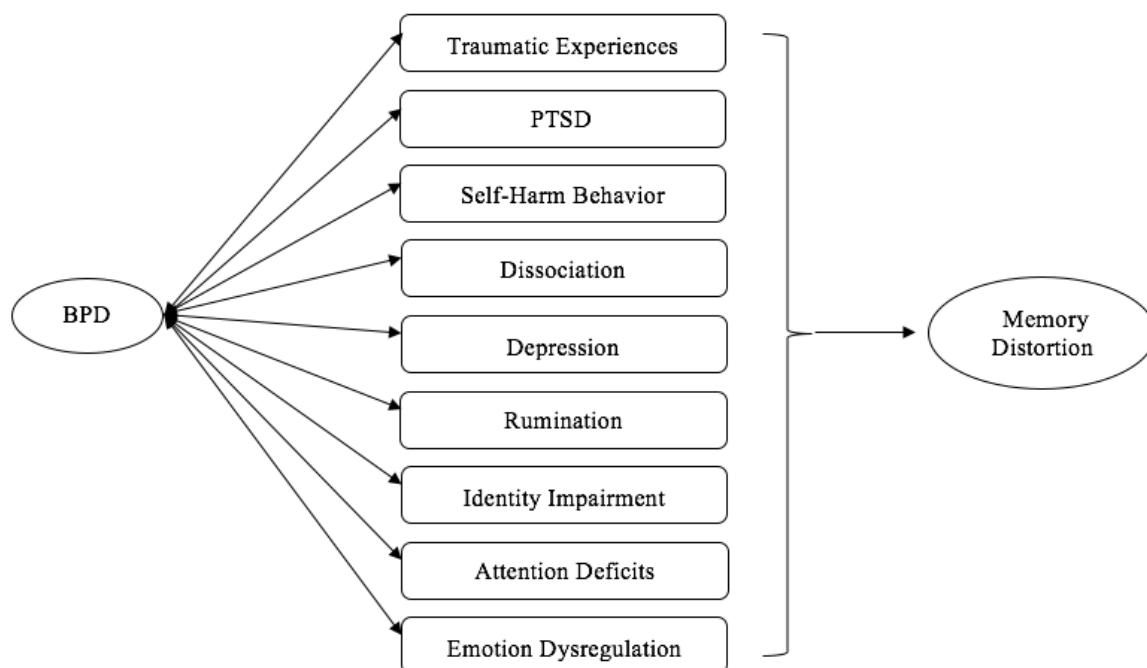
Figure 2. Hypothesized mediation model of BPD and false memory.
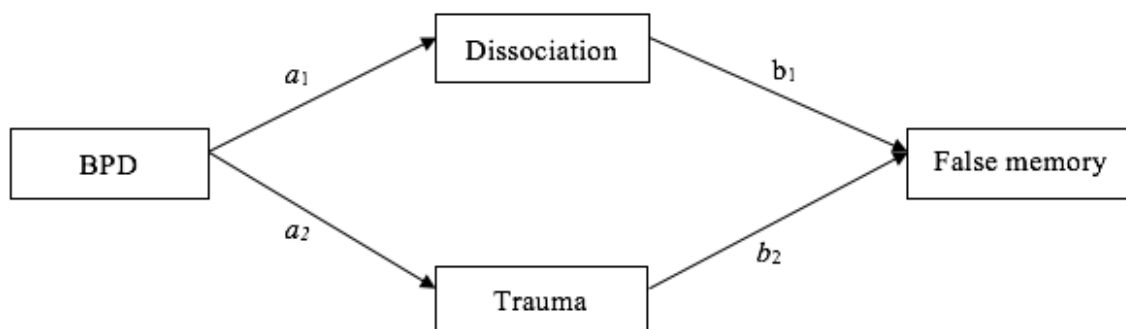
accurately encoding and recognizing positive information. Although the majority of research that has examined the effect of emotional material on attention and memory has focused on negative stimuli rather than on positive stimuli, there are a few exceptions. Contrary to our results, Korfine and Hooley (2000) found no difference between BPD patients and healthy controls in encoding and recalling positive words when they were directed to remember the words. However, when they directed participants to forget, healthy controls recalled more positive words than did BPD patients. Consistent with our results, Domes et al. (2006) found that, compared to healthy controls, BPD patients had reduced recall of positive words in a directed forgetting task, even when the positive words were cued as to-be-remembered. They also found that

