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Anna Thompson's starving children: Emotion regulation and verbal memory in borderline personality disorder

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ANNA THOMPSON'S STARVING CHILDREN:
EMOTION REGULATION AND VERBAL MEMORY IN
BORDERLINE PERSONALITY DISORDER

by

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To date, a relatively small body of neuropsychological research has focused on individuals diagnosed with borderline personality disorder (BPD). Findings vary across studies, with many noting problems with various aspects of impulsivity, attention, and memory. Only one previous study has examined the impact of emotional dysregulation on cognitive processes in this population. Given that problems with modulating emotions are one of the hallmark signs of BPD, the interaction between emotions and cognitive processes seems a crucial consideration in working with individuals with this disorder. The current study examined the relationship between performance on a standard measure of verbal memory, the Logical Memory (LM) portion of the Wechsler Memory Scale, 3rd Edition (WMS-III, Wechsler, 1997b), and emotion regulation, as measured by the Affective Control Scale (Williams, Chambless, & Ahrens, 1997) in a sample of 56 outpatients with BPD. No relationship was noted between level of emotional dysregulation and performance on LM. A manipulation check with 15 inpatients with BPD or BPD features indicated that Story A (Anna Thompson) was rated as more emotionally intense than Story B (Joe Garcia), even when stories were counterbalanced for order of presentation. Results suggested that individuals with BPD have better memory for emotionally evocative stories than for those with a more neutral content, whether the stories are presented in standardized order or are counterbalanced. However, when differential performance for the two stories in the BPD group was compared to performance by a group of healthy controls (n = 38), the same pattern of better performance for the Anna Thompson story was noted. Controls earned scores above the BPD group across LM immediate and delayed recall and recognition. A trend was noted for a positive relationship between a simple measure of attention and immediate recall of the stories but not for delay. No relationship was found between current level of depression and story recall. Results are discussed in terms of implications for therapy and assessment in the BPD population.

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Introduction

Borderline personality disorder (BPD) is complex, manifesting in a variety of presentations. According to the American Psychiatric Association's (APA) Diagnostic and Statistical Manual, 4th Edition, Text Revision (DSM-IV-TR, APA, 2000), the descriptive criteria for BPD include nine possible symptoms, only five of which must be exhibited for diagnosis. These specifiers yield a total of 126 different ways in which borderline diagnostic criteria can be met, if only five criteria are in evidence. In addition to numerous variations within the diagnosis of "pure" BPD, the disorder is notable for its high level of comorbidity with a number of other disorders, including substance abuse disorders (Casillas & Clark, 2002; Grilo et al., 1997; Joyce et al., 2003; Ross, Dermatis, Levounis, & Galanter, 2003), depression and other mood disturbances (Comtois, Cowley, Dunner, & Roy-Byrne, 1999; Joyce et al., 2003), social phobia (Comtois et al., 2003), and posttraumatic stress disorder (Comtois et al., 2003; McGlashan et al., 2000; Zlotnick, Franklin, & Zimmerman, 2002). Indeed, many researchers note that individuals with "pure" BPD diagnoses, without comorbid Axis I or Axis II psychopathology are so rare that, not only is research with such individuals almost impossible to conduct, results of such studies would be questionable in terms of external validity (Donegan et al., 2003).

This level of complexity highlights the need to develop a clearer understanding of BPD through the lens of characteristics that represent common components of the disorder, regardless of other features. Emotional dysregulation has been proposed as the core feature of BPD by Linehan (1993a). The development of effective emotion regulation abilities has been conceptualized as being rooted in early childhood environment (Meares, Stevenson, & Gordon, 1999; Saarni & Crowley, 1990; G. J. Taylor, Bagby, & Parker, 1997; van der Kolk, 1996). Several recent studies investigating the neuroanatomical and cognitive aspects of BPD echo the call for consideration of emotional dysregulation as a critical aspect of BPD. Donegan et al. (2003) place emphasis on the apparent role of the amygdala in the difficulty that individuals with BPD often experience in making judgments regarding others' facial expressions, as well as observing that past research supports the role of this same structure in mood disorders (Drevets, 1998), generalized anxiety (Thomas et al., 2001), and PTSD (Rauch et al., 2000). Other research implicates malfunction of the medial prefrontal cortex, leading to poor inhibition of the amydala, as an important aspect of poor modulation of emotional reactivity in individuals with history of abuse and trauma (Bremner et al., 2004). This latter point is significant, given the high rates of trauma reported by individuals with BPD (McGlashan et al., 2000; Sar et al., 2003; Zlotnick et al., 2002).

The relationship between brain function and emotion regulation is complex, however. As noted by Monarch, Saykin, and Flashman (2004), one's ability to modulate emotional responses appears to have an interactive relationship with cognitive processing. Because therapy is typically a verbally-based activity, the interaction between affective instability and verbal memory seems particularly salient. Individuals with BPD comprise a larger percentage of inpatient populations than in the general community (Sansone, Gage, & Wiederman, 1998; Widiger & Weissman, 1991), suggesting that they are likely to be in settings in which neuropsychological assessment may occur. Clarifying the relationship between emotional and cognitive dysregulation offers the opportunity to apply this knowledge to therapeutic interventions for individuals with BPD and may shed light on assessment issues in this population. The current study addresses disturbances in affect regulation in adults with BPD diagnoses and the relationship between such dysregulation and performance on a standardized verbal memory task, with consideration for factors that have been shown previously to affect memory, such as attention and depressive symptoms.

Following is a review of several aspects of the relevant literature. First, theories regarding the development of BPD are explored. This is followed by an analysis of current theories about emotions in BPD populations, including definitions of emotion regulation and specific strategies for modulating affect. Neuroanatomical and neuropsychological aspects of memory and emotion regulation are covered next. Finally, the paper provides an overview of recent research regarding the interaction between emotions and memory; this final section addresses only samples without BPD, as no literature examining the interaction of these variables in BPD samples has been published to date. Given the wide variety of research on emotion regulation over the past two decades, some clarification of terminology is in order. The terms "emotion regulation" and "affect regulation" will be used interchangeably to refer to management of emotions.

Two Theories Regarding Development of Borderline Personality Disorder (BPD)

BPD affects 0.4% to 2% of the general population and 10% to 25% of the clinical population at some point in their lifetime, with females being diagnosed with the disorder much more frequently than males (D. M. Johnson et al., 2003; Paris, 1999; Trull, Stepp, & Durrett, 2003; Widiger & Weissman, 1991). As with most psychological disorders, there are a number of theories regarding the etiology of BPD. Although BPD can be conceptualized from a number of different perspectives, two major approaches are traditional psychodynamic theory and Linehan's (1993a) biosocial model.

Psychodynamic theories regarding BPD date back to the concept of "hysteria," whose symptoms were eventually dispersed among a number of disorders, with three disorders carrying the majority of the original "hysterical" symptom set: somatization disorder, dissociative identity disorder, and borderline personality disorder (American Psychiatric Association, 1980; Herman, 1992). The term "borderline" originally was applied to individuals who did not fit neatly into either the "neurotic" or "psychotic" diagnostic labels by which disorders were categorized in early psychodynamic thought, indicating that individuals with a "borderline" disorder could vacillate between the two poles depending on severity of the disorder, environmental circumstances, and current level of stress (Kernberg, 1975; Stern, 1938, 1948). Historically, this approach views BPD symptomatology as springing from a childhood history in which the mother has failed to provide appropriate attention and nurturing for the developing child, often responding to the child in an erratic manner (Stern, 1938). In turn, the young child may experience feelings of excess aggression toward the mother and have difficulty synthesizing conflicting negative and positive emotions, leading to the classic "splitting" phenomenon that is often viewed as a hallmark of the borderline personality (Kernberg, 1975). Traditional psychoanalytic treatment is targeted primarily at resolving unconscious conflicts within the client, through the use of transference in the therapeutic relationship (Stern, 1938, 1945). For several decades, even traditional psychoanalysts have recognized the value of modifying therapeutic technique for individuals with BPD, however, employing a more directive and somewhat confrontational approach with this population in relation to their responses and behavior in session (Stern, 1945).

Recently, many analysts have pinpointed the management of affect as a central issue in working with this population (Kernberg, 2003), albeit with a focus on the relationship between unconscious defenses and negative emotions such as anger. However, even researchers with psychoanalytic alliances point out the flaws in employing traditional psychoanalysis in isolation. As noted by (Westen, 1991), "Psychoanalytic theory ... focus[es] primarily on one important class of affect-regulatory mechanisms --- unconscious defenses --- without adequately addressing conscious techniques for self-regulation other than 'insight'." He goes on to state that an exclusive focus on insight does little to implement change in clients, pointing out that insight into the fact that one regularly only accesses negative images of the self, for example, is of little benefit for individuals with BPD, for whom accessing positive images may be linked to past experiences that had aversive consequences. Westen continues in his critique of traditional psychoanalysis by stating that this approach often overlooks the power of cognition and social learning in the development and maintenance of BPD. Additionally, he criticizes the place of affect in psychoanalytic thought, stating that problems with affect regulation often are not recognized by therapists focused on unconscious drives. Finally, Westen (1991) suggests that, just as the micro-management of specific symptoms may be a problem for cognitive behavioral therapists, the tendency to only view the individual as a whole interactive system also may blind analysts to specific behavior problems in clients with BPD, limiting the effectiveness of treatment.

Although behavioral theories regarding the development of BPD share some concepts with psychodynamic theory, agreeing that early life experiences play a role, they generally vary from psychodynamic thought by placing greater emphasis on the influence of social environment and biological makeup. Linehan's (1993a) biosocial model regarding the development and maintenance of BPD symptomatology posits that it is the combination of some degree of biological predisposition toward emotional vulnerability, together with an invalidating environment that gives rise to the symptoms of BPD (McMain, Korman, & Dimeff, 2001). Per Linehan's model, biological components may include "genetic, intrauterine, and developmental factors affecting physiological development" (Wagner, 1995). McMain and colleagues (2001) summarize Linehan's outlook on the role of emotional vulnerability in BPD:

> "The etiology of emotion dysregulation in individuals with BPD is viewed as resulting from the transaction between biological anomalies and an invalidating environment.... Initially, these biological irregularities are thought to result in emotional vulnerability, characterized by high sensitivity to emotional stimuli, emotional intensity, and by slow return to emotional baseline."

In other words, such emotionally vulnerable individuals are more likely than the average individual to experience emotions in reaction to situations and events that others find less affectively stimulating. In addition, once emotions are triggered, they are inclined to be more extreme than for those without such vulnerability. Finally, these individuals are apt to be more challenged by the task of bringing emotional reactions back into check, requiring a longer period to do so than in individuals without such vulnerabilities. The tendency toward emotional vulnerability and dysregulation is conceptualized as being at the heart of many of the characteristics of BPD, as many of the behaviors outlined as diagnostic criteria for the disorder can be thought of as attempts to modulate extreme emotions or as direct results of emotion dysregulation. Many researchers from other theoretical backgrounds agree with the concept that affect regulation disturbances form the core of many of the problems observed in those with BPD (Westen, 1991). As described later, recent research in neuroimaging and neurocognitive assessment in BPD samples also aligns well with Linehan's concept of biological vulnerability.

The other side of the biosocial model of BPD is the environment. An invalidating environment is one in which children's internal perceptions, thoughts, sensations, and interpretations are negated or are responded to in an inconsistent, erratic manner, leading children to doubt their own internal experiences and emotions (Linehan, 1993a). Such an environment may be openly abusive, or invalidation may be more subtle, manifesting as lack of attention to and appropriate mirroring of the child's emotional experience. According to biosocial theory, both living in a mildly invalidating environment for an individual with greater emotional vulnerability, and living in a markedly invalidating or frankly abusive environment for an individual with lower affective sensitivity, may be related to symptoms of BPD.

Linehan proposes that individuals with BPD experience problems with dysregulation across five domains: 1) emotions, 2) interpersonal relationships, 3) behavior, 4) cognitive processing, and 5) sense of identity. As noted earlier, according to Linehan (1993a), emotion dysregulation forms a central component of BPD, from which many of the other four dysregulation problems may originate. A central consideration of the current research is the relationship between emotions and cognition in individuals with BPD. Linehan's theory implies that high intensity affect that is poorly modulated may negatively affect cognitive processing, and poor cognitive performance may be internally evaluated in a negative light by individuals with BPD, creating further emotional distress. Obviously, emotional dysregulation may have an interactive relationship with other aspects of the disorder as well. For example, poor regulation of emotions may contribute to interpersonal problems when others do not understand the intense and dysregulated emotional reactions of individuals with BPD. Behavioral dysregulation, such as erratic sleep patterns, may negatively affect an individual's ability to modulate emotions, effectively shifting the threshold for triggering emotional responses and potentially disrupting normal cognitive functioning. Alternatively, emotion dysregulation might lead individuals to attempt to alter mood by engaging in maladaptive behaviors such as self-mutilation or alcohol abuse. Although affective dysregulation is just one aspect of BPD in this theory, it is worth noting that this type of dysregulation was also the defining feature of BPD relative to the other "borderline psychotic" disorders noted by (Spitzer, Endicott, & Gibbon) in a 1979 survey of American psychiatrists. This research first defined BPD as a separate diagnostic category in the DSM-III (APA, 1980). At that time, BPD was conceptualized as centering around three primary symptom clusters: 1) affective instability, 2) identity/self disturbance, and 3) impulsivity; cognitive dysregulation was not included in the original formulation, however (APA, 1980; Linehan, 1993a)

The biosocial model of BPD has gained enthusiast acceptance in much of the therapeutic community, but it is not universally supported. Other theorists endorse an approach that recognizes the contributions of both environment and biological inheritance but take issue with some aspects of Linehan's formulation regarding the development of BPD. Graybar and Boutilier (2002) state that they are dismayed by the ways in which trauma researchers present data connecting childhood trauma and BPD, and they purport to argue against Linehan's (1993a) formulation regarding the origins of the disorder. Close analysis of Graybar and Boutilier's (2002) argument reveals they actually are restating much of Linehan's theory, albeit with a stronger emphasis on nature than on nurture. They submit that four additional factors bear consideration in research regarding the etiology of BPD: evolutionary load, temperament, affective disturbance, and neurological factors. Evolutionary load includes those features of personality related to the need to maintain attachment and the fear of losing it; this factor is poorly elaborated by the authors, however, and no proposals regarding research are included. Temperament includes "susceptibility to emotional stimulation, ...customary strength and speed of response, the quality of ...prevailing mood, and all peculiarities of fluctuation and intensity of mood," appearing to be remarkably similar to Linehan's concept of biologically based emotional vulnerability. Affective disturbance initially appears to be analogous to Linehan's affect dysregulation concept. However, Graybar and Boutilier (2002) propose that it is rooted in "inherent" temperament, with little to no mention of family environment or the effects of learning, in contrast to Linehan, who discusses it as an outgrowth of poor match between biological sensitivity and family response, or an invalidating environment. Finally, these authors propose that neurological factors are an important consideration. Interestingly, this aspect of BPD is discussed in Graybar and Boutilier's article as though it has a unidirectional, causal relationship with the disorder. Although recent research has noted neurological and cognitive abnormalities that are associated with the disorder, currently, there are no solid data regarding causality. It is possible that many of the neurocognitive deficits found in individuals with BPD are influenced by the emotional dysregulation they experience on a daily basis (including when they are being tested). Additionally, although the strong possibility exists that many people labeled as BPD do indeed have a history of intrauterine or early developmental neurological trauma (see, for example, Kimble, Oepen, Weinberg, Williams, & Zanarini, 1997), it is also true that the developing human brain is plastic. Just as our brains respond to chemical and physical assaults by agents such as fetal alcohol exposure or traumatic brain injury, factors in our early environment, such as emotional abuse and neglect or detached parenting styles, also may influence neurocognitive development.

BPD: Course and Prognosis

Traditionally, mental health professionals have approached individuals with a diagnosis of BPD with trepidation or dislike, avoiding them because of their complexity, their extreme behaviors, and the perception that they are incapable of change. Herman (1992) cites an anecdote from Lazarus, describing an incident in which a psychiatry resident was told by a supervisor that the way to treat a borderline is to "refer them." Nevertheless, recent research indicates that many individuals with BPD can make positive changes over time. In a 6-year longitudinal study of inpatients at McLean Hospital, Zanarini and colleagues (2003) found that of 290 patients diagnosed with BPD at the start of their study, "34.5% met criteria for remission at 2 years, 49.4% at 4 years, 68.6% at 6 years and 73.5% over the entire follow-up." Most subjects received multiple and varied treatments over the course of the study. Recurrence rates were low, with only 5.9% of the remission group experiencing recurrences, suggesting that once an individual with BPD progresses to the point of meeting criteria for remission, likelihood of recurrence is minimal. These results differ dramatically from findings in prior research (see for example, Stone, 1994) and contradict traditional thinking regarding long-term outlook for individuals with BPD.

In the McLean Hospital study, participants were assessed across several domains of functioning and symptomatology, including affective, cognitive, and interpersonal spheres, and they were compared to individuals with other Axis II psychopathology. In spite of the high rate of recovery observed in this study, the BPD group remained "symptomatically distinct" from the group who had never been diagnosed with BPD, even after remission (Zanarini et al., 2003). Impulsivity symptoms generally were the first to disappear, and affective symptoms were the most chronic. Although the study was naturalistic, allowing no means for accounting for the influence of different treatment strategies, the pattern of recovery observed highlights the need for research aimed at increasing our current understanding of specific symptoms of BPD, in particular the apparently more intransigent affective disturbances.

Emotion Regulation: Background and Current Theory

Over the past two to three decades, empirical research supporting the connection between disturbances in emotion regulation and psychopathology has grown enormously. However, the relationship between a person's emotion regulation skills and mental health is not new to psychology; several authors have noted that in Freud's theory (1977), defense mechanisms act to redirect emotional impulses and control anxiety (Barrett & Gross, 2001). Other theorists have pointed to the role of facial expressions and social display rules as critical aspects of human evolutionary development (Darwin, 1999; Duchenne de Bologne, 1990; Izard, 1992). In the 1960's, Tomkins renewed psychology's interest in facial expressions with the publication of *Affect, Imagery, Consciousness* (1963), and inspired a new generation of researchers to investigate the role of emotional expression and control of emotions in human social interaction and mental health (Bonanno, 2001; Ekman, 1993; Izard, 1994).

