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Emotion Regulation in Borderline Personality Disorder: A Psychophysiological Examination of Emotional Responding and Recovery in BPD

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EMOTION REGULATION IN BORDERLINE PERSONALITY DISORDER: A PSYCHOPHYSIOLOGICAL EXAMINATION OF EMOTIONAL RESPONDING AND RECOVERY IN BPD

By

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This work is dedicated to those individuals who have demonstrated exceptional courage in their struggle with Borderline Personality Disorder. Their willingness to share their experience, suffering, and insights has been the inspiration and impetus for this project. It is the hope of this researcher that the findings of this study can help to dispel the stigma of BPD and to give some understanding to the biological underpinnings of the disorder.

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ABSTRACT

This study examined affective instability in Borderline Personality Disorder using the startle-probe reflex as a direct physiological index of emotional reactivity and regulation. Based upon Marsha Linehan's (1993) theory regarding fundamental deficits in emotion regulation in BPD, we hypothesized that borderline participants would show aberrant patterns of startle potentiation while viewing both pleasant and unpleasant pictorial stimuli.

Participants included 19 undergraduate college students who met criteria for Borderline Personality Disorder and 16 non-borderline students. Each participant viewed a series of 126 color slides (42 pleasant, 42 neutral, and 42 unpleasant) that were normed on ratings of valence and arousal. On 64 trials, a 50 ms burst of white noise was presented at differing time frames following onset of the 6-sec slide-viewing period. Slide valence categories were employed to assess the startle valence effects as measures of emotional intensity. Later probes were presented at 6.5, 7.5, 8.5, and 13 sec to assess emotion regulation. Startle blink responses to the probes were recorded via the EMG.

Borderline participants showed significantly higher overall magnitudes of startle reflex response to pleasant, neutral, and unpleasant pictorial slides. While comparisons produced a linear valence effect, borderlines showed no significant valence trends. With respect to emotion regulation, comparison participants produced a positive linear trend across probe times reflecting a general increase in emotional intensity over time. Borderlines produced no such trend and demonstrated sustained magnitudes of startle across the 13-second epoch. Post hoc analyses revealed greater startle reactivity among borderline participants and a higher probability of startle response on any trial. Neither mood state nor affective disposition was found to be associated with the magnitude of startle response, suggesting that the effects observed are relatively unique to Axis II psychopathology. The results support Linehan's (1993) hypotheses regarding heightened emotional reactivity and delayed recovery of emotional responding in BPD.

The results of the present study are interpreted in terms of fundamental deficits in emotion regulation in BPD. Increased "startleability" among borderlines might reflect increased

reactivity of neural circuitry associated with defensive responding. Sustained increase in startle magnitude and probability across probe times might reflect delayed emotional recovery in BPD. Possible scenarios regarding cortical and subcortical deficits in emotion regulation are offered. The contribution of contextual factors, i.e., aversiveness of the experimental procedure and interpersonal context, are discussed.

CHAPTER 1
INTRODUCTION

The aim of the present study was to investigate the magnitude and time course of emotion responding in Borderline Personality Disorder (BPD) using the startle probe reflex. Marsha Linehan (1993) has proposed that the affective and behavioral instability characteristic of borderline patients, in part, stems from fundamental irregularities of the emotion regulation system. These irregularities would include a rapid onset, high intensity, and slow recovery of various positive and negative emotional states. In turn, such irregularities would predictably lead to the implementation, by the individual, of various behavioral efforts to modulate intense and often intolerable emotions. The behavioral regulation of emotion might include maladaptive and characteristic impulsive and self-harming behaviors commonly seen in Borderline Personality Disorder.

Despite a considerable body of research that has looked at neurological structure and function in BPD through attempts to identify biological factors that may be linked to various symptoms or personality characteristics, the irregularities in emotion regulation that are proposed by Linehan (1993) have received little empirical attention. Recently in a series of studies, Herpertz, et al. (1999, 2000, 2001), employed the startle reflex method to test Linehan's hypothesis that borderlines experience a generalized hyperreactivity of emotional responding. Emotional intensity in BPD participants was examined and compared to that of healthy individuals and to individuals in other diagnostic groups. Results of the studies did not support Linehan's hypothesis, and, in fact, the researchers reported similar magnitudes of startle response among borderlines as those seen in mentally healthy individuals under standardized startle conditions (Herpertz, Kunert, Schwenger, Eng & Sass, 1999; Herpertz et al., 2000; Herpertz et al., 2001). Herpertz et al. concluded that borderlines do not exhibit a generalized emotional hyperreactivity but may experience high emotional intensity in response to certain contextual conditions such as situations that might elicit the fear of abandonment (2000).