BPD patients had reduced ability to inhibit negative words when cued to-be-forgotten. Ebner-Priemer et al. (2006) examined the recall bias in BPD and healthy controls and found that BPD patients demonstrated a negative recall pattern, whereas healthy controls demonstrated a positive recall pattern. Our findings add to existing literature that supports the idea that individuals with BPD may actively suppress or inhibit positive information (Hooley & Masland, 2019). Moreover, our results also highlight a limitation of the traditional system: a significant correlation between BPD, as conceptualized by the traditional system, and false memory does not tell us which specific components of BPD are associated with false memory; using the dimensional system with its constituent traits allows us to do that.

As is the case in previous studies using the categorical system. Ebner-Priemer et al. (2006) found that BPD symptoms and recall bias were related, but they failed to identify which features of BPD were associated with recall bias. Similarly, Beblo et al. (2014) found that BPD symptoms were correlated with subjective memory complaints in a clinical sample of BPD patients, however, they did not specify which particular BPD trait(s) were associated with memory problems. Park et al. (2012) found that dimensional scores of BPD were positively correlated with aspects of subjective memory impairment (i.e., heightened worry about memory and a lack of confidence in memory) in a non-clinical community sample, but they did not report which BPD traits were associated with memory impairment. Korfine and Hooley (2000) found that the BPD group recalled significantly more borderline words when they were instructed to forget. Korfine and Hooley also discussed their findings in terms of increased encoding for salient words and suggested that BPD patients tend to remember the themes which are related to BPD. But again, they did not examine which BPD traits predict remembering BPD-related themes, and none of these studies examined the AMPD.

Accordingly, here, we predicted that there might be particular constituent traits of BPD as opposed to the full "disorder" that might be related to DRM false memory. To test this hypothesis, we included the BPD-IS and PID-5 trait scales that measure the AMPD criteria for BPD. Recall that in the DSM-5 AMPD operationalization of BPD, self-functioning is defined by the two constructs of "identity" and "self-direction." We found that identity impairment was only correlated with the rate of false memories for the BPD- and trauma-related word lists, but not with the rate of false memory for the other word lists.

Although we recognize that the size of the correlations between identity impairment and false memory were small, we nonetheless argue that they are potentially important because they involve what many have argued is the core feature of BPD. The importance of identity impairment in developing and maintaining BPD is so critical that some scholars have argued that the core pathology of BPD patients can be found in an impairment of their identity integration (Kernberg, 1967, 1984). The basic assumption is that because many BPD individuals have experienced trauma during childhood and because these individuals experience dissociation to cope with trauma, they are unable to internalize different components of the self and important others into an integrated identity (Kernberg, 1976, 1984). While having a coherent sense of self requires understanding the self in relation to the past and in relation to one's psychological states such as emotions and attitudes (Campbell, 1997), BPD is characterized by a lack of understanding of mental states, thoughts, and actions in one's self and others; an inability to integrate them; and by having multiple versions of the self (Bo et al., 2017).

The sense of self in BPD is also commonly disturbed (i.e., frantic effort to avoid abandonment and self-harm behavior), unstable (i.e., unstable self-image and affective instability), empty (i.e., chronic feelings of emptiness), and traumatic and dissociated (Gold & Kyratsous, 2017). On the basis of these findings, we might conclude that BPD individuals appear not to have the capacity to correctly retrieve memories especially when they encounter information which is the cause (e.g., traumatic experiences) or effect (e.g., self-harm behavior) of their disturbed identity. Moreover, consistent with the fuzzy-trace theory (FTT)4 of false memory (Brainerd & Reyna, 2005), the relation between identity impairment and false memory might be due to gist extraction; that is, the thematic word lists that are salient to BPD individuals or that are consistent with their clinical description encourage gist-based responding and thereby increase false memories.