Defining emotion regulation

Gross and Munoz (1995) propose that emotion regulation is the key to mental health; however, the exact mechanisms involved in the process are elusive. Some theorists describe emotion regulation simply as "behavior aimed at changing feelings in a desired direction," adding that both physiological changes and cognitions should be included under the general heading of "behavior" (Saarni & Crowley, 1990). Dodge (1989) defines emotion regulation as "the process by which activation in one response domain serves to alter, titrate, or modulate activation in another response domain." Barrett & Gross (2001) echo this view when they propose that emotion regulation consists of two elements: 1) "accurately tracking one's emotional state," and 2) "knowing how and when to intervene to shape the emotion trajectory as needed." In this paradigm, emotion regulation is viewed as a combination of neurophysiological, cognitive, and behavioral processes in the individual, interacting with supportive or disruptive elements in the environment (Dodge, 1989). Other authors, although recognizing the importance of biological and behavioral factors, view emotion regulation from an information-processing perspective (Garber, Braafladt, & Zeman, 1991). According to these theorists, problems with emotion regulation can be linked to deficits in one of the following, sequential steps in its process: 1) *perception* of emotions, 2) *interpretation* of emotions, 3) identification of the *goal* of emotion regulation, 4) *response generation*, 5) *response evaluation*, and *enactment* of emotion regulation strategies (Garber et al., 1991).

Westen (1998) summarizes much of affect regulation theory by stating that emotion regulation consists of "...conscious or unconscious procedures used to maximize pleasant and minimize unpleasant emotions. By this definition, affect regulation is purposive. It is aimed at one goal: managing affect...." Tomkins (1991) adds two more goals: the need to limit affect inhibition, or the need to *feel* one's emotions, and the need to feel a sense of efficacy in our ability to modulate our emotions. Westen (1998) states that in many ways the regulation of emotions is based on procedural knowledge that has been developed through experience, adding that implicit knowledge regarding the affective tone of various circumstances is triggered by events that are similar to previous experiences. As such, emotion regulation strategies are chosen automatically, based on how well the current situation matches a previous event in which one has used the strategy as a successful solution to the problem of undesired affect.

Recent definitions by Thompson (1994) agree with Westen's view of emotion regulation as purposive, but depart from his conceptualization in terms of the locus of regulatory mechanisms. Thompson states that emotion regulation involves "intrinsic processes," akin to Westen's concept of implicit knowledge developed through experience, as well as "extrinsic processes," which include things such as social relationships that modify an individual's awareness of and ability to modulate affect. Thompson and other theorists (e.g., Magai & Passman, 1998) posit that interpersonal domains exert almost as much influence over emotion regulation as intrapersonal processes. From this vantage point, individuals with BPD who experience both affective and interpersonal dysregulation problems are at a distinct disadvantage in managing emotions. Indeed, many theorists have observed that individuals with BPD often seem to be least troubled when they are in the midst of a supportive relationship (Linehan, 1993a), lending credence to the role of friends and family as potential reflectors of and buffers for an individual's affective experience.

From the point of view of many biologically oriented theorists, emotion regulation can be viewed as a type of homeostatic mechanism, analogous to those that maintain physiologic equilibrium in the human body, such as the regulation of blood pressure and serum glucose levels. Saarni and Crowley (1990) posit that emotion regulation begins as a simple reflex in the newborn and can be thought of as "a biological drive toward adaptation to environmental change." They are quick to add that affect regulation also may be effortful and influenced by cognition, particularly as an infant develops and gains experience in its environment. Taylor, Bagby, and Parker (1997) subscribe to a similar view of affect regulation as a means of maintaining emotional balance. Bonanno (2001) elaborates on this idea by explaining the concept of open versus closed feedback loops in the human body. An open feedback loop is more or less a preset cascade of events that continues until it reaches its conclusion; the classic example of this in the human body is the process of labor and ultimate delivery of a newborn infant. In contrast, closed feedback loops can be conceptualized have having a "thermostat" or preferred level of balance that needs to be maintained for optimal functioning. Bonanno (2001) proposes that in the healthy individual, emotion regulation processes comprise a closed system. Although many of the activities of both types of systems are dependent on automaticity, or as described by Saarni and Crowley (1990), reflexive responses, both open and closed feedback systems can be affected by instrumental behaviors on the part of the individual. In the case of emotions, human beings can engage in behaviors such as distraction to modulate emotions, just as they can engage in meditation to influence a physiological closed feedback system such as blood pressure.

Barrett and Gross (2001) propose that there are five major time points in the generation of emotions at which an individual can intervene to restore balance: 1) situation selection, 2) situation modification, 3) attentional deployment, 4) cognitive change (such as reframing), and 5) response modulation (such as suppressing an emotional response). In a discussion of recent trends in research on emotion regulation and health, Barrett and Gross (2001) observe that although various studies have revealed seemingly contradictory results, differences can be accounted for by considering antecedent versus response focused strategies. They propose that the first three points in the above sequence constitute primarily antecedent-focused strategies, related to modifying one's exposure to emotion-evoking situations. Antecedent-focused strategies are generally associated in the research literature with maintaining psychological well-being. The latter two approaches represent response-focused strategies, aimed at modulated the emotions one is already experiencing. Particularly in the form of emotional suppression, response focused strategies have been correlated with negative physical health outcomes (e.g., Gross & Levenson, 1997; Pennebaker, Kiecolt-Glaser, & Glaser, 1988). Failures at each of the five points of the emotion regulation chain can be observed in many individuals with BPD. Indeed, DBT skills training includes a primary focus on helping participants recognize these points in the chain when they occur and learning to respond appropriately (Linehan, 1993b).

Specific emotion regulation strategies

Research over the past two decades suggests that there may be links between particular disorders and the use of different emotion regulation strategies. These strategies may be antecedent-focused or response-focused, implicit and automatic or explicit and effortful, depending on the strategy, the situation, and the individual. The current study focuses primarily on response-focused strategies, in that participants are not warned about the potential for exposure to emotionally evocative material prior to listening to the stories that make up the verbal memory portion of the study. Although it is possible that participants could dissociate and "tune out" the stories as they listen, thus altering their level of exposure to the material, the demands of the task's instructions are likely to decrease this behavior. If participants experience distress as they listen, they may respond to the story content in a manner that will alter emotions they are already experiencing. Response control strategies for emotion regulation are generally conceptualized as occurring later in the sequence of affective experience, once an individual has been exposed to an emotional trigger and has noted, consciously or subconsciously, an internal response. Just as individuals with a BPD diagnosis may engage in behaviors that decrease experience or awareness of emotions, they also may react to the experience of emotions through response-focused strategies, such as attempting to control or suppress responses or using self-harm to distract from or reduce negative affect. Although only a few studies to date have focused on response-oriented strategies for emotion regulation in BPD samples, recent research has shed light on some aspects of these approaches to the management of emotions.

The influence of affective response was studied recently in a group of 39 patients recruited from a 5-day partial hospitalization program for the treatment of BPD (Yen, Zlotnick, & Costello, 2002). The study utilized two measures of affect regulation, the Affective Intensity Measure (AIM) and the Affective Control Scale (ACS). The AIM was developed by Larson and Diener (1987) to examine individuals' subjective experiences regarding *strength* of emotional response, using items such as, "My emotions tend to be more intense than those of most people." The ACS was developed to assess subjective sense of one's *ability to regulate* or control responses in emotionally charged situations (Williams, Chambless, & Ahrens, 1997). Items on the ACS include statements such as, "I am afraid I will hurt someone if I get really furious." Data also were collected on levels of depression as a possible confound in emotion regulation in BPD samples. Results of a regression analysis reveal that in this sample, affective intensity and affective control significantly predicted BPD traits beyond the influence of depression (Yen et al., 2002). Scores for the AIM accounted for 16% of the variance, and those for the ACS accounted for an additional 27% of the variance in number of BPD traits. The authors posit that affective intensity represents more of an underlying physiological vulnerability to emotional lability, while decreased ability to control affect is more akin to a lack of skill or efficacy in modulating emotions, relating these two aspects of emotional response to Linehan's (1993a) biosocial theory.

Another area of response-focused research centers on expectations regarding ability to regulate negative mood. Catanzaro and Greenwood (1994) describe the concept of "negative mood regulation expectancies" as belief in one's ability to cognitively or behaviorally alter negative mood states in a desired direction, adding that "...persons with strong NMR expectancies believe, in general, that 'If I try to feel better, I will feel better.' " Past research has shown that such expectancies are negatively correlated with depression and trait anxiety (Catanzaro, 1993). Additionally, they correlate positively with active coping responses and negatively with avoidant responses (Catanzaro & Greenwood, 1994).

A final aspect of response-oriented emotion regulation is the category of self-harm, a behavior characteristic in many individuals with BPD. Many theorists, including Linehan (1993a), propose that self-injury may be a means of diminishing the experience of negative affect for many individuals with BPD. Indeed, recent studies indicate that part of the reason that some individuals may engage in self-harm is the effect on the endogenous opioid system, although social factors also appear to play a role (Symons et al., 2001). Based on research in animals, it appears that engaging in self-harm triggers the release of endorphins in the body, producing feelings of euphoria and diminishing sensation of physical pain.

BPD, Emotions, and Memory

No BPD research to date has examined affective and cognitive functioning simultaneously. A few areas of the brain have been central in prior neuroimaging research on emotions: the frontal lobes (with a focus on the orbitofrontal cortex), the amygdala and hippocampus, the cingulate gyrus, and to a lesser degree, the cerebellum. Each of these regions is discussed first in terms of past research with the general population, followed by a review of current knowledge about each of these areas in imaging studies of emotional processing with BPD samples. Findings from imaging studies of memory in non-BPD and BPD samples are reviewed next, followed by a review of neuropsychological research with BPD samples.

The Brain and Emotions in Non-BPD Samples

Recent work highlights the value of recognizing the role of interactive networks in the brain and avoiding attributing specific tasks to discrete regions of the brain (e.g., Collette & Van der Linden, 2002; Lewis, Dove, Robbins, Barker, & Owens, 2004; McIntosh, 1999). In a review article on the relationship between social interaction and emotions, Adolphs (2003, p.166) describes the interactive nature of processing emotional and social stimuli:

> "Most structures that have been shown to be involved in processing emotions have...also turned out to be important for social behavior. These include, first, specific regions in higher-order sensory cortices;

> second, the amygdala, the ventral striatum and orbito-frontal cortex; and third, additional cortical regions such as the left prefrontal, right parietal, and anterior and posterior cingulate regions.... Higher-order sensory cortices are involved in the perceptual representation of stimuli and their constituent features. The amygdala, striatum, and orbital-frontal cortex mediate an association of this perceptual representation with emotional response, cognitive processing, and behavioral motivation. Higher cortical regions are then involved in the construction of an internal model of the social environment, involving representation of other people, their social relationships with oneself, and the value of one's actions in the context of the social group."

Adolphs' description of the complexity of interactive networks related to emotions highlights the value of developing a better understanding of neurocognitive processes in individuals with and without BPD. Research on many of these regions of the brain is considered below, with the caveat that the best way to understand each structure's functioning is in concert with connected areas of the brain.

The frontal lobes, cognition, and emotions

In addition to their role in the planning of complex motor actions, the frontal lobes traditionally are considered to be crucial in "executive" function (Driessen et al., 2004; Luria, 1980; Stuss & Levine, 2002). Imaging and neuropsychological studies of normal aging (Schretlen et al., 2000), traumatic brain injury (Berthier, Kulisevsky, Gironell, & Lopez, 2001; Kesler, Adams, & Bigler, 2000), and various neurological disorders (Foong et al., 1997; Huber, Bornstein et al., 1992; Huber, Miller, Bohaska, Christy, & Bornstein, 1992; Royall, Rauch, Roman, Cordes, & Polk, 2001) support the idea that frontal lobes play a central role in executive cognitive processes, albeit in concert with other areas of the brain. Executive functions include decision-making, conceptual categorization, inhibition of impulsive responses, direction and shifting of attention, and the "weeding out" of distracting or irrelevant stimuli, all important aspects of encoding, storing, and retrieving information from memory (Bechara, Damasio, & Damasio, 2000; Smith & Jonides, 1999; Stuss & Levine, 2002; Szameitat, Schubert, Muller, & von Cramon, 2002). The ability to attend to information may have special salience in BPD populations, as recent research suggests some overlap between disorders of attention and BPD (Coolidge, Segal, Stewart, & Ellett, 2000; Dowson et al., 2004; Fossati, Novella, Donati, Donini, & Maffei, 2002). With some notable exceptions, such as memory for peripheral information regarding source context (e.g., Doerksen & Shimamura, 2001), what we do not attend to, we do not remember.

In addition to its role in memory processes, the prefrontal cortex (PFC) plays a crucial role in the regulation of emotions. The PFC, in its role as "overseer" of an individual's decision-making and behavior, inhibits the expression of emotions that are too intense or that are not socially acceptable. As a tempering agent, it helps the individual to interpret facial expressions (George et al., 1993; Harmer, Thilo, Rothwell, & Goodwin, 2001) and negotiate through social situations appropriately (Adolphs, 2003; Leduc, Herron, Greenberg, Eslinger, & Grattan, 1999; Stuss & Levine, 2002). A significant body of literature has documented the effects of lesions in the PFC on emotional processing (George et al., 1993) and expression in individuals with traumatic brain injury and fronto-temporal dementia (see for example, Blair & Cipolotti, 2000; Keane, Calder, Hodges, & Young, 2002). A complete discussion of research regarding neuroanatomical correlates of emotion regulation is not within the scope of the present paper; however, highlights of recent research are covered. For a more complete discussion, the reader is referred to Thayer and Lane (2000) and to Adolphs (2003). In part due to this large body of research, theorists interested in BPD became interested in the role of the PFC and other areas of the brain in the emotional disinhibition and the tendency to misread social situations in individuals with BPD.

The role of left/right differences in the brain, primarily the frontal lobes, is worthy of mention. For decades, anecdotal evidence from patients with focal lesions has suggested that the two hemispheres of the frontal and anterior temporal lobes attend to complimentary aspects of emotional experience, with the left side being more attuned to positively valenced, "approach" stimuli and the right to negative, "withdrawal" stimuli (see J. A. Gray, 1970; J. A. Gray, 1994, for a more complete explanation). This concept has been supported by electrophysiological research (Davidson, 1992) and by imaging studies (Lee et al., 2004). Recently, fMRI research conducted by Canli and colleagues (2001) has suggested that differences in extraversion and neuroticism may interact with observed left/right lateralization for emotional response tendencies.

Current research supports the idea that the orbitofrontal cortex (OFC), in concert with other areas, plays a central role in processing of emotions, particularly, the ability to use internal and external affective cues to respond appropriately to others. Leduc and colleagues (1999) posit that the OFC is vital to our awareness of our own responses to others in our environment. Five patients with focal damage to the OFC were compared to six patients with known damage to only the posterior ventromedial frontal lobe for their responses on a self-awareness measure (Leduc et al., 1999). While individuals with ventromedial damage exhibited no deficits in self-awareness, individuals with OFC lesions demonstrated impaired awareness of their own social and emotional skills, when compared with insight regarding their instrumental and cognitive abilities. Bechara, Damasio, and Damasio (2000) explain this lack of awareness in terms of the "somatic marker hypothesis." That is, they posit that deficits in emotional awareness with damage to the OFC are a result of an inability to utilize internal cues to draw accurate suppositions about one's own emotions and the social cues of others. Further, they argue that the lack of such input impairs ability to make decisions about responses to others and to utilize "gut feelings" to inform decision making (Bechara et al., 2000).

Research by Ochsner, et al. (2002) partially supports these theories regarding the role of the OFC, indicating that the OFC works in concert with other prefrontal regions during a specific activity that plays a part in the regulation of emotions, cognitive reappraisal. In this functional MRI study, 15 healthy female controls (age 18 to 30) volunteered for participation. While in the scanner, they were shown neutral or negative images, with the written instruction to "view" each image initially. After four seconds, the word "view" was replaced with the instruction to either "attend" to or "reappraise" the picture. Prior to the experiment, all subjects participated in training sessions to learn the technique of cognitive reappraisal, to insure that they were not simply distracting themselves from the image but rather were reframing the context of the image in order to change its emotional intensity. Results of the fMRI indicated that, during reappraisal, the general trend was for dorsal aspects of the prefrontal cortex to be activated, and for the amygdala and OFC to become less active, suggesting a dampening effect by the former on the latter two regions during reappraisal. In contrast, during simple "attend" trials with negative pictures, the OFC and amygdala, as well as other regions, were more active than the dorsal prefrontal areas. The authors suggest that these trends reveal an intricate pattern of prefrontal and limbic activity during emotion regulation, with different areas contributing to awareness of and modulation of affect (Ochsner et al., 2002). Simply stated, while the OFC is necessary to one's awareness of emotions, one's ability to modulate emotional responses through cognitive processes can be influenced strongly by other, more dorsal areas.

The amygdala, cognition and emotions

The amygdala has been a site of frequent investigation in research on neural mechanisms of emotion. One of the most prominent researchers in the role of the amygdala is LeDoux (1992; 1995; 1996). The amygdalae are bilateral structures located subcortically at the anterior ends of the hippocampi. LeDoux theorizes that the amygdala acts as a "first responder" type of system, designed to detect novelty in the environment, especially novel stimuli that might signal danger. He argues that neuroanatomical studies reveal a short, direct connection between the sensory thalamus and the amygdala, in addition to a longer route of connection from the thalamus to the sensory cortex and back to the amygdala. He posits that the amygdala has evolved as an emergency system for fast activation of emotional response and triggering of internal "alarms" that more or less acts first, then interprets and responds to feedback from the cortex after the initial "alarm" response (LeDoux, 1995, 1996).