Thus far, other aspects of Linehan's (1993) theory of emotion dysregulation in BPD have not been examined. Empirical work is needed to determine whether borderlines experience

physiological irregularities in emotional responding and regulation and under what conditions such irregularities might result in affective and behavioral dyscontrol. It was the purpose of this study to explore some aspects of emotional responding and regulation in BPD and to provide information that may give clarity with regards to the affective instability among borderlines. Specifically, the intent was to determine by means of the startle blink method whether borderlines differ with respect to the intensity and recovery cycle of their emotional responses.

The Borderline Personality

Characteristics

According to the DSM-IV (1994) the essential feature of Borderline Personality Disorder is "a pervasive pattern of instability of interpersonal relationships, self-image, and affects, and marked impulsivity that begins in early adulthood and is present in a variety of contexts" (p. 650).

The affective component of the diagnosis is a hallmark of the disorder and is reflected in a number of the DSM-IV (1994) diagnostic criteria. The affective style of the borderline is described as labile deriving from a "marked reactivity of mood" (criterion 6). Borderlines suffer intense affective states that are relatively brief in duration and which may include a variety of negative emotions. In contrast, their positive feelings are typically more transitory. Feelings of boredom are also common as are feelings of an inner sense of emptiness (criterion 7). Intense and often inappropriate anger or difficulty controlling anger is frequent (criterion 8) and may be followed quickly by feelings of guilt or shame. These intense affective states are often triggered by interpersonal stresses, particularly when others are perceived as critical, neglectful, uncaring, withholding or abandoning.

According to DSM-IV (1994), the interpersonal relations of borderline individuals are characterized by alternating, rapid and dramatic shifts in their perceptions of and reactions to others (criterion 2). There is a propensity toward idealization that may be accompanied by excessive demands on others for their time and attention. However, idealization may change quickly to devaluation when others are perceived as punitive, withholding, or abandoning. Within the interpersonal realm, borderlines have a basic fear of abandonment and they make frantic efforts to avoid separation whether separation is imminent or merely perceived (criterion 1). These efforts may include impulsive acts including self-mutilation and/or suicidal behaviors (criterion 5). The perception of impending abandonment may also evoke extreme changes in self-image, cognition, and affect and may be precipitated by actual loss of another or merely

realistic time-limited separation.

Impulsivity and a proclivity to self-aggression are common in BPD (DSM-IV, 1994). Borderlines tend to engage in impulsive acts that have a high potential for self-harm (criterion 4). These acts include but are not limited to gambling, spending money irresponsibly, binge eating, substance abuse, unsafe sex, and reckless driving. Self-mutilation (e.g., cutting, burning) and suicidal behaviors are also common (criterion 5). Interpersonal stressors such as threats of separation or expectations by others that the individual assume increased responsibility may spark self-destructive acts. Self-mutilation may also occur during periods of dissociation (criterion 9), when the mutilation may provide relief by reaffirming the individual's ability to feel or dispelling a sense of being bad.

Borderline individuals frequently suffer an identity disturbance that is characterized by a fragile sense of self (criterion 3) (DSM-IV, 1994). Similar to their perceptions of others, they experience sudden and dramatic shifts in their self-image. These changes in self-perception often correspond to sudden shifts in goals, personal values, sexual identity, and choice of relationships. The self-image of the borderline is presumably based upon a self-perception of being bad or evil, however, at times borderline individuals may feel as if they do not exist at all. Again, interpersonal stressors may precipitate the feelings of emptiness or nonexistence.

Prevalence and Course

Borderline Personality Disorder affects from 2 to 5 percent of the general population (DSM-IV, 1994; Ekselius, 2001) with higher prevalence rates among patient populations. According to the DSM-IV, ten percent of individuals who seek outpatient treatment meet diagnostic criteria for BPD. Among inpatient populations Borderline Personality Disorder accounts for 20% of all diagnoses given, and for those diagnosed with primary personality disorders, prevalence rates range from 30 – 60%. The occurrence of BPD among non-psychotic individuals who are involuntarily hospitalized for dangerousness to self or others has been found to be as high as 84.4% (Sansone, Gage, & Wiederman, 1998).

In the majority of cases, the course of BPD is considered to be chronic (DSM-IV, 1994). The affective and behavioral dyscontrol typically begins in early adulthood when the highest risk of suicide and functional impairments generally occurs. Symptoms typically diminish in the later years, and patients may begin to display greater stability during middle age. Borderline individuals also show generally poor outcomes to traditional psychotherapeutic treatment approaches and there is much variability across individuals for the relief of symptoms in

response to pharmacological interventions (Brinkley, 1993; Linehan, 1993).