The correlation between identity disturbance and false memory can be further explained by the results of the test of our third hypothesis, where we found that the effect of BPD on false memory was mediated by traumatic and dissociative experiences. Dissociation allows individuals to mentally escape from overwhelming emotional or physical agony caused by trauma, where no actual physical escape is possible (Lanius, 2015; Sinason, 2002). In dissociation, the link between experience, memory, and identity is severed (Sinason, 2002). One of the underlying correlates of dissociation is identity disturbance, including an altered sense of self (Putnam, 1994), which also occurs as a response to trauma (Kernberg, 1967, 1984; Pollock et al., 2001). These parallel consequences of trauma are associated with disturbed memory encoding on free-recall tests, deficits in retrieving autobiographical memory, and difficulty in determining whether the remembered event is real or a pseudo-memory (Dorahy, 2001; Putnam, 1994; Vermetten & Spiegel, 2014). Thus, increased levels of false memory in BPD via the mediating role of trauma and subsequent dissociative states might be due to the difficulties that individuals have in monitoring the source of their memories in the DRM paradigm. In other words, due to increased activation of BPD- and trauma-related words, they are more likely to generate false memories that are consistent with the gist of these lists.

Regarding the role of depression in false memories, in contrast to some studies (Joormann et al., 2009) and in line with some others (Howe & Malone, 2011; Storbeck & Clore, 2005; Turner, 2011), we did not find any correlation between depressive symptoms and

higher false recognition for any type of word list. In line with previous studies (Storbeck & Clore, 2005), we suggest that the impact of mood on false memory creation might be due to differences in encoding5, rather than retrieval processes. This finding sits well with the affect-as-information approach, which argues that negative mood promotes detailed, or "item-specific" processing, and may subsequently reduce false memory (Clore et al., 2001; Zhang et al., 2017). Moreover, in terms of fuzzy-trace theory, negative mood might impair gist processing; implying that item-specific encoding might reduce individuals' access to the semantic gist representations which subsequently result in reduced false memory (Storbeck & Clore, 2005).

Also, in contrast to previous studies (e.g., Brennen et al., 2007; Moradi et al., 2015), we did not find a correlation between traumatic experiences and higher DRM false memory for trauma-related stimuli. Moreover, the mediation models of BPD also failed to predict false memories for trauma-related information. Windmann and Krueger (1998) suggest that traumatized individuals not only are more inclined to falsely recognize critical lures for trauma-related information but also, they tend to over-interpret many non-trauma-related stimuli as trauma-related. In the present study, however, we did not find support for a response bias for trauma-related information. Goodman et al. (2011), who constructed the trauma-related word lists that we used, argued that these word lists motivate more relational processing for free recall and consequently induced increased false memory, but in a recognition task, these word lists induced greater item-specific processing and subsequently result in reduced false memory. Moreover, it is also possible that the nature of the trauma-related word lists (e.g., rape, sex) which are distinctive, and taboo might cause even more item-specific processing (e.g., sick, lie; Goodman et al., 2011). Correspondingly, those individuals with a history of traumatic experiences showed better memory for trauma-related word lists than for simple negative word lists. In a similar vein, some researchers have found that individuals with traumatic experiences have a memory bias which supports accurate memory for trauma-related information, but they are more prone to produce false memories for other information (e.g., McNally et al., 1998).