The amygdala appears to functioning better under conditions of stress or threat, whereas the adjacent hippocampus, critical in the consolidation of episodic memory, appears to be somewhat inhibited by exposure to the increased cortisol levels commonly produced in response to threatening stimuli (Nadel & Jacobs, 1998). Research by Anderson and Phelps (2001) suggests that the amygdala is critical in the encoding of aversive words in memory, suggesting that, although the hippocampus may be central to the process of consolidation of information in memory, the amygdala appears to strongly influence our awareness of stimuli that are aversive or threatening, enhancing memory for negatively valenced material. Supporting this hypothesis, Lee and colleagues (2004) found that blood flow to the amygdala was increased significantly when participants in a fMRI study viewed negative pictures. Recent research also suggests that the amygdala plays an important role in the evaluation of facial expression (Anderson, Spencer, Fulbright, & Phelps, 2000), possibly due to the evolutionary survival value of being able to rapidly and correctly interpret others' emotions (Adolphs, 2003; LeDoux, 1996).

The cingulate gyrus, cognition, and emotions

The cingulate gyrus is another area of the brain that often is cited in research on emotional regulation. Most research has focused on the anterior cingulate and it connections to frontal and limbic structures, although some recent research suggests that the posterior cingulate also has a part to play. A number of research studies converge on the point that the anterior cingulate gyrus, with its intimate connections both to subcortical limbic system structures and to the frontal lobes, plays an intricate part in communicating "alarm" signals from the amygdala to the cortex and other structures, as well as appearing to be involved in the inhibition and modulation of emotional responses (Beauregard, Lévesque, & Bourgouin, 2001; Cabeza & Nyberg, 2000; George et al., 1993; Lee et al., 2004; Thayer & Lane, 2000). Some research indicates that the anterior cingulate also is involved in recognizing facial expressions in others (Anderson et al., 2000; George et al., 1993). Other studies posit that this region is crucial to maintenance of attention (Lee et al., 2004; Thayer & Lane, 2000). This combination of skills makes the anterior cingulate an area of interest in populations with BPD, given the tendency among individuals with BPD to misread other's emotions, to have poor attention skills, and to have decreased ability to modulate affect. Other research indicates that the posterior cingulate, in an area also known as the retrosplenial cortex, may be involved in making connections between emotional experiences and episodic memories, via the consolidation and integration of new experiences with previous experience, affect, and knowledge (Maddock, 1999; Maguire, 1999).

The cerebellum, cognition, and emotions

A small body of literature suggests that the cerebellum, once thought to be specialized for coordination of muscle activities and balance, also may be actively involved in aspects of emotional experience and memory, via connections to the PFC, superior temporal lobes, cingulate gyrus, and parahippocampal regions, through projections to the intralaminar "nonspecific" thalamic nuclei (Schmahmann, 1996). Just as they noted increased activation in the anterior cingulate and amygdala, Lee, et al. (2004) found that the cerebellum was more active during participants' exposure to negatively valenced visual stimuli. The role of the cerebellum in emotional processing and memory tasks has been relatively unexplored; however, a theoretical paper regarding the potential anatomical substrates of its connections to the limbic system and plausible role in cognitive and emotional processes examines these connections in detail (Schmahmann, 1996). A summary of regions of the brain outlined above and their respective roles in emotions and some aspects of cognitive processing is displayed in Table 1.

Table 1

Emotions and the brain: Summary of research findings in non-BPD samples

Region	Emotional/Cognitive Function or Response
Frontal lobes	
General	"Executive" functions, including decision-making, conceptual categorization, inhibition of impulsive responses, direction and shifting of attention, and the "weeding out" of distracting or irrelevant stimuli
Orbitofrontal (OFC)	Ability to use internal and external affective cues to respond appropriately to others
	Awareness of our own responses to others in our environment
Amygdala	"First responder" system, responds to novelty that may signal danger in the environment
	Function enhanced by release of cortisol in threatening situations, in contrast to the hippocampus, whose function appears to be inhibited by same
	Appears to influence awareness of aversive stimuli, enhancing memory for negatively valenced material
	Role in evaluation of others' facial expressions
Cingulate gyrus	
Anterior cingulate	Connections both to subcortical limbic system structures and to the frontal lobes
	Helps communicate "alarm" signals from the amygdala to the cortex and other structures
	Involved in inhibition and modulation of emotional responses
	Involved in recognizing facial expressions in others
	May be important in maintenance of attention
Retrosplenial cortex	Connections between emotions and memories, via integration of new experiences with previous experience, affect, and knowledge
Cerebellum	Increased activity in response to negative visual stimuli

The Brain and Emotions in BPD Samples

Research regarding neurophysiological and anatomical aspects of emotions in the general population provides a backdrop against which similar research with BPD samples can be evaluated. Each of the areas above has been investigated to some extent in neuroimaging research on BPD. Findings from a review of this research are covered below, followed by a table comparing and contrasting results to research findings in the general population.

The frontal lobes, cognition, and emotions in BPD samples

One group of researchers has developed a fairly comprehensive theory regarding the etiology of neurological differences often observed in individuals with BPD, based primarily on alterations in neural connections in the frontal lobes. Meares, Stevenson, and Gordon (1999), argue that neurological differences in BPD samples may be a result of an interaction between the individual and the environment. Specifically, they posit that BPD can be conceptualized as a "failure" in the environment that has a detrimental impact on neural development, tempered by the inherited vulnerability of the individual. They propose that such changes in neural development can best be considered through a framework outlined by John Hughlings Jackson (J. Taylor, 1931-1932). Jackson proposed that neurological functions that developed later in evolutionary history, which also commonly develop later in childhood, are more vulnerable to environmental insult. Jackson referred to this process, the opposite of evolution, as "dissolution." Meares and colleagues (1999) argue that according to this paradigm, many of the functions of the frontal lobes are likely to be affected by an invalidating or traumatizing childhood environment, resulting in disturbances in sense of self, decreased impulse control, poor modulation of attention, and problems with affective regulation, all hallmark symptoms of BPD. This theory appears to be supported not only by clinical, behavioral observations but also by recent neuroimaging research involving the frontal lobes and their connections to other cortical and subcortical regions.

A series of experiments by Soloff and colleagues suggests that prefrontal hypometabolism is a common observation in individuals with BPD (Soloff, Kelly, Strotmeyer, Malone, & Mann, 2003; Soloff, Meltzer et al., 2003; Soloff, Meltzer, Greer, Constantine, & Kelly, 1999). Individuals with BPD were compared to healthy controls for response to a serotonergic agonist (Fenfluramine). In the earliest of these studies, while control subjects responded with increased activation in the right PFC (Brodman's Area 10) relative to individuals with BPD, BPD participants demonstrated increased activity in the pons and right occipital lobe (Soloff et al., 1999). Subsequent studies revealed decreased response in bilateral OFC's in BPD subjects relative to controls; gender differences were observed, such that males showed a more marked diminution than females. Further, levels of impulsivity and aggression were significantly and negatively correlated with activation in the PFC (Soloff, Kelly et al., 2003; Soloff, Meltzer et al., 2003). In a similar study using a different radioactive marker, De la Fuente and colleagues (1997) also noted hypometabolism in the PFC in women with

BPD relative to matched controls. Other research shows volumetric differences in BPD subjects compared to healthy controls. In a comparison of eight nonmedicated women with BPD diagnoses to eight healthy female controls matched for age and education, Tebartz van Elst et al. (2003) found that the BPD group demonstrated a 24% decrease in volume in the left OFC relative to the control group.

In a study by Schmal and colleagues (2003), PET scans were administered to twenty women, half of whom met criteria for BPD, with the other half comprised of healthy volunteers. During scans, participants listened both to neutral stories and to scripts involving personal traumatic material. Women in the control group showed increased blood flow in the right anterior cingulate gyrus, and left orbitofrontal cortex during trauma scripts. These same participants evidenced differential effects in the dorsolateral prefrontal cortices while listening to trauma scripts, with activation increased in the right and decreased in the left. Given the research on left versus right prefrontal involvement in processing of positive and negative material and emotions described earlier, these results make sense. In contrast to these findings, women with BPD evidenced no changes in the prefrontal cortex. They also failed to activate the orbitofrontal or anterior cingulate regions while listening to traumatic material. In addition, in the BPD group, decreases in blood flow to the right hippocampus during trauma script were observed, which were not present in the other group of subjects. Schmahl and colleagues (2003) point out that past research has revealed a role for the medial prefrontal cortex, including the anterior cingulate, in the regulation of glucocorticoid and sympathetic responses during stress, inhibition of the amygdala, and extinction of fear responses. These authors propose that failure to differentially activate left and right frontal lobes, as well as dysfunction of the anterior cingulate, orbitofrontal cortex, and hippocampus, may play a role in many of the symptoms seen in individuals with BPD (Schmahl et al., 2003). Research by Herpertz, et al. (2001) contradicts these findings, however, showing increased activation in the bilateral PFC in BPD versus non-BPD participants.

Possibly clarifying these contradictory findings, Driessen and colleagues (2004) examined the relationship between areas of brain activation and the presence or absence of PTSD in an fMRI study of women with BPD. Participants included 12 women with a history of trauma, 6 of whom had current PTSD and 6 of whom did not. Trauma scripts were derived from a focused autobiographical intake interview, with four discrete stories between ages 12 and 18 for each participant; two stories concerned events that met criteria for PTSD and two events were negative but non-traumatic. Words were selected from these stories to evoke memories of the events and were agreed upon in advance by participants and researchers. Results from the fMRI analyses indicate that women with combined BPD and PTSD showed increased activation in the anterior right temporal lobe, amygdala, retrosplenial gyrus, occiput, and cerebellum, while those with no PTSD evidenced increased activity in the OFC bilaterally (Driessen et al., 2004). Generally this set of findings is congruent with previous research in traumatized samples without BPD, in which differential activation was noted individuals with PTSD; the trend across this body of research is for people without PTSD to activate the PFC with exposure to trauma cues, while those with PTSD preferentially activated occipital and temporal regions. Findings in the Driessen study argue for the need to better understand the effects of trauma in this population.

Hypothalamic-pituitary-adrenal axis and BPD

A related area of research concerns the hypothalamic-pituitary-adrenal (HPA) axis. The HPA axis is a network of neuroendocrine components whose primary function is response to stress. A major product of HPA activation is corticosteroids, which, as noted previously, particularly affect the limbic system, most notably the hippocampus (Lopez, Vazquez, Chalmers, & Watson, 1997). Increased HPA activity is associated with increased risk for suicide (Lopez et al., 1997; Ranga Rama Krishnan, Davidson, Rayasam, & Shope, 1984). According to some theorists, there are four major contributors to suicidality:

> "(1) an acute pathway involving severe anxiety/agitation associated with high brain corticotrophin-releasing factor ... levels, (2) trait baseline and reactivity hopelessness, (3) severe anhedonia, and (4) trait impulsiveness associated with low brain serotonin turnover ... as a possible peripheral correlate" (Lopez et al., 1997).

Given the behaviors commonly observed in individuals with BPD, as well as the observations of low serotonin turnover described above, it is not surprising that researchers would be interested in investigating the HPA axis in this population.

Rinne and colleagues have conducted a series of experiments examining HPA response in women with BPD and reported histories of childhood abuse (Rinne et al., 2003; Rinne et al., 2002). They ground this research in part on recent animal studies suggesting that exposure to adverse environments in early neural development produces changes in HPA responses (Oitzl, Workel, Fluttert, Frosch, & De Kloet, 2000). Based on the results of their work with BPD women, Rinne and colleagues conclude that sustained abuse in childhood is related to hypersensitivity in the HPA axis in individuals with BPD, making them more susceptible to the effects of stress (Rinne et al., 2003; 2002). Research by other authors supports this finding (Martial et al., 1997).

The amygdala, cognition, and emotions in BPD samples

In the MRI study described above by Tebartz van Elst and colleagues (2003), women with BPD also had significant reductions in bilateral amygdala and hippocampal volumes. Supporting these findings, another MRI study found 16% reduction in hippocampal volume and 8% reduction in amygdala volume in women with BPD relative to healthy controls (Driessen et al., 2000). In addition, as noted above, the presence of PTSD in BPD subjects also appears to be correlated with increased activation in the amygdala (right greater than left) relative to patterns seen on fMRI in individuals with BPD but no PTSD (Driessen et al., 2004). Although they did not control for PTSD, other studies support the concept that hyperactivation of the amygdala is common in BPD. Herpertz and colleagues (2001) noted increased bilateral activation in the amygdala when individuals with BPD were exposed to emotionally aversive visual images during fMRI, as compared to patterns of activation in matched healthy controls. Other research has used photographs of a spectrum of facial expressions designed to evoke happy, sad, fearful, or neutral responses in subjects (Donegan et al., 2003). Participants in this study were 15 men and women with BPD and 15 matched healthy controls. Results of the study indicate that BPD participants showed significantly greater activation of the amygdala in response to all but the happy slides when compared with controls. Based on post-scan debriefing, the authors posit that many individuals with BPD have difficulty disambiguating neutral versus negative facial expressions in others, contributing to clinical observations of hypersensitivity and occasional signs of paranoia in clients with BPD (Donegan et al., 2003).

The cingulate gyrus, cognition, and emotions in BPD samples

In their MRI comparison of 8 borderline and 8 healthy control females matched for age and education, Tebartz van Elst et al. (2003) also found a 26% reduction in volume in the anterior cingulate gyrus in women with BPD relative to the control group. Further, De la Fuente and colleagues (1997) noted resting state hypometabolism in the anterior cingulate in PET scans studies of BPD subjects, in addition to that observed in the PFC described above. Interestingly, Driessen and colleagues (2004) found a differential activation for the left versus right posterior (retrosplenial) cingulate in women with BPD with and without comorbid PTSD, suggesting further research into the effects of trauma in this population is warranted.

The cerebellum, cognition, and emotions in BPD samples

Little research to date has examined the cerebellum's role in emotional processing in BPD. The study by Driessen and colleagues (2004) reported increased activation of the left anterior aspect of the cerebellum with recollection of traumatic autobiographical material. This was the single study in the current review that noted changes in activation in the cerebellum, so results should be considered with caution. However, given research by Schmahmann (1996) that demonstrated increased cerebellar activity with exposure to negative visual images in the general population, these results suggest that further investigation of cerebellar function may prove fruitful, especially in the context of research examining past history of trauma in BPD.

Table 2

Summary of differences in the brain and neurophysiology in BPD samples

Region		Function or Response	Summary of Findings in BPD Samples*
Frontal lobes			
	General	Decision-making, categorization, inhibition, attention	Decreased PFC response to serotonergic agonists Impulsivity & aggression negatively correlated with PFC activation
	Orbitofrontal (OFC)	Use of affective cues in social responses Awareness of own responses	Decreased OFC response to serotonergic agonists (males more than females) 24% decrease in left OFC volume
HPA Axis		Response to stress Appears to have role in suicidality	In BPD samples with childhood abuse, hypersensitivity of the HPA axis and increased sensitivity to stress
Amygdala		Response to novelty in the environment Awareness and subsequent memory for aversive stimuli Role in evaluation of others' facial expressions	Bilateral decreases in amygdala and hippocampal volume Increased activation when exposed to aversive stimuli, relative to controls Increased activation to sad, fearful, and neutral facial expressions relative to controls: problems disambiguating expressions (?)
Cingulate gyrus			
	Anterior cingulate	Connects limbic system structures to the frontal lobes Communicate "alarm" signals from the amygdala to the cortex and other structures Inhibition and modulation of emotional responses Role in recognizing facial expressions in others Role in maintenance of attention	26% decrease in anterior cingulate volume Resting state hypometabolism in anterior cingulate compared to healthy controls
	Retrosplenial cortex	Helps connect emotions and memories	Differences in left/right activation dependent on comorbidity of PTSD
Cerebellum		Coordination/balance Involved in procedural memory Increased activity to negative visual stimuli	One study noting increased left cerebellar activation with recall of traumatic memories

** Details and references in section preceding this table*

Neurophysiology of Memory in Non-BPD and BPD Samples

Verbal memory is an area of cognitive functioning that bears further research in BPD. Relative to an abundance of imaging research involving visually presented language, letter, and design recognition, fewer studies have examined brain areas that are activated during aurally presented verbal memory tasks. The comparative dearth of imaging information on verbal memory is due in part to the complication of head motion in the scanner when such tasks traditionally require vocal responses from participants (S. C. Johnson, Saykin, Flashman, McAllister, & Sparling, 2001), resulting in the frequent use of either forced choice verbal recognition of single words (which can be selected with the click of a button) or correlational studies of listening tasks while in the scanner with administration of recall and recognition trials outside the scanner. The general trend across these studies in non-BPD samples suggest the left prefrontal cortex and bilateral temporal lobes are common areas of activation, with some studies revealing increased activity in the right frontal lobe, right medial frontal gyrus, and right anterior cingulate gyrus (Cabeza & Nyberg, 2000; Heun et al., 1999; S. C. Johnson et al., 2001; Nyberg et al., 2000; Saykin et al., 1999; Tsukiura et al., 2002). Results vary across studies with familiarity/novelty of words presented and method and timing of word presentation. Further complicating the picture, these studies vary considerably in regards to gender distribution and age of subjects, although all recruited healthy volunteers. One study was located that compared active areas during encoding of sentences versus encoding of pictures (Nyberg et al., 2000). This research revealed greater activity in left temporal and left frontal regions with cognitive processing of sentences and in bilateral occipital and right medial temporal regions with processing of pictures.