The intractable nature of Borderline Personality Disorder creates a challenge for mental health professionals and researchers to develop viable treatment options. The development of effective treatment for BPD, however, may be better facilitated by an understanding of the factors involved in the development and maintenance of the disorder, including underlying physiological irregularities that contribute to emotion dysregulation.

Biopsychosocial Theory of BPD

Over the past four decades, various theories have been offered regarding possible factors associated with the development of Borderline Personality Disorder. A brief overview of major theories and hypotheses is given here in order to provide a background for a subsequent discussion of a Biopsychosocial Model of BPD.

The first theory of BPD was psychodynamic in nature, and posited that failures of separation and individuation during early childhood were precursors of the later development of the disorder. These developmental failures presumably lead to abnormal identity formation as well as defects in object-relations and ego functioning (Mahler, 1971; Masterson, 1976; Kernberg, Selzer, Koenigsberg, Carr & Applebaum, 1989; Fine, 1989). From the psychodynamic perspective, the hallmark of BPD is an inability to integrate opposing representations of the self and of others resulting in what object relations theorists have termed "splitting." Splitting, or the tendency to alternate between views of self and others as "all good" or "all bad" consequently impairs effective interpersonal relations, emotional functioning, and adaptive behavior. Masterson (1976, 1989) argues that the emotional instability of borderlines stems from a basic fear of abandonment that develops in the young child as a result of the primary caregiver's emotional withdrawal, unavailability, or over-protection. It is the fear of abandonment that is posited to trigger recurrent episodes of dysregulated emotion.

Cognitive theorists propose that the emotional and interpersonal dysfunction in borderline disorder reflects the sequelae of sets of dysfunctional thoughts, beliefs, and schemas that lead to presenting "core" problems (Freeman & Leaf, 1989; Beck & Freeman, 1990). These problems may include negative self-concept, self-punitive or self-destructive behavior, impulsive behavior, frequent crises, and intense emotional reactions. Maladaptive schemata, which are developed at an early age, presumably underlie the core problems. According to Beck and Freeman, these schemata focus on abandonment and loss, unlovability, dependence, mistrust, and fear of losing

emotional control, to name a few. These maladaptive schemata can also lead to errors in judgment and thinking, which include a tendency toward "black and white" thinking in which evaluations of experience are cast in terms of mutually exclusive categories. Consequently, extreme evaluations of situations trigger extreme emotional reactions and, subsequently, inappropriate and/or impulsive behaviors.

Biological theories of BPD loosely attribute the behavioral patterns associated with the disorder to structural and/or biochemical abnormalities in the central nervous system. Biological theorists characterize BPD as a set of clinical syndromes that occurs along a continuum and which may be subtyped as variants of other major mental disorders such as Schizophrenia, affective disorders, or organic brain dysfunction (Gunderson & Elliott, 1989; Akiskal, 1981; Andrulonis, et al., 1987).

In contrast to these other theories, Marsha Linehan (1993) provides a multi-theoretical approach to Borderline Personality Disorder. Her biopsychosocial theory encompasses various factors in the development and maintenance of BPD, including biology, environment, and learning. Her theory has received increasing attention in recent years due to the reported reduction in suicidal behavior, hospitalizations, and treatment dropouts among borderline patients who are treated with interventions based upon the biopsychosocial model (Swenson, Sanderson, Dulit, & Linehan, 2001). Although these interventions have shown promise in the clinical arena, many aspects of the theory are as yet untested.

Linehan argues that Borderline Personality Disorder develops as a result of the interactive effects of biological deficits, exposure to dysfunctional or traumatic environments, and the failure to acquire a repertoire of adaptive coping strategies that are necessary for the regulation of emotion. The behavioral manifestations of BPD, according to Linehan, are simply efforts by the individual to modulate painful emotions or to engage others in care taking acts when self-regulation is difficult.