Limitations and Future Directions
Our conclusions need to be tempered by some limitations to our research. First and foremost, our observed effect sizes were small; we believe that the size of these correlations is likely owing to the hetero-method design of the current study. Indeed, personality and performance data associations are often in this range (e.g., Zhu et al., 2010). Thus, in light of expected weak correlations, we were unable to correct for family-wise error, which increases the possibility that some of these results were due to Type I error. Second, all of the BPD measurement was via self-report questionnaires. Although this approach is commonplace in personality and psychopathology research, self-report has been associated with high false positive rates of BPD symptomatology relative to structured clinical interviews (Hopwood et al., 2008). Third, a non-clinical sample of university students might both influence the results as well as limit their generalizability. For example, non-clinical participants manifest BPD symptoms to a much lesser degree, which introduces range restriction, likely in both BPD symptoms and in false memory dysfunction, potentially attenuating the magnitude of the correlations. If this is true, we would predict that the strength of the correlations we observed here would be even stronger in a clinical population. This prediction remains to be tested. Future research should replicate and extend our findings using structured clinical interviews to measure BPD symptoms and examine their associations with DRM false memory in clinical populations.

Conclusion
Taken together, the findings of the current study suggest that there might be a role for identity impairment and traumatic and dissociative experiences in increasing the likelihood of false memory in the context of BPD. Because of what we know about the role of memory dysfunction in the maintenance of depressive and trauma-related disorders (Dalgleish & Werner-Seidler, 2014; Otgaar et al., 2017), false memory might also contribute to the maintenance of BPD-related dysfunction. Furthermore, because the focus of the treatment of BPD relies heavily on patients' reports of experiences they have had in the past (e.g., schema therapy, transference-focused therapy), it is important to expand this line of research in clinical and treatment settings.

Footnotes
[1] In this study, we used the term "false memory" to describe the kind of memory errors produced by the Deese/Roediger–McDermott paradigm (see our introduction for the full description). It is important to note that the normal population create false memories for everyday life situations all the time, and false memory is mostly seen as an error in memory function (i.e., error of commission), not a stigma. Thus, we do not view false memory as a phenomenon that can further stigmatize individuals with BPD features. Instead, we see false memory as a channel through which we can further understand how BPD features

impact memory function (i.e., remembering prior events) and what sort of information triggers higher rates of false memory among individuals with BPD features. It is also important to note that false memory creation does not suggest unreliability. Despite the adverse impact of lying on memory and beliefs (see Otgaar & Baker, 2018), lying is the intentional provision of incorrect information, whereas false memory is a memory commission error, of which individuals are not aware.

[2] As suggested by previous studies (Schönbrodt & Perugini, 2013), to achieve stable correlation estimates that are more likely to reflect the population effect, our sample size was greater than 250.

[3] To examine whether our small effect sizes were due to a lack of statistical power, we conducted a post-hoc power analysis using G*Power (Erdfelder et al., 1996). For the statistical power analysis, we used the sample size of 298, on the basis of our weakest significant correlation (r = .11, p < 05). A post-hoc power analysis revealed that the statistical power for this study was .47 for the detection of small effect sizes. Thus, due to limited statistical power, it is likely that our small effect sizes can be attributed to sample size.

[4] According to FTT, memory is not unitary, but, rather, two independent memory traces are formed when we experience an event; gist traces are memory representations of relational information (i.e., the general meaning of the event), and verbatim traces are item-specific features of that information (i.e., the exact details of an experience; Brainerd & Reyna, 2012; Brainerd et al., 2008; Calado et al., 2018; Wang et al., 2019). When we experience an event, gist and verbatim traces will be encoded in parallel and are stored separately in memory. Therefore, gist and verbatim traces can be elicited independently by different cues (Reyna & Lloyd, 1997). It is also argued that verbatim traces will fade rapidly, whereas gist traces can be retrieved after a long delay (Wang et al., 2019). Because it is difficult to remember the details of the event as time passes, people rely primarily on the general meaning of the event which may contain associations between the memory of the event and the information, eventually causing false memories (Calado et al., 2018). In this way, a reliance on gist processing evokes higher false memories (Brainerd & Reyna, 2002).