In the present review, only one imaging study incorporating a story memory task was found. In a project by Maguire, Frith and Morris (1999), thirteen healthy male volunteers (25-43 years old) listened to six different short stories, each repeated two times over a series of twelve PET scans. Immediately following each scan, they were asked to rate comprehension of each story heard and recall as much of each as possible. Participants heard both "standard" and "unusual" stories, with a description of the basic idea of only some of the unusual stories given to them beforehand. Standard stories were rated by the participants as easier to comprehend than unusual stories, which were in turn more easily understood than unusual stories without a pre-established mental framework. PET scans revealed activation of anterior and ventral areas of the medial parietal and of the posterior cingulate cortex only with unusual studies preceded by a mental framework. Given the small, healthy sample of males only included in this study, as well as the lack of other studies examining story recall, it is unclear how these results might translate to a population of individuals with BPD, the majority of whom are female; however, the results do pose interesting questions regarding the role of the cingulate and parietal cortices in verbal encoding, recall, and comprehension.

No studies could be located examining brain activation during a task involving memory for newly acquired information in subjects with BPD. One study examined brain activation during memories of childhood abuse in individuals with and without BPD (Schmahl et al., 2003). This research is more focused on participants' emotional responses to traumatic memories than on active memory tasks, however, and it is covered in greater detail in the earlier section on the neurophysiology of emotions in BPD.

Neuropsychological Studies of Memory in BPD Samples

One of the earliest studies of neuropsychological performance in individuals with BPD was conducted by O'Leary and colleagues in 1991. In this research, 16 outpatients diagnosed with BPD were compared with 16 healthy volunteers for performance on the Wechsler Adult Intelligence Scale-Revised (WAIS-R, Wechsler, 1987), the Wechsler Memory Scale (WMS, Wechsler, 1945), and the Embedded Figures Test. The participants with BPD performed significantly worse than the comparison group for story recall and on tests requiring visual discrimination and filtering (O'Leary, Brouwers, Gardner, & Cowdry, 1991). In this early rendition of the WMS, both stories contained emotionally evocative material; one is the first story of the current WMS-III, which involves a robbery and financial hardship for a mother and her four children, and the other story, dropped from the current version of the measure, described the wreck of an 18-wheeler in the rain, with the driver striking his head on the dashboard. At about the same time, another research team was comparing 25 outpatients with BPD to 25 matched controls from archival data for performance on a more extensive neuropsychological battery (Judd & Ruff, 1993). Findings from this study indicate that individuals with BPD had poorer visuospatial recall, slower processing speed, and decreased verbal recall of stories. Recent work has examined and summarized findings across studies over the past decade. Monarch, Saykin, and Flashman (2004) conclude in their review of literature that there are three primary findings regarding the neuropsychology of BPD that are fairly consistent: 1) impairment on impulsivity and executive functioning; 2) impaired performance on the Digit Symbol subtest of the WAIS and its subsequent editions, suggesting difficulty with sustained attention and visuomotor speed; and 3) impairments in verbal memory.

Verbal memory also was found to be decreased in individuals with BPD in a study by Cummings (1998). The sample for this study was drawn from a group of inpatients at a state psychiatric facility. All participants carried a diagnosis of depression, but 23 had the additional diagnosis of BPD, while 21 did not. Participants were compared for performance on the California Verbal Learning Test (CVLT, a test of word list learning and recall), the LM portion of the WMS-R, and the Rey Complex Figure Test (RCFT, a measure of visuospatial organization and memory). Both groups scored in the mildly to moderately impaired range on the RCFT. Neither was significantly impaired on the LM portion of the WMS-R. The borderline group was significantly more impaired on the CVLT, however, and their performance relative to the control group did not improve on the cued recall or recognition portions of the CVLT. Cummings (1998) proposes that these findings, all drawn from a sample high in depressive symptoms, attenuate the effect of depressive symptomatology on test performance, suggesting that differences, including deficits in verbal learning and memory, are better accounted for by the presence of BPD in one group. Dinn and colleagues (2004) found recently that inpatients with BPD scored significantly lower than a group of healthy controls across several measures, including the LM portion of the WAIS, supporting a general dysfunction in verbal memory in this population.

A recent study by Monarch, Saykin, and Flashman (2004) also found impairments across several domains of cognitive functioning in a group of inpatients with BPD, including verbal memory. In this study, twelve women meeting diagnostic criteria for BPD who were consecutively admitted to a state psychiatric facility were assessed across a range of cognitive domains. Their results were compared to data from a normative sample collected from the same geographic region (see Saykin et al., 1995). Participants with BPD performed significantly worse than the normative sample on seven of nine domains of functioning, including "attention-vigilance, visuomotor speed and attention, immediate auditory memory, verbal intelligence and language, spatial organization, visual memory, and verbal learning and memory" (Monarch et al., 2004). Results from tests of attention-vigilance, learning, and verbal memory revealed the greatest deficits for the group with BPD, with scores falling more than three standard deviations below the mean for the normative group. It is worth noting that at the time of testing, these individuals were psychologically impaired to a degree that mandated emergency admission (for most) to a state psychiatric facility; however, the pattern of deficits lends credence to the some of the authors' previously noted observations regarding general trends in the research literature with BPD samples.

Other studies have noted decreased speed of processing (Dinn et al., 2004), impaired visual perception (Stevens, Burkhardt, Hautzinger, Schwarz, & Unckel, 2004), impairments in nonverbal memory (Dinn et al., 2004), and deficits in working memory (Stevens et al., 2004) in BPD samples. Attention deficits also appear to be elevated in this population. In a study of inpatients at a psychiatric facility, Fossati and colleagues (2002) administered the Wender Utah Rating Scale, a retrospective self-report questionnaire designed to assess childhood symptoms of attention deficit hyperactivity disorder (ADHD). The primary group of interest was 42 individuals with a diagnosis of BPD (58% females), who were compared to 96 inpatients with other cluster B personality disorder diagnoses, 38 patients with cluster A or C (but not B) diagnoses, 69 inpatients with no personality disorder diagnosis, and 201 nonclinical volunteers. 25% of the participants with BPD scored about the recommended WURS cut-off score of 46, compared to 10% of individuals with other cluster B disorders, 4% of those with cluster A or C disorders, 4% of inpatients without personality disorders, and 13% of the nonclinical sample, $F(2, 171) = 16.84$, $p < .001$. In a different study examining attention and conduct problems in a group of children exposed to family violence, Becker and McCloskey (2002) found that this group had significantly elevated rates of attention deficits in the violence exposed group ($n = 141$), compared to rates in a non-exposed group ($n = 146$). In this longitudinal study, attention and conduct problems were assessed at time one and patterns of delinquency were assessed at time two, approximately one year later. Given research findings from several studies noting elevated rates of BPD in juvenile offender populations (e.g., Barylnik, 2003; Eppright, Kashani, Robison, & Reid, 1993; Trupin, Stewart, Beach, & Boesky, 2002), as well as the high rates of trauma in BPD populations, these findings suggest that problems with attention bear consideration in any exploration of cognitive functioning in individuals with BPD.

Two final aspects of neurocognitive functioning in BPD populations that bear consideration are executive functioning (other than attention) and developmental research on BPD and cognition. Dowson and colleagues (2004) investigated levels of self-reported impulsivity symptoms and performance on various computerized tasks thought to be mediated by the frontal lobes in 41 inpatients with BPD and 35 nonclinical control participants. Participants completed the Attention-Deficit Scale for Adults, the National Adult Reading Test (an estimate of verbal intelligence), the Brief Symptom Inventory (BSI; a self-report measure reflecting current psychological distress), a motor screening task (measuring speed of motor responses), the Tower of London task (measuring ability to plan steps for building a tower sequence correctly), and a computerized decision-making task involving guessing the location of a hidden token and placing bets regarding the likelihood of having the correct answer. After Bonferroni correction, the BPD group was found to be significantly higher than the control group on seven of nine categories on the attention deficit measure, six of which reflect tendencies toward impulsive behavior. Multiple regression analysis revealed that performance on the Tower of London task was predicted by self-ratings on the attention deficit measure, including a scale reflecting emotional lability, even after controlling for estimated verbal intelligence and severity of symptoms on the BSI. Poor motor coordination and response time also were related to ratings on the attention deficit measure. The authors propose that the set of neurocognitive tasks chosen for the study tap into dorsolateral and orbitofrontal functioning, speculating that these areas of the brain may represent common sites of dysfunction in individuals with BPD, given the general trend of increased impulsivity, poor decision-making, and decreased ability to plan and strategize effectively observed in the BPD participants (Dowson et al., 2004).

Another body of research has examined neuropsychological performance in children with features of BPD, in an effort to explore neurodevelopmental aspects of the disorder. Coolidge, et al. (2000) conducted a study with 21 children diagnosed with borderline features and 21 controls with features of another personality disorder but not BPD. All participants were community referred and not hospitalized at the time of analysis. Males and females were included in the study, and the average age of participants was 11 years (*SD* = 3.6 years; range 5-17 years). Parents of participants completed a 200-item questionnaire developed by the authors with a threefold purpose: 1) assessment of personality disorder traits, 2) assessment of symptoms of Axis I disorders, and 3) assessment of indicators of neuropsychological dysfunction. After correction for multiple comparisons, the children in the BPD were found to have significantly higher ratings than the control group for attention deficits, problems with executive function, and signs of mild neurocognitive disorder, including memory and perceptual motor difficulties (Coolidge et al., 2000). Although this single mode of assessment gathered only through the primary caregiver's report is not conclusive, the differences between the groups are striking and suggest the possibility that at least in some individuals with features of BPD, both symptoms of the disorder and neurocognitive deficits may date back well into childhood.

A recent investigation that included computer administered tasks that are standard in neuropsychological assessment supports the findings of the study described above (Zelkowitz, Paris, Guzder, & Feldman, 2001). In this study, 86 children (75 males) who were in a day treatment psychiatric program completed the Wisconsin Cart Sorting Test (WCST, Heaton, 1981) and the Continuous Performance Test (CPT, Conners, 1994) on computer, in addition to measures of psychopathology and past exposure to trauma. The WCST is traditionally considered to be a measure of executive function that requires complex sustained attention, set shifting, abstract thinking, novel problem solving, and cognitive flexibility. The CPT is designed to measure vigilance, impulsivity, and sustained attention. Average age of participants was 9.8 years (range 7 to 12 years). Thirty five children were diagnosed with BPD. Data were analyzed using a series of logistic regressions, with "neuropsychological vulnerability" and "psychosocial risk" as predictors for level of BPD pathology. An abnormal WCST score alone was related to a 6:1 odds ratio for being classified as BPD. A combined model which included witnessing violence, experiencing sexual abuse, CPT score, WCST score, and a "thought problems" score from a behavioral checklist completed by parents accounted for 48% of the variance in BPD group assignment in this sample (Zelkowitz et al., 2001). Although only limited data exist at present regarding the relationship between neurocognitive functioning and BPD symptoms in childhood, these two studies both support the idea that cognitive vulnerability may be intertwined with BPD symptoms in early development.

How Do Emotions Affect Memory in Non-BPD Samples?

Do emotions help or hinder our ability to remember information? Based on recent research, the answer varies, depending on type of task, emotional valence of the material, and area of the brain being activated at the time of encoding and recall/recognition. Some research indicates that memory is enhanced when emotions are evoked, other studies suggest that emotions dampen our ability to remember, and still others view the problem from the perspective of approach/withdrawal tendencies, noting differential performance based on task, and theorizing that lateralization between the hemispheres may interact with memory for emotional material. Recent research in each of these areas is explored below, with the caveat that no research could be located that examined the effects of emotions on memory in samples with BPD.

Several studies suggest that recall is enhanced when emotions are stimulated. In a list-learning paradigm, Kulas, Conger, and Smolin (2003) found that all participants, regardless of their reported ratings of fear of spiders, recalled the word "spider" in lists at a significantly higher rate than other words on the list. In addition, memory for the word presented subsequent to the word "spider" was recalled at a significantly lower rate, even when word order was altered in several follow-up studies. Recent work by Keil and Ihssen (2004), using several series of rapidly presented word lists, suggests that enhanced memory may be present for both positively and negatively valenced words, compared to neutral words.

In a Stroop paradigm, requiring participants to name the color of ink in which words were printed rather than the word itself, Vrana, Roodman, & Beckham (1995), found that Vietnam vets were significantly slower at naming the ink color for combat-related and emotionally negative words than for neutral words. In addition, recall and recognition for these words was enhanced. These authors frame the results as an "attentional bias towards the anxiety-related material rather than avoidance of it." In another study utilizing the Stroop technique, recall bias for emotional (positive and negative) versus neutral words was found (Doerksen & Shimamura, 2001). In an interesting follow-up, these researchers conducted a second study in which all words were printed in black ink on white paper but were surrounded by a thin line of either yellow or blue ink. Participants exhibited significantly higher rates of recall for the surrounding line color for emotional words versus neutral words. Doerksen and Shimamura (2001) posit that these results indicate enhanced memory not only for emotional content but also for surrounding stimuli, or the "source context" of the emotional material.

Recent research by Anderson & Phelps (2001) suggests that the left amygdala may play a crucial role in memory for negative emotional words. This study included a unique subject, S.P., a 47-year-old woman whose right amygdala and some adjoining temporal lobe structures were removed surgically, due to intractable epilepsy. After surgery, it was found that S.P. had abnormal signal density in her left amygdala, although none of the surrounding tissue appeared to be atypical, and the site did not appear to be epigenetic for seizure activity. For the purposes of the memory study, S.P.'s memory performance was compared to 5 participants with right anteromedial temporal lobectomy (TLB, often performed for intractable seizures), 5 patients with left TLB, and 20 healthy controls of similar age and education. Participants were shown several series of lists of rapidly projected single words, with 2 target words in green ink, versus 13 in black ink for non-target, neutral words in each series. Targets were high intensity, negative words (e.g., "rape," "bastard") in some sequences and affectively neutral in others. After each 15 word trial, participants typed in words to indicate recall for targets. In the control participants and in the right TLB subjects, memory for target words was enhanced when the stimuli were negative. For S.P. and for left TLB participants, however, no enhancement for negative stimuli was noted. The authors propose that this evidence supports earlier research and theory that suggests the amygdala plays a vital role in memory for aversive stimuli, helping us to separate the "mundane" from the significant in our environment, in order to enhance perceptual awareness of salient material (see also LaBar & Phelps, 1998; LeDoux, 1992, 1995). Anderson and Phelps (2001) posit that the left amygdala may be particularly crucial to this process, emphasizing that the amygdala's many projections throughout the temporal lobe and other areas of the brain indicate that it is not working alone but rather in concert with a network of other sites in the brain.

In contrast to these studies revealing improved performance with increased emotional intensity, other work suggests that emotions may interfere with memory and other aspects of cognitive processing. Kensinger and Corkin (2003) conducted a study examining the way in which emotional content of visually presented stimuli affects speed of processing, reaction time, and working memory. They conducted an "*n*-back" study of working memory for words and for photographs of scenes or people's faces. In an *n*-back approach, the subject is asked to identify any stimulus that they heard *n* number of times previous to the current exposure. The simplest form of this approach is a 1-back, in which the participant presses a button any time that they hear the same word (or see the same picture) two times in a row. The most commonly used form is the 2-back, in which the subject presses a button when they hear a word that they just heard two words back (in other words, with only one word in between the two targets). Occasionally, researchers use a 3 or even 4-back approach, which becomes extremely challenging for most people. The procedure provides a good picture of the person's ability to hold onto and retrieve information over short periods of time with interference; in other words, it taps into working memory. Another advantage of the procedure is that it allows for analysis of data such as reactions times, false positives, and impulsive responding. Kensinger and Corkin (2003) used this paradigm in a series of five 2-back experiments to test memory for auditory and visual stimuli that included positive, neutral, and negative emotional content. Participants viewed several trials, counterbalanced for order of presentation. In addition to the standard working memory task, the researchers also collected data from participants the following day, asking them to list every stimulus they had seen or heard in the experiment. The main findings of the study included better retention for negative stimuli after the delay period, no effects for emotional content on working memory, and significantly slowed reaction times for specific negative visual content (i.e., fearful faces only). Additionally, although it did not reach statistical significance, reaction times for all emotionally evocative stimuli were consistently slower across all tasks than for neutral stimuli (Kensinger & Corkin, 2003).

Other studies have examined the effects of emotions on memory by inducing physiologic responses that mimic the effects of stress. Newcomer, et al. (1999) utilized variable dosing with orally administered cortisol in a randomized, double-blind experiment that also included placebo doses in a group of healthy volunteers. The lower dose of cortisol was similar to the type of natural increases observed with mild stress, and the higher dose was analogous to that seen with major stress. Higher doses of cortisol were significantly and negatively correlated with poorer verbal recall but were not related to nonverbal memory, attention, or executive abilities. Paragraph recall was particularly impeded, both immediately and after a delay for wash-out of the drug. Some research suggests that self-harm behavior may be related to increases in serum cortisol (Sachsee, von der Heyde, & Huether, 2002), indicating that consideration for the effects of stress in borderline populations may be of interest in developing a better understanding of cognition in this group.

A final approach to understanding the effects of emotions on memory is examining the differential effects of positively versus negatively valenced material on tasks that traditionally are thought to rely more on the left or right hemispheres. As noted previously, language based tasks are thought to generally be more left-sided, and visual tasks more right-sided activities. Additionally, the left hemisphere is believed to be activated more by "approach" signals and positive tasks, while "withdrawal" signals and negative emotional stimuli generally activate the right hemisphere to a greater degree. J.R. Gray (2001) used these observations to explore the effects of positive and negative mood induction prior to memory tasks to look for differential effects on memory for spatial and verbal stimuli. Participants included 152 healthy college undergraduate volunteers. In a series of experiments, subjects watched 10 to 15 minute video clips with positive, neutral, or negative emotional content, then participated in 2-back memory tasks. Stimuli consisted of letters visually presented at any of nine points on a 3x3 viewing screen for brief periods. In the verbally loaded task, subjects were to look for repetitions of target letters, and in the nonverbal task, they were looking only for repetition of the same placement, regardless of letter. J.R. Gray (2001) found a double dissociation by task and emotional valence, such that "an approach state tended to impair spatial performance and improve verbal, whereas a withdrawal state tended to improve spatial performance and impair verbal." The interaction of emotion by task was strongest for those performing below average.