It is proposed that, when emotional states are intolerable, humans attempt to regulate their affect through the implementation of cognitive and behavioral strategies. Such strategies may be directed toward changing the environment (e.g., problem solving) or changing cognitive schemata regarding one's own ability to have an effect upon the environment. Adaptive behavioral patterns are presumably learned through interaction with others (e.g., through modeling) and the reinforcing properties derived from effectively regulating positive and negative affective states. According to Linehan (1993), borderline individuals have a deficit in adaptive

learning, which predisposes them to use maladaptive cognitive and behavioral repertoires. These maladaptive though likely effective emotion regulation strategies may have been modeled by significant others and reinforced by the temporary reduction of painful negative emotional states. In addition, during times of distress, the cognitive abilities of borderlines may be compromised resulting in feelings of being out of control and an inability to employ rational thought and judgment to solve problem situations. During these times, borderlines may be more likely to revert to old patterns of behavior that have proved useful for the short-term reduction of painful emotions and/or the short-term production of positive ones. As such, suicidal, self-aggressive, and impulsive behaviors may be employed to cope with intense affect or to engage others in care-taking acts. The end result may be the temporary amelioration of intense emotional states but an increased risk of subsequent negative emotions when problems persist or are exacerbated.

Putative Biological Irregularities in Emotion Regulation

Linehan (1993) has proposed that the biology of BPD involves a physiological "vulnerability" to emotion dysregulation that places individuals at risk for intense emotional responses that have a rapid onset and are long-lasting. The term "vulnerability" is used by Linehan to describe various deficits in emotion regulation processes that are due to pre-existing factors. She suggests that these deficits might involve irregularities within areas of the central nervous system that are involved in the experience, regulation, and expression of emotion, such as the limbic system. She further proposes that the functional irregularities involve homeostatic differences in the time course parameters of emotion and its regulation, including the onset of affective responding, the rapidity with which the emotion reaches its peak or maximum intensity, the actual intensity of the felt emotion, and the recovery cycle or return to emotional baseline. Expressive manifestations of such deficits might include intense affective states, high reactivity to lower levels of stress than would be considered normal, and subsequent behavioral coping strategies to manage emotions.

Linehan (1993) proposes that the deficits in the neural circuitry involved with the regulation of emotion in BPD may exist at birth (e.g., genetic influences or unfavorable intrauterine events) or may develop early in life as a result of childhood environmental effects on the brain and nervous system development. She notes that while little research has been reported that would link temperament in BPD to biological causes, detrimental factors associated

with intrauterine environment have been linked to defects in fetal development and subsequent behavioral patterns in children. For example, Linehan points out that excessive maternal ingestion of alcohol or drugs during pregnancy has been associated with intellectual deficits and disinhibition of behavior in childhood.

From the nurture perspective, dysfunctional family environments that are fraught with conflict, violence, neglect, or child abuse may also affect the normal development of the central nervous system resulting in "hyperreactivity" within the limbic system. Some researchers have referred to the neurological changes in emotion function in response to environmental stress as "kindling" (Post & Weiss, 1998; van der Kolk, 1996). According to these researchers, kindling involves the repeated electrophysiological stimulation over time, which "results in increasing behavioral and physiological responsivity, culminating in the occurrence of a major motor seizure to a previously sub-convulsant stimulation" (p. 194). However, kindling may also be involved in pathophysiological mechanisms related to progressive limbic-related abnormalities including a variety of phenomena associated with various forms of psychiatric illness that do not involve convulsive outcome but which show evidence of increasing physiological responsivity to corresponding stimuli over time.

Biological irregularities may not be sufficient for the later development of BPD but may influence an individual's response to environmental events and, reciprocally, may be subject to alterations as a result of environmental stressors. Linehan (1993) proposes a transactional model for the development of BPD in which the individual and the environment influence and adapt to each other in a reciprocal fashion. In this model, irregularities in the biological circuitry involved in emotion regulation would be contributory factors to psychopathology but do not solely determine the outcome.

Although her theory represents a novel and potentially useful conceptualization, Linehan (1993) is somewhat vague about the neuroanatomical substrates of the emotional dysregulation that is part and parcel of BPD. Although she cites a body of experimental research that provides general support for her theory (see p. 47-48), her hypotheses regarding possible neural defects are not specifically defined, perhaps because the molar circuitry is believed to be more important than the more molecular components of that circuitry. Indeed, Linehan does offer some specific hypotheses regarding emotional experience, regulation, and expression, and current advances in affective neuroscience and biological psychiatry may shed some light on the exact neural underpinnings of these processes, thus enhancing and extending Linehan's theory. Thus, in the

following, Linehan's hypotheses regarding emotion processing in BPD are outlined, followed by a brief review of some relevant biological findings. Subsequently, a psychophysiological paradigm for the assessment of the proposed hypotheses is outlined, followed by a test and discussion of that paradigm.

Hypotheses of the Biopsychosocial Model

According to Linehan (1993), the following irregularities in emotion regulation processes account for the affective instability seen in Borderline Personality Disorder (pp. 43-45).