[5] Encoding can be accomplished in two ways--item-specific and relational processing (Hunt & Einstein, 1981). In item-specific processing, the items will be encoded by their characteristics, elements, and distinctive qualities. In relational processing, the items

will be encoded in association with other concepts in memory (Storbeck & Clore, 2005). Hege and Dodson (2004) suggest that when people focus on the distinctive features of items, the critical lures in a DRM test are less likely to be activated and recalled, thus the probability of creating false memory will decrease (Arndt & Reder, 2003). Therefore, the creation of false memories also depends on the false memory paradigm with which participants are tested and the extent to which relational or item-specific processing is involved (Storbeck & Clore, 2005).

Additional Information

Abbreviations
BPD: Borderline Personality Disorder; DRM: Deese-Roediger-McDermott paradigm; DSM-IV: Diagnostic and Statistical Manual of Mental Disorders, 4th edition; AMPD: Alternative Model of Personality Disorders; PTSD: Posttraumatic Stress Disorder; MSI-BPD: McLean Screening Instrument for Borderline Personality Disorder; SCID-II: Structured Clinical Interview for DSM-IV axis II disorders; BPD-IS: Borderline Personality Disorder Impairment Scale; PID-5-SF: Personality Inventory for DSM-5 Short Form; BDI: Beck Depression Inventory; DES: Dissociative Experiences Scale; TLEQ: Traumatic Life Events Questionnaire; FTT: Fuzzy-Trace Theory.

Supplementary Materials
Supplementary materials for this article can be viewed here:
https://osf.io/np58z/files/osfstorage/646bf2b6f4be380 15062bb17

Conflict of Interest
The authors have no conflict of interest to declare.

Ethical Approval
The research was reviewed and approved by the University of Otago Human Ethics Committee (Health), which is accredited by the New Zealand Health Research Council and whose guidelines are consistent with those of the American Psychological Association. All participants provided written, informed consent.

Data Availability
Because sharing the data would violate confidentiality and participants did not consent for their data to be publicly available, we are unable to share the data.

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Appendix

DRM Word Lists used in the current study

BPD-related word lists			Trauma-related word lists (from Goodman et al., 2011)		
Critical lure: **Impulsive**	Critical lure: **Loneliness**	Critical lure: **Self-harm**	Critical lure: **Sex**	Critical lure: **Secret**	Critical lure: **Rape**
Thoughtless	Sad	Suicide	Intercourse	Confidential	Statutory
Anger	Alone	Depression	Orgasm	Hush-Hush	Non-consensual
Quick	Empty	Hurt	Cum	Undisclosed	Molest
Unpredictable	Sadness	Cut	Gender	Classified	Violated
Rash	Isolation	Pain	Shag	Mystery	Abuse
Fast	Dark	Depressed	Hump	Restricted	Torture
Fight	Solitude	Knife	Partners	Conceal	Degrade
Spontaneous	Apart	Blood	Love	Silence	Struggle
Reckless	Lost	Lonely	Babies	Betrayal	Violent
Uncontrolled	Unhappy	Wrist	Laid	Taboo	Force

Positive word lists			Negative word lists		
Critical lure: **Happy**[1]	Critical lure: **Nice**[1]	Critical lure: **Beautiful**[2]	Critical lure: **Lie**[1]	Critical lure: **Sick**[1]	Critical lure: **Kill**[2]
Glad	Pleasant	Gorgeous	Fib	Ill	Assassinate
Pleased	Polite	Stunning	Deceive	Illness	Slay
Joyful	Compliment	Picturesque	Deception	Flu	Slaughter
Content	Considerate	Breath-taking	Cheat	Nausea	Murder
Elated	Genial	Pretty	Untruthful	Cough	Execute
Satisfied	Sweet	Lovely	Dishonest	Virus	Massacre
Laugh	Thoughtful	Exquisite	Mislead	Fever	Stab
Enjoyment	Friend	Striking	False	Vomit	Behead
Ecstatic	Amiable	Attractive	Betray	Cold	Homicide
Enjoyable	Smile	Elegant	Trick	Hurt	Shoot

[1] from Zhang et al., 2016

[2] from Palmer & Dodson, 2009