Purpose of the Current Study

In terms of the current study, the research results outlined above are interesting yet problematic, due to both the contradictory nature of the results and to the fact that no research to date has targeted the interactions between affective and cognitive functioning in individuals with BPD. Given the verbal nature of most therapies, including many aspects of the skills training used in

DBT, investigating verbal memory abilities in individuals with BPD may be helpful in developing a better understanding of the reasons that traditional approaches to therapy may be problematic in this population. The present study seeks to address the apparent gap in the literature through an initial exploration of the interaction between emotions and verbal memory in a sample of community referred individuals who meet diagnostic criteria for BPD. Background literature suggests several possible avenues of exploration. Given the current dearth of information in this area for BPD samples, a set of hypotheses was generated, based on what is currently known about affect and memory in non-BPD samples, as well as indicators of potential areas of difficulty for individuals with BPD.

Hypotheses:

1. On an aurally administered verbal memory task, the Logical Memory (LM) portion of the Wechsler Memory Scale, 3rd Edition (WMS-III), immediate recall for Story A and Story B will be different within participants across all groups, and delayed recall for Story A and Story B will be different within participants in Phases 1 and 2.
2. LM performance will be related to estimated verbal IQ scores (ANART), a measure of attention (Digit Span subtest of the WMS-III), and depressive symptoms (BDI-II scores).

3. Affective Control Scale (ACS) scores will be correlated with scores on the BDI-II and BSI, suggesting a relationship between problems with emotion regulation and other measures of distress in BPD populations.
4. Problems with emotion regulation, as reflected by total scores on the ACS, will be predictive of variance in performance for immediate and delayed recall on the LM portion of the WMS-III.
5. The relationship between emotion regulation and verbal memory will be significant even after controlling for other variables likely to impact performance, including depression, estimated verbal intelligence, and attention.
6. Emotion regulation (ACS scores) also will be related to recognition scores on the LM portion on the WMS-III, reflecting alterations in encoding of information with increased emotional dysregulation.
7. In a manipulation check, individuals with BPD features will rate Story A as more emotionally intense than Story B, supporting the proposed relationship between affective response and verbal memory performance.

Methods

Procedure

Participants were referred for possible participation in the study from therapists in the Missoula and Seattle areas, as part of an ongoing research project regarding the use of videotape teaching modules for DBT skills. All referred individuals were aware of their diagnosis of BPD prior to referral, as a part of the referral criteria for the study given to therapists. All data used in the current project were collected prior to exposure to DBT skills videos for any participants. Referred individuals initially were given information regarding the general purpose of the study and the time commitment involved via a telephone call. Participants who chose to participate were scheduled for an appointment to meet researchers in person at Behavioral Technology Transfer Group in Seattle, Washington, or at the Clinical Psychology Center on the University of Montana campus in Missoula.

In the first meeting, participants were given explanations of informed consent, followed by a clinical interview using the Structural Clinical Interview for the DSM-IV for Axis I disorders (SCID-I, Spitzer, Williams, Gibbon, & First, 1994), as well as the BPD portion of the SCID for Axis II disorders (SCID-II, First, Spitzer, Gibbon, & Williams, 1996). The SCID interview was conducted by one practitioner certified in its administration, in person at the Seattle location and via a speaker phone with another clinician in the room with the participant for the Missoula administrations. Following the interview, volunteers who were screened out due to the lack of a current BPD diagnosis were paid for their time and informed that they would not be able to participate.

Individuals who met criteria for BPD were invited to continue with further explanation of the schedule for data collection. Aside from the inclusion condition of meeting diagnostic criteria for BPD, all participants were at least 18 years of age, demonstrated understanding of and willingness to give informed consent, were literate, and were currently involved with treatment by a mental health professional (to insure availability of mental health resources should the individual become extremely distressed or suicidal). All participants also were screened for a set of exclusion criteria. Specifically, participants with an estimated verbal IQ score below 85 on the American National Adult Reading Test (ANART) were excluded, due to confounds introduced by having too low of a demonstrated verbal ability to be able to learn the material being presented in the larger study. (See "Measures" for more detail on the ANART.) In addition, individuals who were actively psychotic, who had prior exposure to DBT skills training, or who using substances to a degree that would interfere with participation in the study were excluded.

All participants were aware that they could voluntarily withdraw from the study at any time. All data for Phases 1 and 2 were collected under guidelines set forth by the Institutional Review Board (IRB) at the University of Montana. Meetings varied from between 1 ½ to 4 hours in length, depending on tasks to be completed. Participants were paid between $15 and $45 for each meeting, based on a pre-set scale that considered planned length of each meeting and a $5 incentive for arriving on time, resulting in total payment for completers of all six sessions of between $150 and $200.

For the manipulation check, participants were recruited from therapist referrals at the Montana State Hospital and from the community in Missoula. The manipulation check also was conducted in accordance with guidelines set forth by the IRB at the University of Montana, as well as according to the guidelines of the Ethics Committee at Montana State Hospital. All participants gave consent after careful review of the rules and constraints of consent. Participation in the manipulation check occurred at Montana State Hospital for 14 participants and at the Clinical Psychology Center on the University of Montana campus for 1 participant. Meeting length for the manipulation check varied from 30 to 60 minutes, and all participants were paid $10 for their time.

In the course of conducting the study, several additional questions arose regarding memory for the two stories that necessitated the addition of a healthy control group for comparison. Data from the WMS-III normative sample could not be obtained from the test's developer. However, a group of healthy adult controls were located who were participating in research on the effects of chemotherapy on neuropsychological performance at Dartmouth-Hitchcock Medical Center's (DHMC) Neuropsychology Laboratory. Demographic characteristics for this group are briefly described near the end of the results section, where differences between groups on LM performance are explored. In the primary study from which their LM data were drawn, these participants served as matched controls for a group of individuals with breast cancer receiving chemotherapy. Control participants were recruited via flyers posted in health care facilities and advertisements in local newspapers in the Hanover, New Hampshire area. Volunteers were excluded if they had a history of breast cancer, any type of previous cancer treatment, history of traumatic brain injury with loss of consciousness, neurological disorder, previous diagnosis with learning disability, substance abuse, or psychiatric diagnosis. Informed consent was obtained from all participants to have their data used in a variety of studies being conducted by the lab at DHMC, and all data collection occurred with the prior review and approval of the IRB at DHMC. Participants participated in a total of 4 assessments during this longitudinal study and were paid $50 for each assessment session.

Measures

The Brief Symptom Inventory (BSI, Derogatis, 1993) was completed by participants in Phases 1 and 2 during the second meeting, following completion of the SCID I and II interviews during the initial meeting. The BSI was completed immediately following the demographics questionnaire by participants in the Manipulation Check. The Affective Control Scale (ACS, Williams et al., 1997) was completed during the second meeting by Phase 2 participants only. WMS-III subtests and the American National Adult Reading Test (ANART, Crawford, Stewart, Cochrane, Parker, & et al., 1989) also were administered during the second meeting with participants in Phases 1 and 2. Only the first recall of each story, in counterbalanced order, was completed by Manipulation Check participants.

Demographics Questionnaire

During initial telephone screening, a questionnaire was completed by the interviewer regarding participants' age, gender, ethnicity, income, and a variety of other demographic background data. More focused demographic data questions in a shortened, written format were completed by participants in the manipulation check.

Brief Symptom Inventory (BSI)

The Brief Symptom Inventory is a 53-item self-report questionnaire designed to assess "psychological symptom patterns of psychiatric and medical patients as well as community referred respondents" (Derogatis, 1993, p. 3). It was included in the present study to assess general level of distress of participants. On the BSI, participants rate each item on a five-point scale (range of 0 to 4), from "not at all" to "extremely," to reflect the degree to which they have been bothered by a variety of symptoms over the prior seven days. In addition to a total score, described by three potential global indices, scores can be analyzed across nine subscales: somatization, obsessive-compulsive, interpersonal sensitivity, depression, anxiety, hostility, phobic anxiety, paranoid ideation, and psychoticism. The test developer reports correlations between scores for the BSI and the SCL-90-R, another scale commonly used to assess global mental health, ranging from .92 to .98 in a sample of 565 psychiatric outpatients. Internal consistency of scores in a normative sample (n = 719) ranged from .71 to .85 for the nine subscales (Derogatis, 1993; Derogatis & Melisaratos, 1983). Reliability of the BSI for the current study is reported in the results section.

Affective Control Scale (ACS)

This self-report measure was developed by Williams, Chambless, and Ahrens (1997) to assess fear of losing control of one's emotions and fear of one's behavioral response to emotion. Items are presented using a 7-point Likert scale, with four subscales with seven to eleven items each: Anger, Depression, Anxiety, and Positive Affect. The authors state that the general measure shows evidence of strong test-retest reliability and internal consistency for scores in their samples. Internal reliability for scores on the four subscales also appears to be moderately strong. Reliabilities of scores for the whole measure and its subscales for the current study are reported in the results section.

Beck Depression Inventory, 2nd Edition (BDI-II)

The BDI-II is a self-report measure of depressive symptomatology developed by Beck, Steer, and Brown (1996). The scale consists of 21 questions, with responses ranging in severity from 0 to 3. Suggested cut scores for the scale are 0-13 for "minimal depressive symptoms," 14-19 "mild," 20-28 "moderate," and 29-63 "severe" (Beck, Steer, & Brown, 1996). Contrary to gender norms in the general population, research using the BDI-II in BPD samples has found no differences in scores for the measure by gender (D. M. Johnson et al., 2003). The measure's authors report reliability of scores in normative samples ranging from .82 to .94 (Beck et al., 1996). Reliability of scores on the BDI-II for the present study is reported in the results section.

American National Adult Reading Test (ANART)

The ANART is a measure designed to estimate verbal intelligence based on an individual's ability to read and correctly pronounce words with spellings that are atypical for English language standards (e.g., "syncope"). The ANART is considered to provide a fairly reliable estimate of general intellectual functioning that is relatively stable over time (Crawford et al., 1989). The measure is also often used as an estimate of premorbid functioning in individuals with psychopathology, dementia, traumatic brain injury, and normal cognitive changes from aging (see for example, Crawford, 1992; Crawford, Deary, Starr, & Whalley, 2001; Deary, Whalley, & Crawford, 2004; Willshire, Kinsella, & Prior, 1991). The ANART consists of a list of 50 words that the participant is asked to read aloud. Verbal intelligence scores are calculated based on the number of words pronounced correctly.

Digit Span subtest of the Wechsler Memory Scale, 3rd Edition (DSp)

The Digit Span subtest is part of both the Wechsler Adult Intelligence Scale, 3rd Edition (WAIS-III, Wechsler, 1997a) and the WMS-III (Wechsler, 1997b), with no variation in form or content between the two measures. On the first half of DSp, the participant listens to a series of single digit numbers and repeats the sequence back to the examiner; the length of the sequence increases with successive correct trials. The second part of DSp has the same form, except that the participant is required to say the sequence in reverse order. The total score for the DSp subtest is the number of sequences correctly repeated (i.e., forward and reverse correct sequences summed). The subtest is considered to be a measure of working memory and ability to attend to auditory stimuli. The developers report Digit Span score reliabilities ranging from .84 to .92 across the 13 age groups in the normative sample(Wechsler, 1997a).

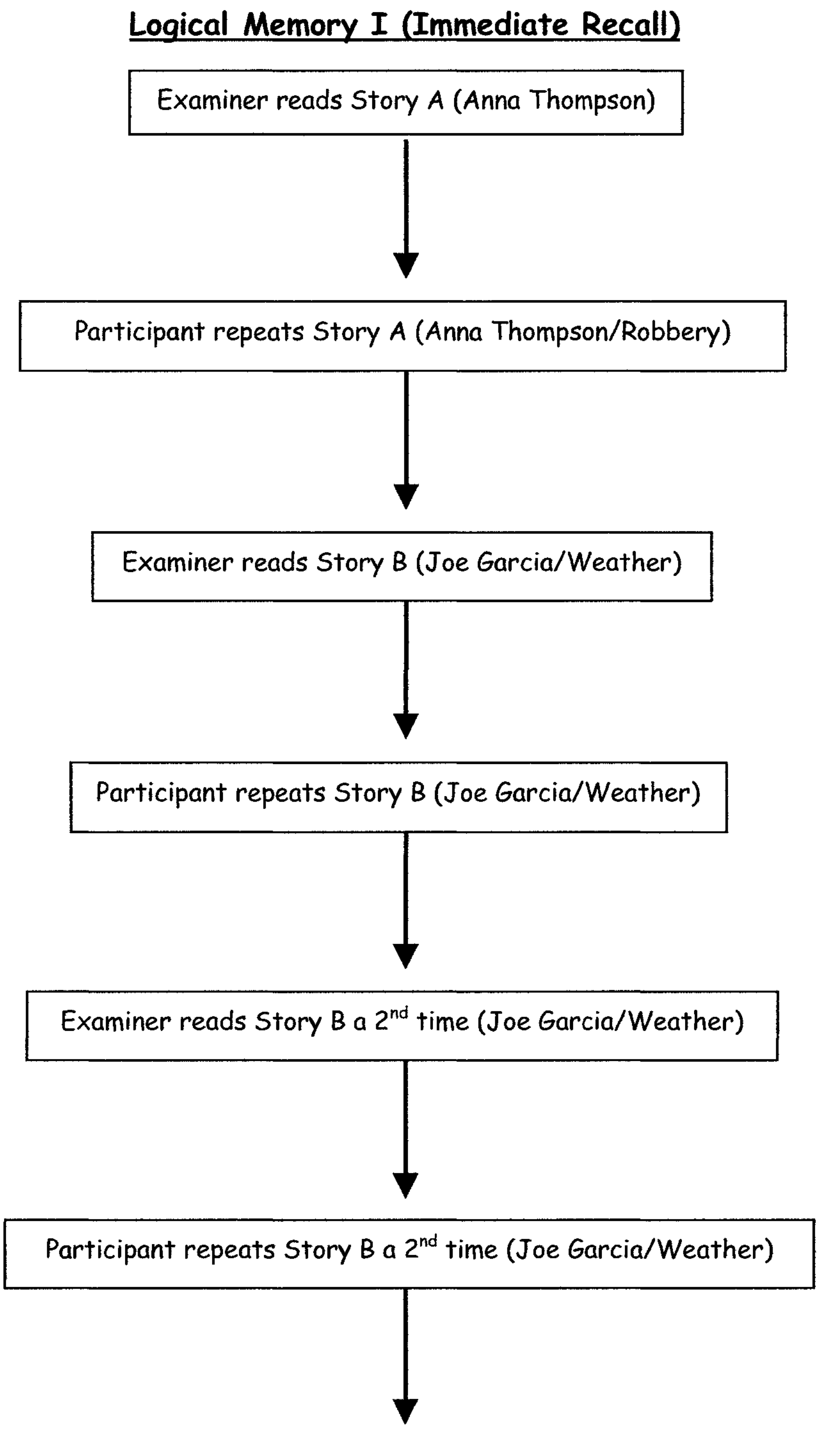
Logical Memory subtest of the Wechsler Memory Scale, 3rd Edition (LM)

The original Wechsler Memory Scale was developed during World War II (Wechsler, 1945), followed by a revision four decades later (WMS-R, Wechsler, 1987), and the currently used third edition (WMS-III, Wechsler, 1997b). The measure was designed for individual administration in clinical practice, although it has been used extensively in research. Norms for the WMS-III were derived from administrations with samples of eleven age groups between 16 and 79, with 100 people per group, plus 75 people age 80-84 and 75 people age 85-89. The authors report that the normative sample was consistent with U.S. census reports of ethnic distributions, with data gathered at 28 different sites across the U.S. (Wechsler, 1997b). The normative sample includes individuals with an education span from less than 8 years to 16 years or more. Scores for the LM1 (i.e. immediate recall) portion of the WMS-III have reported reliability between .81 and .91 across the 13 age groups comprising the normative sample (Wechsler, 1997b). LM2 (i.e., delayed recall) score reliabilities range from .71 to .87 in the normative sample (Wechsler, 1997b). Score reliabilities for the recognition portion of LM alone are not reported by the test developer.

The LM subtest includes two stories which are read to the participant, followed by elicitation of their recall for the story immediately and after a 25 to 35 minute delay, recorded according to 25 different elements per story. On the WMS-III, Story A concerns a woman who is robbed, while Story B is about a man who decides to stay home because of a weather bulletin about an approaching storm. Story B on the WMS-III was changed from the version used on the first two editions of the measure, which described a man who was involved in a wreck in his 18-wheeler in which his head struck the dashboard. The manual states the author desired a "story with more neutral content, which will consequently be less likely to evoke an emotional reaction from some examinees" (Wechsler, 1997b, p. 13), although no significant changes were made for Story A.

Recall scores for each story on LM may range from 0 to 25. Consistent with other Wechsler tests, scores also are normed by age for standardized scoring, with a mean of 10 and a standard deviation of 3. In the current study, the LM subtest was administered according to standardized instructions outlined in the WMS-III manual for participants in Phases 1 and 2 of the study. For the purposes of the manipulation check, only the first recall for the stories was administered, randomly counterbalanced for order, followed by ratings for each story. The standard administration used in Phases 1 and 2, as well as the version used for the manipulation check, is outlined in Figures 1 and 2.

Figure 1. Flowchart: Standard administration of Logical Memory subtest (Phases 1 & 2).