(1) *High sensitivity to emotional stimuli reflected in quick reactions and low threshold for emotional response*

(2) *High emotional intensity in which reactions are extreme*

(3) *Slow return to emotional baseline in which reactions are long lasting.*

Although BPD is generally associated with the recurrence of intense negative emotional states, as described in DSM-IV, Linehan proposes that these individuals also have difficulty regulating positive emotions and their sequelae.

Evidence for Symptom-relevant Biological Irregularities in BPD

Recent research suggests the relevance of biological factors in the etiology of Borderline Personality Disorder. A number of researchers have explored various parameters of central nervous system functioning in borderline patients in order to identify biological irregularities that might account for overt symptomatology. Findings across studies using various techniques have yielded a variety of indicators that would suggest that the brains of borderlines differ in some respects from those of healthy individuals in both structural and metabolic aspects. Although some studies have attempted to link neural function to various symptoms or personality characteristics, much of this research tends to be largely atheoretical and exploratory in nature. Its premise and focus has not been well integrated with current psychological theory, especially more cognitive-behavioral theories such as Linehan's. The following section will provide some background regarding possible neurological defects given Linehan's premise that Borderline Personality Disorder is primarily a dysfunction of the emotion regulation system.

Structural Brain Abnormalities

Neuroimaging techniques have been used to examine CNS structural differences in

borderline patients. Computerized tomography (CT) has shown *smaller* ventricles in some BPD patients as compared to schizophrenics and healthy controls (Schulz, 1983; Parnas & Teasdale, 1987). Despite the evidence for reduced ventricular size in BPD, ventricular/brain ratios (VBR) have been shown to be comparable to non-hospitalized healthy controls in these studies. Using magnetic resonance imaging (MRI), Lyoo, Han, & Cho (1998) found significantly *smaller* frontal lobes in some borderlines. (Note: The frontal lobes are very important for emotion regulation). Dreissen, et al. (2000) reported a 16% reduction in brain volumes for the hippocampus and 8% reduction in volumes of the amygdala in BPD patients. The amygdala is proposed to be involved, along with other structures of the limbic system, in the emotional aspects of behavior related to survival. The hippocampus is one of the many brain structures involved in the formation of memories, and specifically, in the consolidation of memories from a spatiotemporal frame of reference, a process that is quite important for explicit, episodic, and autobiographical memory function (Jacobs & Nadel, 1985). Alterations in the volumes of these CNS regions have been implicated in symptoms associated with early trauma in BPD. For example, Dreissen et al (2000) also assessed the inter-relationship between hippocampus volumes and the extent of childhood trauma in their BPD sample. Results revealed a negative correlation between volumes of the hippocampus and degree and duration of traumatic experience but only for the whole sample that included both BPD and healthy individuals. The correlations were non-significant when groups were analyzed separately suggesting that reduced hippocampus volumes may be related to the extent of trauma but not to diagnostic category.

Electroencephalogram (EEG) Abnormalities

A number of studies have examined EEG abnormalities in BPD. Although many of the findings are discussed as being suggestive that Borderline Personality Disorder may be related to brain dysfunction, these studies diverge with regard to the focus and nature of these putative abnormalities. Cornelius, Brenner, Soloff, & Schulz (1986) reported a frequency of occurrence of dysrhythmias in BPD at about 18.8% as compared to 5-10% among healthy individuals. However, the researchers found no statistically significant difference between the prevalence of EEG dysrhythmias in BPD and those observed in non-BPD axis II controls, suggesting a nonspecific finding. Snyder & Pitts (1984) observed marginal, definite, and combined abnormalities in the EEGs of male borderline patients as compared to male dysthymic patients. The most prevalent so-called abnormality was increased slow-wave activity. The mixture of wave frequencies in the EEG (fusing) occurred significantly more often in the BPD

group. The severity of illness was not correlated with EEG abnormality in either group. In another study, Cowdry, Pickar, & Davies (1985-86) observed a 45% incidence of definite EEG abnormalities in BPD patients as compared to unipolar depressed patients. Most definite abnormalities consisted of non-focal posterior spike or sharp activity. Finally, De la Fuente, Tugendhaft, & Mavroudakis (1998) found a 40% incidence of diffuse slow activity in their group of borderline patients. The records revealed an absence of epileptiform activity.

Although EEG studies have revealed an increased prevalence of EEG abnormalities among individuals diagnosed with BPD, these abnormalities are relatively diverse, as well as nonspecific and non-focal in nature. Cowdry et al. (1985-86) speculated that the pathophysiology involved in BPD might be characterized by a relatively low threshold for arousal in limbic structures that may be difficult to observe on routine EEG. They note that the surface EEG seldom reflects paroxysmal activity in deep limbic structures, and that the EEG abnormalities that are observed do not appear to be related to clinical manifestations occurring at the time of the EEG recordings. They recommended pharmacologic activation of limbic structures, and computer analysis of the surface EEG patterns to examine abnormal responses in limbic structures.