(25 - 35 Minute Break)

Logical Memory II (Delayed Recall)

Participant repeats Story A (Anna Thompson/Robbery)

↓

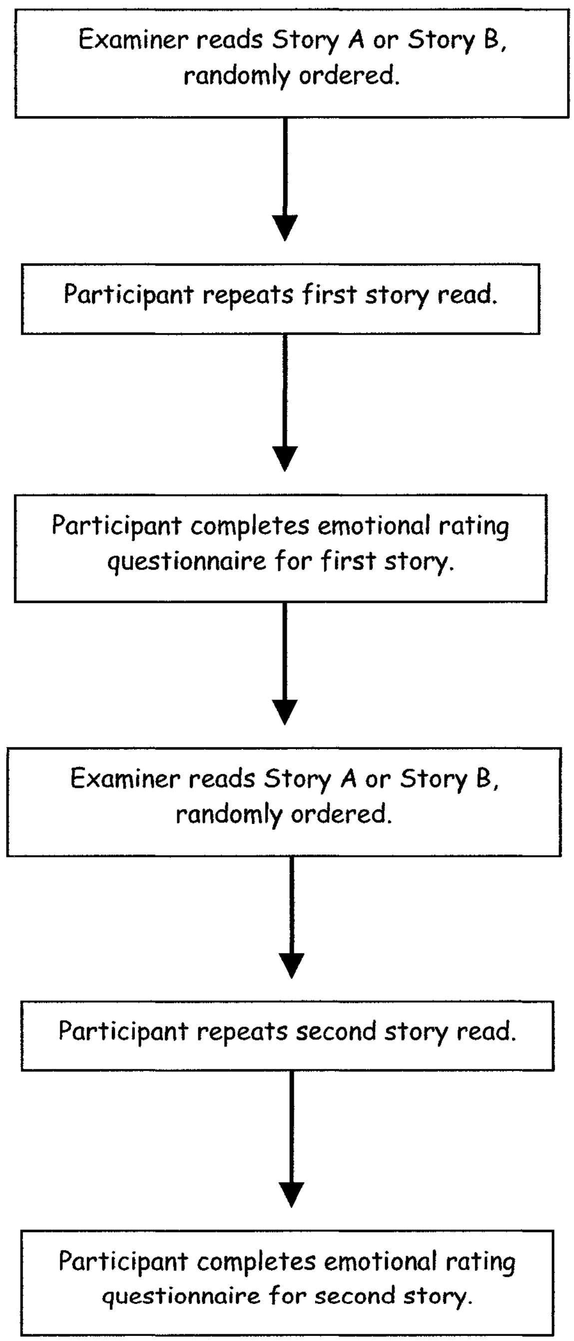
Participant repeats Story B (Joe Garcia/Weather)

↓

Logical Memory Recognition Trial

Recognition Trial
Participant answers a series of Yes/No questions about each story (15 each).

Figure 2. Logical Memory as administered in manipulation check.



Results

Participants

Participants from Phase 1 were excluded from the current analysis if they had not completed the BSI, BDI-II, or the LM subtest of the WMS-III. (The ACS was not collected from the first group.) Phase 1 participants included a total of 37 people who met criteria for BPD, of whom 28 completed all of the instruments deemed necessary for inclusion in the study. Participants from Phase 2 also included a total of 37 individuals who met criteria for BPD, of whom 28 completed the BSI, BDI-II, and the LM subtest, as well as the ACS. A total of 15 people participated in the manipulation check, all of whom completed the immediate recall portion of the LM subtest, the BSI, and ratings of both stories.

In order to determine whether these groups were similar, demographics were compared for Phase 1 and 2 and the manipulation check. Demographic characteristics were significantly different across Phase 1 and 2 and the manipulation check for age and gender, but no significant differences were observed for level of education (see Table 3). Participants in Phase 2 were older than those in Phase 1 and the Manipulation Check. Participants in Phase 1 were more likely to be female than those in Phase 2 and manipulation check. A trend was noted for ethnicity (p = .08), with a greater percentage of participants in the manipulation check identifying themselves as Native American and fewer as white. Average annual personal income for Phases 1 and 2 was $5,000 to $10,000, with 87% earning less than $15,000 per year, with no significant differences by group. Income data were not collected from participants in the manipulation check. Data regarding marital status were collected only from Phase 1 and 2 participants, of whom 45% identified themselves as never married, 43% as divorced or separated, 7% as married, and 5% declined to list marital status.

Table 3

Demographic variables by group

Variable	Phase 1 $n = 28$	Phase 2 $n = 28$	Manipulation Check $n = 15$	Significance
Gender: % female	**96%**	63%	67%	$p < .005$
Age	$x = 33.7$ (8.8) $n = 27$	**$x = 41.4$ (7.5)** $n = 26$	$x = 29.9$ (7.7) $n = 15$	$p < .001$
Ethnicity	$n = 27$	$n = 26$	$n = 12$	*n.s.* ($p = .08$)
White	85.7%	60.7%	40.0%	
Native American	3.6%	3.6%	33.3%	
Latino/Latina	3.6	--	6.7%	
Asian	3.6%	--	--	
Black	3.6%	17.9%	--	
Other	--	10.7%	--	
Not identified	--	7.1%	20%	
Education	$n = 28$	$n = 25$	$n = 15$	*n.s.*
Did not complete high school	14.3%	3.8%	6.7%	
Graduated HS / Earned GED	10.7%	23.0%	26.7%	
Some college	60.7%	46.2%	53.3%	
Associate's Degree	3.6%	7.7%	6.7%	
Bachelor's Degree	7.1%	11.5%	--	
Some graduate school	3.6%	3.8%	--	
Graduate Degree	--	--	6.7%	

Because of the significant differences between groups for age and gender, each of these variables was compared to scores for measures of interest in the current study. An ANOVA analysis revealed no significant differences by gender for the ACS, BDI, BSI, or recall or recognition portions of LM. Similarly, Pearson correlations revealed no significant relationship between age and scores on the ACS, BDI, or BSI. Age also was not related to raw scores for LM recall or recognition after Bonferroni correction for multiple comparisons.

Prior to analyses for each hypothesis, reliability checks were run for scores on ACS, BDI-II, and BSI within the Phase 2 group. Only Phase 2 data were included in these reliability analyses because they were the only group for whom scores for all three measures were available to be included in the comparison under the third hypothesis. Alpha coefficients were run for each measure as a whole, as well as for the four subscales of the ACS. As noted in Table 4, reliability of each measure as a whole was good, ranging from .85 to .93. Alphas for the four ACS subscales were more variable, with scores for the depression and anxiety subscales evidencing the greatest reliability.

Table 4

Phase 2 Descriptive Statistics: Scores for BDI-II, BSI, and ACS

Measure	Mean Score	Standard Deviation	Range	Reliability (alpha)
BDI-II, Total Score	31.5	9.5	8 - 46	.85
BSI, Total Score	106.1	30.2	42 - 151	.93
ACS, Total Scores				
Whole Scale (35 - 245)	167.2	22.3	90 - 215	.89
Positive Affect (10-70)	42.9	7.0	22 - 58	.67
Anger (7 - 49)	36.8	6.1	26 - 48	.64
Depression (7 - 49)	38.4	6.4	27 - 49	.81
Anxiety (11-77)	52.1	9.7	19 - 68	.85

An average BDI-II score of 30.1 (*SD* = 11.8) for participants in Phases 1 and 2 indicates that most participants were experiencing moderate to severe depressive symptoms (see Table 5). Average total scores for the BSI for the entire BPD group (Phases 1 and 2 and manipulation check) were analyzed next. Because 15 people declined to respond to between one and four of the 53 questions on the BSI and thus were excluded from initial analysis of these data, series means were substituted for missing data points to allow for analysis of BSI scores for the entire group. The rationale for substituting series means was based on analysis of items typically not answered, which were ones that most individuals in the group responded to with a number higher than 0, indicating that within this sample of individuals with BPD, these items represented beliefs and experiences common to most participants. Average total scores for the BSI also are displayed in Table 5. Average Global Severity Index (GSI; total score divided by 53 items) is also displayed and represents the average rating for each item across the entire BPD sample. The average GSI for BPD participants in the current study was 1.72, which is comparable to a *t*-score of 71 in a group of nonpatient females and a *t*-score greater than 80 in a group of nonpatient males from the BSI normative sample (Derogatis, 1993), suggesting that BPD participants in the current study were considerably distressed.

Table 5

Scores for the BDI-II and BSI in BPD groups

	Mean	***SD***	***SE***	**Min**	**Max**
BDI-II: Phases 1 & 2 only (n = 56)					
Total Score (0 - 63 possible)	30.1	11.8	1.6	0	52
BSI: all BPD participants (n = 71)					
Total Score (0 – 212 possible)	91.1	42.0	5.0	12	175
GSI (0 – 4 possible)	1.72	0.8	0.1	0.2	3.3

Note: GSI = total score on the BSI divided by 53 and represents the average rating for each item.

Hypothesis 1: Immediate recall for Story A and Story B will be different within participants across all groups, and delayed recall for Story A and Story B will be different within participants in Phases 1 and 2.

In all analyses, "Story A" always indicates the "Anna Thompson" robbery story, while "Story B" always indicates the "Joe Garcia" weather report story.

Hypothesis 1 was supported for the first recall of the stories but not for delayed recall. A repeated measures multiple analysis of variance (MANOVA) was used to test this hypothesis for variables that should not be affected by the repetition of Story B during LM1. The first recall of Story A was compared to the first recall of Story B for all participants in phases 1 and 2, with no need for a co-variate for learning through repetition. As noted in Table 6, for LM1 (n = 56), first recall for the two stories was significantly different, with better recall for Story A (x = 12.55, SD = 4.44) than for Story B (x = 10.45, SD = 4.19). A similar pattern was observed for recall of the stories during the manipulation check, in spite of counterbalancing order of presentation (see below).

Table 6

Repeated measures MANOVA: First recall for stories

Immediate Recall (LM 1): Story A versus First Recall for Story B					
	Mean (0-25)	*SD*	*F*	*p*	η^2
Phases 1 & 2			*df* (1, 55)		
Anna Thompson (A)	12.6	4.4	14.17	< .001	.21
Weather Report (B)	10.5	4.2			
Manipulation Check			*df* (1, 14)		
Anna Thompson (A)	14.3	4.0	4.99	.04	.26
Weather Report (B)	12.0	3.1			

Note: Story A always represents the "Anna Thompson" story, and Story B always indicates the "Joe Garcia" story, regardless of order of story presentation.

Due to the potential confound of repetition of Story B in LM1, a repeated measures multiple analysis of covariance (MANCOVA) was conducted for variables that were likely to be influenced by this repetition. The co-variate chosen for this analysis was the learning slope for Story B in LM 1 (i.e., the difference between the first and second recall for Story B on LM1). In this case, the MANCOVA compared performance on Story A and Story B on LM2, with learning slope co-varied out. For LM2 (n = 56), although actual recall for the two stories appeared different, with recall for Story A (x = 10.23, SD = 4.87) less than that for Story B (x = 13.29, SD = 4.88), the difference was not significant prior to covariance for learning slope, F (1, 54) 1.41, p = .24, η^2 = .03. Once learning slope was co-varied out, differences in performance for the two stories still did not reach significance, in spite of a large effect size (see table below).

Table 7

Repeated measures MANCOVA: Second recall for stories, with learning slope for Story B repetition co-varied out

Delayed Recall (LM2): Story A versus Story B

	Mean (0-25)	SD	F	p	η^2
Phases 1 & 2			df (1, 54)		
Anna Thompson (A)	10.2	4.9	3.12	.08	.54
Weather Report (B)	13.3	4.9			

Performance on the two stories was explored next in terms of retention of material from immediate to delayed recall. First, a repeated measures MANOVA was conducted to compare immediate and delayed recall for each story. For story B, the second recall from LM1 was compared to recall for LM2.

Not surprisingly, immediate recall for both stories was better than after delay, although the effect was stronger for Story A (see Table 8).

Table 8

MANOVA: Immediate versus delayed recall for each story

Immediate versus Delayed Recall for Each Story

	Mean (0-25)	*SD*	*F*	*p*	η^2
Anna Thompson (A)			*df* (1, 55)		
Immediate	12.6	4.4	41.47	<.001	.43
Delay	10.2	4.9			
Weather Report (B)			*df* (1, 55)		
Immediate [a]	14.8	4.7	18.73	<.001	.25
Delay	13.3	4.9			

[a] *Note that Story B immediate recall for this analysis refers to the second recall on LM1.*

Following these comparisons, two new variables were created to reflect percentage of material retained for Story A and Story B. Percentage of data retained was greater than 100% for some participants, who appeared to consolidate material for better recall with delay. Because percentage retained seemed likely to be affected by Story B's repetition on LM1, these two new variables were compared using repeated measures MANCOVA, with learning slope as a co-variate. Prior to covariance, differences in percentages retained for each story were not significant, F (1, 54) 3.03, p = .09, η^2 = .05. Table 9 reveals that differences in percentage retained also were negligible after co-varying for learning slope.

Table 9

MANCOVA: % retention from immediate to delayed recall for each story, with learning slope co-varied out

Percentage Retained from LM1 to LM2: Story A versus Story B

	Mean %	*SD*	*F*	*p*	η^2
Phases 1 & 2 (*n* = 56)			*df* (1, 54)		
Story A	80.7%	26.4	0.58	.45	.01
Story B*	89.9%	21.1			

* *Note that % retained for Story B compares the second recall in LM1 to recall for LM2.*

Hypothesis 2: LM performance will be related to estimated verbal IQ scores (ANART), a measure of attention (Digit Span subtest of the WMS-III), and depressive symptoms (BDI-II scores).

This hypothesis was supported for ANART scores only, although a trend was noted for DSp and LM1 scores ($p = .06$ after correction). A Pearson correlation compared immediate and delayed story recall to scores for the ANART, Digit Span, and the BDI-II. To reduce the chance of Type I error, Bonferroni correction was used. Table 10 shows results of these analyses.

Table 10

Pearson's Correlations: LM and scores for the ANART, Digit Span, and BDI-II

Phases 1 & 2 (*n* = 56)	**ANART**	**Digit Span**	**BDI-II**
LM1 (Immediate Recall)	**.43****	.33[a]	-.08
LM2 (Delayed Recall)	**.40***	.24	-.10

* $p < .05$ after Bonferroni correction
** $p < .01$ after Bonferroni correction
[a] Note: $p = .06$ after Bonferroni correction

Hypothesis 3: Emotion regulation (ACS scores) will be correlated with depressive symptoms and general distress (scores on the BDI-II and BSI).

This hypothesis was partially supported. As previously noted, ACS data were collected only from the Phase 2 group (n = 28). Pearson correlations were run to examine these relationships in the Phase 2 group. Due to the number of comparisons, Bonferroni correction was used to reduce the chance of Type I error. Total scores for the ACS were positively and significantly related to scores for the BSI (see Table 11). Scores for the anxiety subscale of the ACS also were positively related to total BSI scores. All other comparisons were nonsignificant.

Table 11

Correlations between ACS, BDI-II, and BSI in Phase 2 (n = 28)

	BDI-II	BSI
ACS, Whole Scale	.20	.63*
ACS, Positive Affect Subscale	.03	.48
ACS, Anger Subscale	.05	.35
ACS. Depression Subscale	.29	.42
ACS, Anxiety Subscale	.26	.67*

* $p < .01$ *after Bonferroni correction*

Hypothesis 4: Problems with emotion regulation, as reflected by total scores on the ACS, will be predictive of variance in performance for immediate and delayed story recall.

This hypothesis was not supported, although it only could be examined using data from Phase 2 (n = 28). First, Pearson correlations analyzed relationships between total ACS scores and immediate recall for Story A and first immediate recall for Story B, as well as total ACS scores and delayed recall for each story. No significant relationships were found. Next, a difference score (always A minus B) was created for LM1 and LM2 story performance. When Pearson correlations were run for ACS scores and these two new variables, differences were again nonsignificant.

Following the above analyses, variables were created reflecting percentage retained for each story by Phase 2 participants alone (Story A, x = 89.91%, *SD* = 19.23; Story B, x = 92.42%, *SD* = 21.43). Consistent with comparisons conducted for the previous hypothesis for the combined Phase 1 and Phase 2 samples, differences between these percentages of retained material for Phase 2 alone were nonsignificant, both before and after co-varying for learning slope. Next a variable was created that reflected the *difference* in percentage of material retained from immediate to delayed recall for stories (i.e., % retained for Story A minus % retained for Story B). First a simple correlation was run, using total ACS score and *difference* in percent retained; results were nonsignificant, $r = .04$, $p = .82$, two-tailed. Because learning slope might play a role in this analysis, a linear regression was performed, forcing learning slope into the equation first, then ACS score, with difference in percent retained as the dependent variable. These results also were nonsignificant, $F(1, 26)$ .05, $p = .82$.

Hypothesis 5: The relationship between emotion regulation and story recall (ACS and LM scores) will be significant even after controlling for other variables likely to impact performance, including depression (BDI-II), estimated verbal intelligence (ANART), and attention (Digit Span subtest of the WAIS-III).

This hypothesis was not supported; however, these data were available only for the 28 Phase 2 participants. A linear regression was run to test this hypothesis, forcing scores for the BDI-II, the ANART, and Digit Span into the equation first, followed by scores for the ACS. When used to predict immediate recall performance, total ACS scores did not predict a significantly greater amount of the variance, $r^2\Delta = .000$, $F\Delta(4,24) = .000$, $p = .98$. Similarly, when the same regression was run for delayed recall, the ACS did not predict a significantly greater amount of the variance, $r^2\Delta = .003$, $F\Delta(4,24) = .07$, $p = .80$.

Hypothesis 6: Emotion regulation (ACS scores) also will be predictive of variance in story *recognition* scores, reflecting alterations in encoding of information with increased emotional dysregulation.

This hypothesis was not supported. Sample size was smaller, however, as the recognition portion of LM inadvertently was not administered to five individuals in Phase 2. A Pearson correlation was used to explore the relationship between total ACS score and total recognition score. The relationship was not significant, $n = 23$, $r = -.22$, $p = .31$, two-tailed. Because this sample was small, and because total ACS score was found in a previous analysis to be correlated with total BSI score, a second Pearson correlation was run with the larger (Phase 1 and 2) data set, to explore the relationship between general emotional distress (BSI) and encoding of aurally presented material. This relationship also was nonsignificant, $n = 40$, $r = -.03$, $p = .86$, two-tailed, suggesting that differential recall for the two stories was not related to general emotional distress.

Hypothesis 7: In a manipulation check, individuals with BPD features will rate Story A as more emotionally intense than Story B, supporting the proposed relationship between affective response and verbal memory performance.

This hypothesis was supported by the data in the small sample comprising the manipulation check ($n = 15$). A repeated measures MANOVA was conducted, entering emotional valence ratings for each story and emotional intensity ratings for each story as four different variables. General emotional *valence* was rated on a 6-point Likert scale, ranging from "1" for "extremely negative emotions," "2" for "moderately negative emotions," "3" for "mildly negative emotions," "4" for "mildly positive emotions," "5" for "moderately positive emotions," and "6" for "extremely positive emotions." Emotional *intensity* also was rated on a 6-point Likert scale, on which "1" equaled "no emotions," "2" equaled "very mild emotions," "3" equaled "mild emotions," and "4" equaled "moderate emotions," "5" equaled "intense emotions," and "6" equaled "very intense emotions." As shown in Table 12, ratings of *intensity* for both stories were relatively low but significantly higher for Story A than Story B.

Table 12

Repeated Measures MANOVA: Emotional valence & intensity ratings from manipulation check data

	Mean	*SD*	*F* (1, 14)	*p*	η^2
Emotional Valence (0 - 6, Negative to Positive)					
Anna Thompson (A)	3.5	1.1	1.77	.21	.11
Weather Report (B)	4.1	0.8			
Emotional Intensity (0 - 6, None to Extreme)					
Anna Thompson (A)	3.3	1.6	13.91	.002	.50
Weather Report (B)	1.9	0.8			

Interestingly, there were no significant differences in emotional *valence* ratings between the two stories. The average valence rating for Story A was 3.5, while that for Story B was 4.1. These ratings represent the difference between the choice of "3" for "mildly negative" and "4" for "mildly positive," again on a 6-point Likert scale. Because stories were presented randomly in A/B (8 subjects) or B/A (7 subjects) order in the manipulation check, a repeated measures MANOVA was run to examine differences in emotional reaction ratings related to order of presentation of the two stories. When story order was included as a between subjects variable, no significant difference in emotional valence or intensity was found, F (1, 13) = .23, p = .64, η^2 = .02 for valence X order and F (1, 13) = .08, p = .79, η^2 = .01 for intensity X order. These results suggest that participants rated stories differently based on order of presentations. As seen in Table 13, there were greater differences in both valence and intensity ratings for the two stories when Story A was presented first than when Story B was presented first. Results of these analyses should be interpreted with caution, however, because power was less than .30 for the MANCOVA in this small sample, leaving open the strong possibility of Type II error.

Table 13

Means and standard deviations for emotional rating of stories by story order

	Order of Story Presentation	
	A/B (n = 8)	**B/A** (n = 7)
Emotional Valence (0 – 6)		
Anna Thompson (A)	3.4 (1.4)	3.7 (0.5)
Weather Report (B)	4.3 (0.9)	3.9 (0.7)
Emotional Intensity (0 – 6)		
Anna Thompson (A)	3.4 (1.6)	3.1 (1.7)
Weather Report (B)	1.5 (0.8)	2.3 (0.8)

Finally, an ANOVA was run to explore differences in the amount of material recalled for each story based on order of presentation in the manipulation check. Participants recalled more from Story A than from Story B regardless of order. As shown in Table 14, participants recalled more of Story A and less of Story B when Story B was the first presented, although no significant differences for story recall by order of presentation were found in the small sample in this analysis.

Table 14

Means and standard deviations for recall of each story, by order of story presentation

	Order of Story Presentation	
	A/B (n = 8)	B/A (n = 7)
Total Recall (0 - 25)		
Anna Thompson (A)	13.6 (3.7)	15.1 (4.5)
Weather Report (B)	12.3 (3.3)	11.7 (3.1)

Note: Paired samples t-test found significantly better recall for Story A (Anna Thompson) than for Story B(Joe Garcia), regardless of order of presentation, $t = 2.23$, $df = 14$, $p < .05$.

Finally, because the general pattern of results observed was relatively consistent for data from all three groups in the study and did not appear to be related to story order or the presence of emotional dysregulation in these BPD samples, the question arose of whether differential performance for the two stories is typical in other groups. To examine this question, data on LM performance from a convenience sample of 38 healthy control subjects (90% females; described previously) was compared to the results for the Phase 1 and 2 BPD participants. Control participants were significantly older than those with BPD, with an average age of 54 (SD = 11.4, range of 20 to 73 years), F (1, 93) = 57.94, $p < .001$. Control participants reported a significantly level of education, with 65.7% stating that they had earned a bachelor's degree or higher, compared to more than 70% of the BPD sample having no college degree. Most controls were working or had retired from a health care related field, compared to the majority of BPD participants, who were unemployed or living on disability.

First, performance for recall of each story was compared within the control group. As in earlier analyses, data were analyzed using repeated measures MANOVA for those scores that should not have been affected by the repetition of Story B during the immediate recall portion, and using MANCOVA, with learning slope co-varied out, for comparisons that were likely to be affected by Story B's repetition. Consistent with the results for the BPD groups, immediate recall for Story A was significantly better than for Story B (see Table 15). After delay, differences in recall were not significant following covariance for learning slope.

Table 15

Repeated measures MANOVA/MANCOVA: Immediate and delayed recall for each story in the non-BPD control group

Recall for Story A versus Story B in the Control Group

	Mean (0-25)	*SD*	*F* (1, 36)	*p*	η^2
Immediate Recall (LM1)					
Anna Thompson (A)	16.2	3.0	57.35	<.001	.64
Weather Report (B) [a]	13.0	2.7			
Delayed Recall (LM2) [b]					
Anna Thompson (A)	14.1	2.8	1.41	.24	.04
Weather Report (B)	15.8	3.6			

[a] *Note that LM1 immediate recall for Story B refers to the first recall only.*
[b] *Note that MANCOVA was conducted for this comparison, co-varying for learning slope from repetition of Story B during LM1.*

Recognition scores for each story in the control group were examined next. As described previously, under standardized administration of LM, a recognition trial follows the delayed recall portion of the test and consists of 15 Yes/No questions about each story. A paired samples *t*-test was used to examine differences in recognition performance. As noted in Table 16, participants responded correctly to slightly more of the questions for Story B than for Story A, likely reflecting the effects of improved memory for material that has been repeated.

Table 16

Paired samples t-test: Control group recognition trial performance for each story

Control Group Recognition Trial: Story A versus Story B				
# Correct (0 - 15)	**Mean**	*SD*	*t* (*df* = 37)	*p*
Anna Thompson (A)	13.5	1.1	2.27	.03
Weather Report (B)	14.1	0.9		

Next, an ANOVA was run to explore differences in story recall performance for the healthy control group versus the BPD group (Phases 1 and 2). As noted in Table 17, after Bonferroni correction, the control group performed significantly better than the BPD group for first recall of each story and for total immediate and delayed recall. Learning slope, or the amount of improvement in free recall for Story B from the first to the second repetition of the story during LM1, was not significantly different between groups.

Table 17

ANOVA: Comparison of recall performance for control (n = 38) and BPD (n = 56) groups

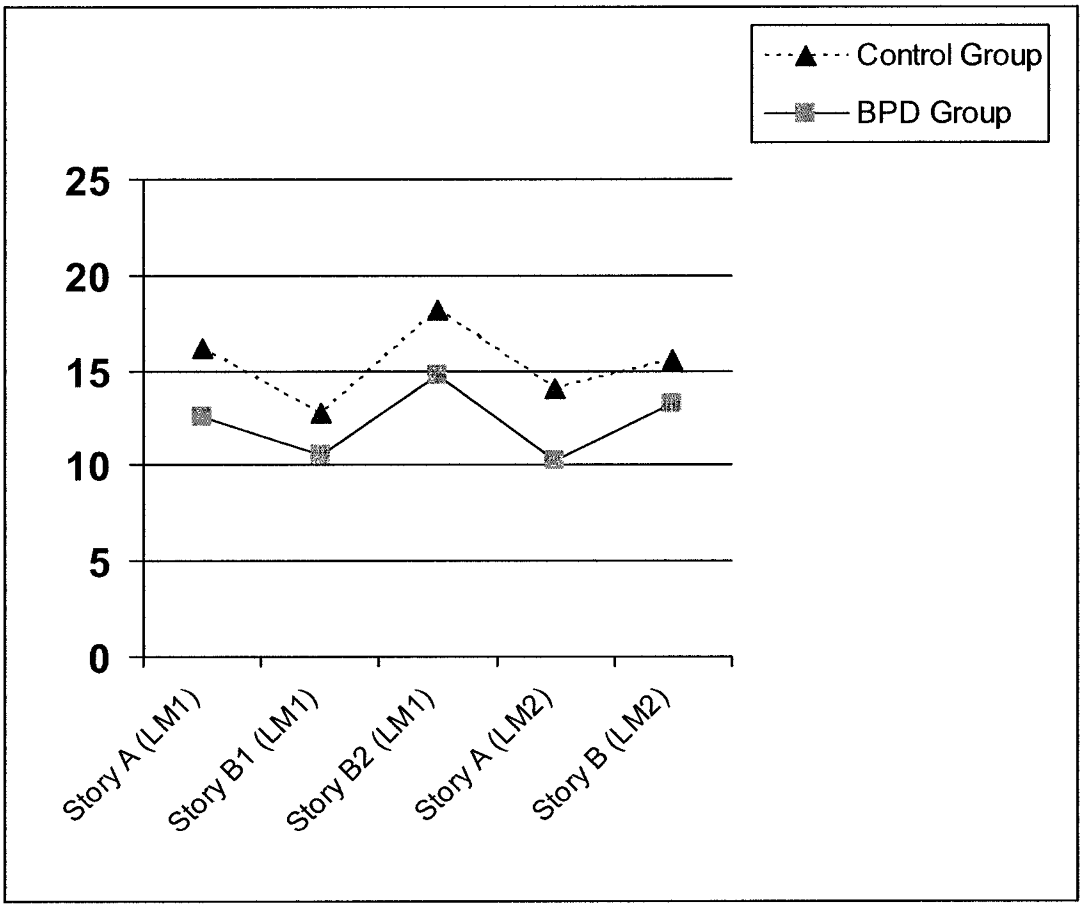
	Mean	*SD*	*F* $df(1, 93)$	Significance*
1st Recall for Story A and for Story B				
Story A (0 – 25 possible)				
Control Group	16.2	3.0	19.34	$p < .005$
BPD Group	12.6	4.4		
Story B (0 – 25 possible)				
Control Group	12.8	2.8	9.73	$p < .01$
BPD Group	10.5	4.2		
Immediate and Delayed Recall				
Immediate (LM1; 0 – 75 possible)				
Control Group	47.3	7.2	19.47	$p < .005$
BPD Group	38.0	11.5		
Delayed (LM2; 0 – 50 possible)				
Control Group	29.9	5.5	16.00	$p < .005$
BPD Group	23.5	8.8		
Learning Slope: 2nd minus 1st recall for Story B				
Control Group	5.3	3.0	2.76	*n.s.*
BPD Group	4.3	2.8		

** Significance is p value after Bonferroni correction.*

When a repeated measures MANOVA was run to examine differences in recall and recognition for each story between groups, no interaction was found between group membership and differences in performance for Story A versus

Story B. Figure 3 displays mean (raw score) performance for each recall of each story by group. As seen in the figure, recall for Story A was better than for Story B for both groups initially, with improved recall for Story B after repetition and better recall for Story B after delay. The control group consistently outperformed the BPD group across all trials, in spite of non-BPD participants being significantly older than those in the BPD group.

Figure 3. Mean scores for each recall of stories by group: BPD participants and healthy controls



Discussion

The current study yielded several interesting findings, some of which support prior research and some of which pose new questions concerning emotion regulation, memory, and content of memory instruments. Contrary to expectations, no relationship was noted between self-reported fear of emotional dysregulation and observed differences in memory for two stories in a sample of individuals with BPD, even though a subset of this group rated one story as significantly more emotionally intense. In addition, participants with BPD and healthy controls both showed better memory for an emotionally evocative story than for a more neutral story, although recall for both stories was consistently better in the healthy controls than in the BPD group. Each of these findings is considered below, followed by a brief discussion of their relationship to therapy and assessment issues in BPD. Finally, limitations and strengths of the study are noted, followed by suggestions for future research.

Emotion Regulation: Relationship to Verbal Memory in BPD

In the current study, self-reported problems with emotion regulation were not related to participants' ability to recall stories or to differential recall for emotionally evocative versus more neutral stories. These results are surprising in light of Linehan's (1993a) proposal that in BPD dysregulation in one domain of functioning interacts with one's ability to modulate other domains. The reason for the lack of relationship is unclear, although several possibilities are readily apparent. It may be that there truly is no relationship. If indeed difficulty regulating affect is not related to memory in BPD, therapists may feel reassured that clients with BPD, regardless of emotion regulation abilities, may have less difficulty retaining material from therapy than expected. This explanation is likely too simplistic, however. Given that no previous studies have explored the relationship between emotional regulation and memory in BPD, this conclusion seems premature, as it is equally likely that a relationship exists that was not detected in this study.

Why wouldn't the relationship be detected? It may be that the differences between the emotional tone and intensity for each story were not sufficient to provide a strong effect in terms of actual emotions aroused in the listener. The content of the Logical Memory stories, in the context of the relatively secure, well-controlled setting of a therapy clinic, may not have been enough to evoke an intense emotional response. Indeed, the relative mildness of the emotional response to the stories was born out in ratings of valence and intensity by the participants in the manipulation check. Researchers who have studied emotionally evocative material in other populations have found that reliable activation of emotion processing systems occurs only with intensely negative images (Canli, Zhao, Brewer, Gabrieli, & Cahill, 2000; Ochsner et al., 2002). Individuals with BPD may be able to contain and modulate their emotions in the face of a relatively mild stimulus that may feel somewhat remote from anything in real life. Based on the relatively mild ratings of each story by the participants in the manipulation check, the content of the stories appears to be widely divergent from the type of stimuli that typically evoke strong emotional reactions in individuals with BPD and may not accurately model the level of emotional response needed to affect cognitive functioning per Linehan's paradigm.

Aside from their theoretical level of emotional impact, specific content of the stories also may have affected outcome. If the material in the stories was not personally relevant to the listener, the emotions evoked may have been less intense. For example, Story A's focus on being poor, hungry, unable to care for children, and the target of crime may have been very personally relevant to some subjects, but irrelevant to others. The degree of personal relevance also may be important to the encoding process in that the listener may be distracted if the relevant content acts as a cue to his/her own life difficulties. Such cues may cause listeners to attend primarily to relevant material at the expense of less personally meaningful material. Such an interpretation would be partially consistent with the findings regarding recall for the word "spider" and surrounding words in the study outlined earlier by Kulas and colleagues (2003). Phenomena observed in other research, such as the cocktail party effect, also support a bias for attending to others' words more when those words have personally relevant meaning. Given the generally poor financial status and high rates of trauma in BPD populations, it may be that the Anna Thompson story (Story A) was simply more personally relevant for some individuals and was recalled better regardless of ability to regulate emotions.

Akin to this idea, gender differences between the protagonists of the two stories may have affected the degree to which participants responded emotionally. For example, males may have more readily identified with and responded to a story about a single father being robbed, and women may have listened more closely to a story about a woman planning to go out but being stopped by bad weather. Phase 2 participants were the only group to complete the ACS, and about a third of this sample were male. Although no main effect for gender was found in the current study, the possibility exists that had stories been counterbalanced for the gender of the protagonist in each, gender effects might be detected, both in terms of recall and emotional reaction.

Measurement poses another issue in the lack of observed relationship between emotion regulation difficulties and memory. The fact that this relationship could only be analyzed for the 28 participants from Phase 2 raises the possibility of Type II error; it may be that there was a small effect that could not be detected with this limited sample due to low power. In addition to a larger sample, a wider contrast of emotional intensity and tone in the stories might increase the effect size and help clarify the relationship. Additionally, the ACS asks about the extent to which the respondent "fears losing control of emotions." It would have been helpful to include a second self-report instrument to assess actual emotion regulation difficulties, as different measures may assess different aspects of the larger construct, providing a more complete picture of the relationship between emotions and memory in BPD. Further, measuring level of emotional dysregulation through self-report alone may not be adequate to capture an accurate picture of level of emotional dysregulation in individuals with BPD. Some might argue that using only self-ratings of this construct in a population that is known to have high rates of dissociative phenomena and alexithymia is problematic. If participants in the current study were highly dysregulated but had poor insight into their emotional lability, self-reports regarding emotion regulation may be less valid than observed behavior. Supplementing self-reports with observations from others regarding dysregulated behavior might shed light on the degree of emotional dysregulation being experienced by participants. Others would argue that self-report provides the most accurate assessment of an individual's internal state. Having another person's report may be another useful way to look at things, but would not necessarily be helpful. For example, a person with BPD may experience intense negative affect, but be able to successfully mask emotions much of the time, displaying dysregulation only in the most stressful of circumstances. In that case, others would not be able to accurately assess the extent to which the person is having difficulty regulating. At this juncture, it is unclear to what extent alternate ways of measuring difficulty with regulating emotions would help clarify the relationship between emotional dysregulation and verbal memory in individuals with BPD.

Differential Performance for Emotionally Evocative Versus Neutral Material

In spite of a lack of correlation between memory and emotion regulation difficulties, the current study provides evidence for differential recall of aurally presented material with emotionally evocative content versus more neutral content in a BPD sample. Immediate recall for Story A, containing descriptions of a woman being robbed at a time when her children were going hungry and her rent was due, was significantly better than immediate recall for Story B, describing a man listening to a weather bulletin warning of incoming storms and deciding to stay home. Differences in amount of material recalled were attenuated with delay, although this relationship is complicated by order effects and the repetition of Story B in the immediate recall portion under standard administration.