Functional CNS Correlates

The vast majority of the research on biological correlates of Borderline Personality Disorder have focused on proposed functional or biochemical abnormalities that may relate to observed behaviors or dimensional characteristics. Deficits in central serotonin function have received much attention.

Serotonin (5-HT) is an excitatory neurotransmitter that appears to be involved in the induction of sleep, sensory perception, temperature regulation, and *control of mood*. The highest concentration of serotonin is in the neurons of the *raphe nucleus* of the brainstem with projections to the *limbic structures* (hypothalamus and thalamus), the spinal cord, as well as other parts of the brain including different areas of the neocortex (Tortora & Anagnostakos, 1987). Thalamic nuclei serve as primary relay stations for all sensory impulses to the cerebral cortex, with the exception of olfaction. The anterior nucleus of the thalamus is presumably involved in emotion and memory and is densely connected with the frontal lobes. The hypothalamus is involved in a variety of functions associated with the metabolic and homeostatic aspects of emotional states. Reduced overall central 5-HT function in the limbic-hypothalamic

system has been associated with suicidal and impulsive aggressive behaviors including self-mutilation in patients with major mood and personality disorders, particularly BPD (Coccaro et al., 1989). The *serotonin theory of BPD* posits that diminished 5-HT post-synaptic receptor function may constitute a biologic diathesis to disinhibition, impulsivity, impulsive aggression, and affective dyscontrol (Coccaro, 1992).

Serotonin function may be measured in a variety of ways. Neuroimaging with pharmacological challenge, neuroendocrine, platelet binding, and cerebral spinal fluid metabolite studies have yielded information that would suggest irregularities in serotonin function in BPD.

Metabolic Abnormalities

Positron Emission Tomography (PET) imaging provides means to observe the brain's metabolic activity in order to assess regional activation in response to various tasks or conditions. PET works through a computerized, three-dimensional reconstruction of radioisotope decay. Radioisotopes can be used to track blood flow, to track specific neurotransmitter function, or to examine regional glucose metabolism. By assessing glucose metabolism, PET can provide a measure of regional brain metabolism. Assessing the degree of brain glucose uptake in response to a serotonin agonist, such as Flenfluramine (FEN) provides one means by which regional 5-HT activity can be assessed. Among healthy individuals, FEN modulates ongoing neuronal activity in a regionally specific fashion with a relative increase in metabolism in the prefrontal cortex and a relative decrease in occipital-temporal regions (Kapur, Meyer, Wilson, Houle, & Brown, 1994). Within the prefrontal cortex, increased uptake of F-fluorodeoxyglucose (FDG) in response to FEN has been observed in Broadman's areas 10, 44 – 47, areas in the frontal lobes that are believed to be important in the regulation of mood and impulse (Mann et al., 1996).

PET imaging has been used to examine the metabolic aspects of neural function in BPD, and decreased central serotonin (5-HT) function has been associated with the disorder. De la Fuente et al. (1997, 1994) found bilateral hypometabolism in the prefrontal and premotor cortical areas, anterior areas of the cingulate cortex, and thalamic, caudate, and lenticular nuclei of BPD patients. However, results were similar to those observed in other patient groups including schizophrenia, bipolar disorder, unipolar depression, obsessive-compulsive disorder, and alcohol dependence. Healthy individuals who suffered sleep deprivation also showed hypometabolism in the same brain regions.

It has been proposed that impulsive aggression in BPD is associated with decreased

ability to regulate serotonergic inputs by the frontal lobes. Soloff, Maltzer, Greer, Constantine, and Kelly (2000) reported that PET imaging under pharmacological challenge with FEN revealed significantly reduced uptake of FDG in response to FEN in the medial and orbital regions of the right prefrontal cortex. As cited by Soloff et al., lesions to the orbital medial area are associated with "profound dysregulation of affect and impulse including disinhibited, socially inappropriate behaviors, impulsive aggression, sensation seeking, irritability, emotional lability, and devastating personality changes" (p. 545).