Within the framework of the current study, the most obvious difference between the two stories is emotional tone and intensity. As described previously, it seems likely that individuals with BPD might identify with the Anna Thompson story. As such, they may be able to connect the events in the story to things they also have experienced. In this sense, information in the Anna Thompson story would have an inherent and emotionally salient framework for organization and encoding that may not be present for the weather report story. In addition, evocation of an emotional response might enhance recall, as long as emotions are not too intense.

What else about Story A might make it more memorable, if not simply the fact that individuals listening to the two stories rated one as more emotionally intense than the other? It may be because Story A (65 words) is actually shorter than Story B (89 words), even though only 25 points could be earned on each. Perhaps participants are more likely to recall the specific 25 details that are needed to earn the points for Story A merely because the odds are better. In addition, Story A contains three number items (i.e., "*fifty-six* dollars," "*four* small children," and "*two* days"), whereas Story B contains four (i.e., "*six* o'clock," "*two* to *three* hours," "*four* inches of rain," and "*fifteen* degrees"). People who have difficulty with math and numbers may immediately block these items or experience so much anxiety when they hear them that they have difficulty attending to the story. Each number item makes up one of the 25 criteria for points on each story, so such anxiety might skew results. Finally, most people hear weather reports on a daily basis, whereas they are less likely to hear detailed accounts about the personal effects of a robbery. Hence, it may be that the relative novelty of the Anna Thompson story, compared to the weather report story, enhances attention to and memory for its details, resulting in better scores.

Results of the manipulation check, in which order of stories for immediate recall was counterbalanced, offer some enticing hints about what might be expected if the entire sequence were counterbalanced. Even with counterbalancing in the manipulation check, recall for the Anna Thompson story was better than that for the weather report story. In fact, when Story A was presented after Story B, participants recalled more of Story A and less of Story B, suggesting a fairly robust relationship between story content and memory. The sample in the manipulation check was small and split into two groups of only 7 and 8 each for the counterbalanced administration, so it is not clear that these results would generalize to a larger group. However, small sample size would be more likely to contribute to failure to detect an actual effect rather than to detecting an effect when none exists, due to lower power. This suggests that the effect of differential recall for the two stories was large in this group. Under a counterbalanced full administration of LM, if recall for Story A were to be better when the story was presented after Story B in a larger sample, one might expect that repetition of Story A would only enhance the differential recall for the two stories on delay.

Verbal Memory Performance in BPD and Non-BPD Samples

All of the above points regarding differences between the two stories bear consideration in light of the results noted in the comparison group of healthy controls. The control group, although also potentially affected by the emotional content of the stories, may have been influenced similarly by factors such as novelty, story length, and the presence of numbers in each story. Indeed, the performance of the control group paralleled that of the BPD groups, albeit with consistently higher average raw scores for each point in the time series.

What might be some of the reasons for better recall in the non-BPD group? Previous research indicates that rates of anxiety and depression are significantly higher in BPD than healthy control populations. High levels of anxiety and depression have also been shown to have negative effects on memory. At first glance, it seems reasonable to assume that each of these factors may play a role in the differences in memory performance for the BPD and control groups in the current study. Anxiety was not assessed as a separate construct in the current study; however, level of depression within the BPD group was *not* correlated with memory performance. Depression scores ranged from a low of 0 to a high of 52 out of 63 possible points on the BDI-II, suggesting that although scores were significantly elevated as a group, there was adequate variability to consider the relationship with memory performance. Thus, the lack of relationship cannot be dismissed simply because all members of the BPD group were too similar in levels of depressive symptomatology.

A more likely candidate for differences in memory performance between the control and BPD groups is substance abuse. Participants who served as controls were excluded for any history of substance abuse. In contrast, BPD participants were excluded only if they were currently abusing substances to such an extent that it was interfering with their daily life. Rates of substance abuse are substantially elevated in the BPD population as a whole. As such, even those BPD participants who were not using at all at the time of the study had a high likelihood of previous abuse history. This difference may not have completely accounted for memory differences between groups, but it does appear to be an important consideration when reviewing these data.

Other discrepancies between the groups also may play a role in observed memory differences. For example, socioeconomic factors, such as level of education and current employment, may have some relationship to differences in performance. The control group had a higher level of education than the BPD group. School typically emphasizes auditory over other forms of learning, and group differences may be suggestive of more training on the part of the control group for auditory memory. Alternatively, it may be that individuals with BPD are more likely to have learning disorders or behavioral problems with school that negatively interact with their memory capacity and decrease the chances that they would pursue higher education. Problems with attention, discussed further below, are one central consideration. The control group's higher rate of current employment also may be relevant. Again, the relationship seems likely to be a two-way street rather than a one-way, causal effect. Individuals with BPD may have so many problems with dysregulated emotions, sleep, and interpersonal skills that they are less likely to hold jobs, and these same problems may contribute to memory difficulties, as described by Linehan (1993a). It also is possible that being in the workforce helps maintain memory abilities by demanding a higher level of these skills than is required in unemployed life. The latter point obviously would vary across different types of employment and across the varying burdens carried by different unemployed individuals;

however, it seems plausible that some relationship between employment status and memory may contribute to the differences between groups in the present research.

Ability to attend to auditory stimuli also bears consideration. One measure of attention was included in the present study (Digit Span subtest), and performance on this measure was not related to memory for the two stories. This measure requires only brief retention of a short series of numbers, however, and does not specifically assess an individual's ability to attend to a longer, more complex stimulus. Attention measures were not included in the comparison (control) group data for the current project, so it is not possible to compare the two groups on this factor. Based on prior imaging and neuropsychological research, however, it seems likely that the BPD would have more problems with attention than the control group, contributing to relative impairment in memory performance. It is also possible that problems with other aspects of executive functioning interfered with memory in the BPD group. For example, if BPD participants had difficulty mentally organizing/categorizing the various aspects of each story, they would be likely to experiencing more problems with storing and retrieving the information.

Other factors also may play a part. Estimates of intelligence *appear* to be slightly higher in the control group ($x = 114.03$, $SD = 5.05$, $SE_x = 0.82$, range of 100 to 119) than in the BPD group (Phases 1 and 2 only, $x = 111.02$, $SD = 8.34$, $SE_x = 1.11$, range of 92 to 127), but each of these sets of estimates were based on two very different formulas. In the control group, estimates of intelligence were based on a demographic formula that includes race, geographic region in which people are raised, gender, level of education, and nature of current employment (see Barona, Reynolds, & Chastain, 1984), resulting in an unexpectedly narrow range of IQ estimates for that group. It is unclear how well these estimates translate to performance-based IQ estimates. Verbal IQ estimates in the BPD group were based on individual performance on a word reading measure (i.e., the ANART). Although the ANART is only an estimate, it is based on actual performance data collected from individual subjects, and the wider range of estimated scores derived from the ANART in this group were closer to the distribution that would be expected in the general population, lending some credence to its degree of validity. Given the different formulas and their resulting scores, these estimates could not reasonably be compared statistically. Thus, it is unclear to what degree intelligence played a role in memory differences in the present study.

Age may be a more significant factor in the comparison of the participants in the two groups. Control participants were significantly older than those in the three BPD groups. As with many cognitive tests, scaled scoring for WMS-III is based on age and generally allows for declines in cognitive functioning later in the lifespan. If they were representative of a relatively normal group of individuals, control group participants, most of whom were in their fifties and sixties, might be expected to perform slightly worse on memory tasks in terms of raw scores than those in the BPD groups, most of whom were in their thirties and forties. In light of these expectations, the higher average raw scores on Logical Memory in the older control group are somewhat surprising. In addition, given that verbally based estimates for BPD participants' IQ scores were at the upper end of the normal range, their scaled scores for a verbally based memory test might be expected to also be at the upper end of the normal range. However, mean immediate recall scaled scores for the Phase 1 and 2 groups for LM were 9 to 10, at or just below the middle of the average range.

If ANART scores are reasonable estimates of verbal intelligence, this pattern of results, while clearly not indicating generalized impairment on story recall scores in participants with BPD, is suggestive of performance somewhat below expectations. Previous research, showing verbal memory deficits in BPD samples, typically has focused on individuals with BPD who were hospitalized, primarily because people meeting this diagnosis are more accessible in inpatient populations. Hospitalized individuals with BPD would be expected to demonstrate more problems with verbal memory. In the present study's group of individuals with BPD who were functioning well enough to be living outside a hospital setting at the time of the study, performance slightly below the mean was noted for immediate verbal recall, in the context of verbal intelligence estimates slightly above the mean. Given the fact that they still scored in the average range, however, these results for LM performance should not be over interpreted. Predicting verbal intelligence using the ANART or demographic factors and using such an estimate for comparison to performance on the WMS-III is an approach fraught with problems, some of which are discussed later under a section on the relationship between results of this study and issues in therapy and assessment.

Equally important, participants from both BPD and healthy control groups demonstrated similar patterns of performance in memory for each of the two stories comprising the Logical Memory subtest of the WMS-III. These results challenge the comparability of the content and structure of the two stories, in that immediate recall was better for one regardless of group membership or order of story presentation. If story content can affect memory so demonstrably and consistently, the reliability and validity of verbal memory tests comes into question. This issue is also touched on in the section below on relationship of the results to assessment.

How Do These Results Relate to Real Life?

Individuals with BPD in the present study, while performing significantly more poorly on a verbal memory test compared with a control group and less well than might be predicted by IQ estimates, still earned scaled scores in the normal range as a whole. These results have implications for our general understanding of cognitive performance in BPD, as well as for therapy and assessment. Just as was true for the control group, the BPD group demonstrated better recall for the story that was rated as more emotionally intense by manipulation check participants. Also of note, although BPD participants performed less well for *immediate* recall than their non-BPD counterparts in the present study, for the most part, their *delayed* recall scores generally fell near the high end of the average range, suggesting an ability in the group as a whole to consolidate aurally presented, contextual information over time. Distribution of scaled scores into the "borderline range" and "superior range" was also noted in this sample (WMS-III criteria and descriptors, Wechsler, 1997b), with a distribution curve close to normal for both immediate and delayed recall.

How do these results relate to our current understanding of individuals with BPD? In general, it appears that among people with BPD who functioning well enough to live in a community setting, verbal memory may be less impaired than previous research has suggested. At least within the context of a calm atmosphere into which they have voluntarily ventured, people with BPD appear to be able to listen to a narrative with a moderate number of details presented in a coherent format and retain the information they have heard fairly well. Results of the study indicate that recall improves after delay. The reason for this improvement over time may be related to anxiety on first hearing the stories, which may inhibit their ability to recall information initially. Alternatively, individuals with BPD simply may require extra time to organize and consolidate information from the stories, resulting in recall more in line with their estimated level of verbal intelligence after delay.

Results of the current study also have implications for conducting therapy with this population. Typically, therapy is highly verbal, contextually relevant to the individual, and emotionally evocative. As such, the present results suggest that individuals with BPD as a group may be able to retain material from therapy reasonably well. However, therapy is likely to evoke much stronger emotions than the controlled, brief exposure to another person's story that was part of the current research. It is not clear how well these results would generalize to more intensely emotionally evocative material in a population with poor emotion regulation skills. It also appears that individuals with BPD may benefit from repetition and, to a greater degree, from being allowed time to process and consolidate information. What is not clear is the degree to which noncontextual information is remembered and retained in this population. This and previous research has not examined the effects of even mildly emotionally evocative content on the ability of individuals with BPD to retain information that is less contextual. At times in therapy, especially when new skills are being taught or a new framework for understanding personal experience is presented by the therapist, clients experience the new skills or framework as disorganized, alien, and unconnected to their lives and ways of thinking. Presentation of this new material also can evoke strong emotional reactions, even in the most unflappable of clients. It can be difficult even for an individual with a strong ability to think abstractly and conceptually to find a way to "hang" this new information on their existing experience and outlook and to retain it for easy reference outside of therapy. Individuals with BPD may have more difficulty categorizing and organizing less contextual material for retention, based both on prior studies showing neuroanatomical and physiological alterations in the frontal lobes in BPD and on neuropsychological studies indicating deficits on frontally mediated tasks in this population. Strong emotional reactions may further complicate this picture by triggering a dysregulated cycle of emotions that in turn interact with dysregulation in other spheres of functioning, per Linehan's (1993a) model. If indeed future research supports the idea that individuals with BPD have more difficulty retaining noncontextual than contextual information, it may prove helpful for therapists to present new information and ideas in a manner that carefully and concretely connects the material to the client's life. Additionally, the performance of individuals in the current study suggests reasons that groups for skills training outside of therapy have proven beneficial in BPD populations. Although therapy often piques very intense emotions, skills training groups have a central goal of conveying information in an atmosphere that is emotionally safe, allows only limited sharing of emotionally evocative personal material, and is well structured. In such an environment, it appears that individuals with BPD have the ability to learn and remember new information, at least for the short term.

As noted, the content of the stories used in the present study, while rated as mildly to moderately emotionally intense, did not generally provoke the type of strong affective response often seen in individuals with BPD in the course of therapy. The association between increased affective response and ability to memorize new information is not likely to be a simple linear relationship; it seems more likely that it is curvilinear. Based on prior research suggesting that while mild to moderate anxiety may improve learning, intense anxiety is likely to impede it, it seems plausible that more emotionally charged content may impede memory in this population. In terms of therapy, therefore, results of the current research are promising but should be considered in the broader context of emotional intensity and relevance to the individual's life.

These results also present considerations for assessment in individuals with BPD, one of which is the contextual nature of the LM subtest. Individuals with BPD are known to struggle most in situations in which they have little support and structure. In fact, a central emphasis in DBT is helping clients to learn to modify their environments and structure their lives to be as supportive as possible, creating a regular schedule for sleep and ensuring appropriate food intake, for example. With additional structure and balance in areas of their lives that are more easily manageable, the regulation of emotions becomes a more achievable goal. Given that individuals with BPD are generally intensely responsive to environmental stimuli, it may be that something as seemingly small as contextual versus non-contextual verbal material (i.e., stories versus random word lists) creates enough additional structure to temper the effects of the emotional content of the stimulus. It should not be assumed, therefore, that results of the current study would translate to assessment of auditory/verbal memory based on word lists or noncontexual aurally presented material. In addition, it is unclear how these results apply to individuals with BPD who are hospitalized. Per Linehan's model, when an individual with BPD is in crisis, they are likely to become more dysregulated across several domains, including cognitive functioning. Hospitalized individuals with BPD might be expected to have more difficulty organizing the information presented in these stories for recall, resulting in poorer performance. In terms of assessment, these results pose questions about how to best assess verbal memory in BPD populations. Would the inclusion of both contextual and noncontextual stimuli provide a clearer picture of this facet of cognition in this population? It seems possible, for example, that using both LM and a word list paradigm, such as the California Verbal Learning Test, may provide incremental validity to memory assessment results in this population. This approach has a strong basis in prior research indicating problems in frontal lobe functioning in BPD, as well as grounding in the therapeutic literature.

Limitations

Limitations of the current study include factors related to the participants and to the measures/tasks. The lack of careful screening for traumatic brain injury in the BPD group is problematic, in that previous studies have noted significantly elevated rates of such injuries in other BPD samples (Streeter, van Reekum, Shorr, Bachman, & et al., 1995). If there was a high rate of head injuries in the present sample, it could have influenced verbal memory performance. Additionally, no data were available regarding right versus left hand dominance in BPD groups. Differences in age, education, and employment between the BPD and control groups limit the interpretability of group variance in memory performance. For example, it may be that age plays some role in the interaction between difficulty regulating emotions and performance on verbal memory tasks; because age was significantly higher in the only group that completed the ACS, it is unclear to what degree these results would generalize to younger samples.

In another study, J.R. Gray (2001, p. 447) reported a relationship for emotion by task performance of only $r = .24$ under more controlled conditions. Additionally, in Gray's study, the effects of emotions on task performance were strongest for individuals performing in the lower ranges. Similarly, if there was a mild correlation between emotions and memory performance in the relatively small and generally high functioning group of individuals comprising Phase 2, it may not have been detected. Gray proposes that larger sample sizes may be needed in research on emotions and cognition until this body of research is more refined, with less "noise" in the data. In addition, use of only the LM subtest versus inclusion of a more frontally affected verbal memory task, such as the CVLT-II (see Stuss & Levine, 2002, pp. 410-411), limits the ability to fully describe differences in verbal memory in BPD samples. Finally, the lack of a complete counterbalanced trial, including repetition of the second story and delayed recall and recognition, limits the interpretability of these data regarding differential recall for the two stories.

Strengths

In spite of the noted limitations, the present study has a number of strengths. Few studies of BPD to date have included male participants. About a third of the participants in Phase 2 and the manipulation check were male. The fact that no gender differences were observed for the central measures of interest suggests that results may generalize across genders in the BPD population. Similarly, the relatively small number of exclusion criteria is a positive in terms of external validity.

The present research represents the first known investigation of the relationship between emotional dysregulation and verbal memory in the BPD population. Measures that are commonly used in clinical assessment of memory and cognitive performance were used, providing information that may prove useful for assessment in the population in the future. Finally, several significant results were detected even within the context of a small sample size, suggesting that effects for many aspects of the study were fairly robust.

Future Research

Results of the present study suggest that further investigation of the relationship between emotions and memory in BPD samples is warranted. It would be beneficial for future studies to include stories with a wider variety of levels of emotional intensity and tone. In addition, the inclusion of both contextual and noncontextual stimuli would help clarify the nature of memory in this population. More longitudinal assessment research in BPD also seems warranted, in that it is currently unclear how cognition is affected by aging in this population. It would also be helpful to investigate the ability of individuals with BPD to retain information from therapy and skills groups; while aspects of this research have been initiated, in the form of the larger study from which the current data were drawn, more "real-world" information about memory in this population would inform both treatment and assessment. Neuroimaging studies of emotions and memory in BPD also would enhance our current understanding of the disorder. Finally, additional research regarding differential performance for the two stories that comprise the LM subtest seems critical, not only using BPD samples but also other disordered and healthy populations.

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