A number of studies have examined peripheral metabolic indicators of central serotonergic function in BPD. Verkes, Pijl, Meinders, & Van Kempen (1996) found platelet 5-HT to be higher in borderline patients compared to non-borderline Axis II patients and to healthy participants. Platelet 5-HT also correlated positively with a disposition to experience anger. Verkes et al. (1998) examined platelet MAO activity in 144 BPD patients without major Axis I diagnoses. Low platelet MAO activity and multi-impulsive behavior were found to be characteristic of borderline patients who had attempted suicide with less planning, and were also correlated positively with chronic feelings of emptiness.

Neurocognitive Deficits

Neuropsychological testing has given indirect evidence for neurocognitive defects in BPD. O'Leary, Brouwers, Gardner, & Cowdry (1991) observed significant impairments on memory tests that required uncued recall of complex, recently learned material. Auditory cues partially corrected the deficit suggesting that the memory problems stemmed from difficulties in retrieval of learned material rather than from deficits in memory encoding. Impaired performance was also demonstrated on visual perceptual tests, which were attributed to problems in separating essential from extraneous visual information and the recall of complex visual patterns. Borderline patients also showed significant deficits in immediate and delayed visual reproduction (See O'Leary & Cowdry 1994 for review; O'Leary, 2000).

In summary, the growing body of biological literature suggests that BPD is associated with structural and/or functional abnormalities within the central nervous system and that such abnormalities may be related to certain behavioral repertoires or personality dimensions that typify the disorder. However, the techniques utilized to examine the neurobiology of BPD are global measures that provide information about broad mechanisms related to overt symptomatology and which lack diagnostic specificity. As such, the research provides little information regarding the processes involved in emotional experience and its regulation specific

to Borderline Personality Disorder. In order to assess the hypotheses put forth by Linehan (1993), it is necessary to employ a method that will allow for the measurement of specific parameters of emotional responding that are relevant to her theory. As such, the present study employed startle probe methodology in order to examine the parameters of emotional experience, regulation, and expression in BPD.

Emotion and the Startle Probe Reflex

Affective Chronometry

Davidson (1998) proposes that emotional health as well as vulnerability to psychopathology may depend, in part, on variations in the patterns and time course of neural processes associated with emotional responding. He refers to the study of these processes as "affective chronometry". The affective chronometry of emotion would encompass various processing components including threshold, onset, rise time, peak intensity, and the recovery time of the emotional response.

The threshold of an emotional response reflects the system's responsivity to an emotion elicitor and may vary depending upon the intensity or context of the elicitor. Onset is defined by the latency of the response following initial stimulation once threshold has been met. Rise time refers to the rapidity with which the emotion reaches its' peak intensity. Peak intensity is the point in time at which the emotion response reaches its highest magnitude. Finally, recovery time is the time it takes for the peak response to return to an emotional baseline.

Davidson's (1998) concept of affective chronometry provides a framework for the examination of Linehan's (1993) hypotheses regarding anomalies in neural systems dedicated to the experience, regulation, and expression, over the entire time course of an emotional event in persons with BPD. Such anomalies may reflect the fundamental biological irregularities that Linehan has proposed to underlie the observed behaviors and dynamics associated with the disorder. It would therefore seem advantageous to assess the temporal aspects of emotion responding in Borderline Personality Disorder and to compare these parameters to those observed in healthy individuals as well as other diagnostic groups. The startle probe reflex has been used in similar investigations of emotional processing in mentally healthy individuals and in clinical populations and is well suited to this goal.

Emotion-modulated Startle Reflex

Webster (1973) defines *emotion* as "a psychic and physical reaction (as anger or fear)

subjectively experienced as strong feeling and physiologically involving changes that prepare the body for immediate vigorous action" (p. 372). The directional aspect of an emotional response is termed valence. It involves motivational propensities that are categorized as either appetitive and approached-related or aversive/defensive and withdrawal-related (Levenston, Patrick, Bradley, & Lang, 2000). The intensity of the emotional response represents its strength or vigor in response to an eliciting stimulus. As will be discussed below, the startle reflex provides a physiological window into the processes associated with these propensities in emotional responding.

The startle response is a protective reflex (Davis, 1986) that consists of a set of whole-body involuntary responses that occur in reaction to abrupt or intense stimuli (Landis & Hunt, 1939). It involves synchronous activity of body systems including gross body movements, changes in cardiovascular activity, and desynchronization of alpha in the EEG (Hugdahl, 1995). The startle eyeblink, a component of the startle response, is a rapid and reliable facet of the reflex that is easily elicited under experimental conditions (Davidson, 1998). Following an eliciting stimulus, the eyeblink begins at approximately 30 to 50ms post-stimulus and involves a rapid contraction of the obicularis oculi muscles that surround the eye. The magnitude of the startle blink can be measured by the electromyogram (EMG), which provides measurement of the temporal aspects of the reflexive response.

The startle procedure is an experimental method that allows for the observation of phasic (i.e., occurring over a discrete time interval, e.g., in response to a stimulus) emotional processes in order to evaluate the directional components of emotion in response to specific stimuli, the vigor with which these responses occur, and the specific parameters associated with the time course of emotional responding. The procedure involves the brief presentation, to the subject, of a series of pleasant, neutral, and unpleasant pictorial slides, or instructions to contrive in imagery certain emotionally relevant representations. Acoustic (noise burst) or tactile (air puff to the temple) startle probes are administered unpredictably and randomly to evoke the startle eyeblink reflex at varying times during presentation or following offset of emotionally evocative stimuli. The EMG measures the magnitudes of the blink responses, and computer analysis is then used to average startle response magnitudes across presentations for each of the predetermined stimulus valences.

The magnitude of the startle eyeblink response is modulated by the affective valence of the eliciting stimulus. Startle amplitudes vary in a linear fashion as a function of stimulus valence

whereby probes presented in the context of unpleasant stimuli elicit the highest amplitude startles, and those presented in the context of pleasant stimuli elicit the lowest amplitudes (Vrana, Spence & Lang, 1988; Bradley, Lang & Cuthbert, 1993). The modulation of the startle response is presumably based upon a match or mismatch between the individual's defensive reaction to the startle stimulus (i.e., their motivational propensity) and their ongoing emotional state elicited by the emotionally evocative stimulus (Lang, Bradley & Cuthbert, 1990). Elicitation of the startle response during a pleasant emotional state results in a reduction in the magnitude of the startle reflex, whereas startles produced during a negative emotional state lead to amplification of the reflex response.

The emotion-modulated startle response can be used to examine the time course of emotional responding in humans. By probing at differing times during the onset and offset of the affective foreground stimulus, one can measure the course of the amplitude of the blink response from emotion onset to recovery (Larsen, 2000). Mapping the amplitudes of the startle response over time provides temporal- and magnitude-relevant estimates of various parameters of emotional responding and emotion regulation (Bradley et al., 1993). For example, probes given soon after the onset of the eliciting stimulus (e.g., 300 – 800 ms) demonstrate the effects of early attentional demands on the subject by the visual stimulus. The magnitude of the blink reflex during this time frame varies depending upon the attentional demands of the evocative stimuli. Probes given between 1.3 and 4.0 seconds are useful for observing the magnitude (i.e., intensity) of the emotional response and the startle reflex is most robust during this time frame. Probes given at even later times (e.g., 6.5 seconds and above) provide information related to the recovery cycle or regulation of the emotional response.

To determine whether the emotion-modulated startle method is a reliable procedure to assess the recovery function of the emotional response, Larsen (2000) examined the recovery functions of healthy individuals using this method. By mapping the amplitudes of the startle response at various times following the onset and offset of the emotion elicitors, she showed that the startle paradigm is an effective method for examining the recovery function by facilitating measurement of homeostatic temporal changes in emotion responding.

The Effects of State and Trait Mood on Startle Magnitude

Fear-potentiated startle magnitudes have been shown to vary dependent upon an individual's dispositional mood or negative affective state. Mood states such as depression,

heightened fear, and anxiety have been shown under some circumstances to be associated with increased potentiation and/or inhibition of startle response amplitudes beyond that which is typical under standardized startle procedures. This is particularly important to the current study given the fact that Borderline Personality Disorder is associated with high cormorbidy of depression, anxiety disorders, and trait anxiety (DSM-IV, 1994; Lecic-Tosevski & Draganic, 1997; Markowitz, Moran, Locsis, & Frances, 1992; Skinstad & Swain, 2001; Zanarini et al., 1998). As a result, when measuring startle responsivity in borderline patients, it is critical to determine the extent to which prevailing mood or affective disposition may have influenced the startle magnitudes.

Although not extensively researched, some studies have explored the effects of state and dispositional mood on startle response in normal individuals and in those diagnosed with particular mood or anxiety disorders. A brief review is given here focusing on the individuate effects of depression, anxious apprehension, and specific anxiety disorders on startle responsivity.

Depression

As discussed before, the typical valence pattern of the startle response among healthy individuals shows a monotonically increasing linear trend with lowest amplitudes to pleasant stimuli and highest amplitudes to unpleasant stimuli (Bradley, Lang & Cuthbert, 1993; Vrana, Spence & Lang, 1988). However, startle patterns among depressed individuals have shown a varying pattern of responsivity with atypical valence effects. In one study, Allen, Trinder & Brennan (1999) found that severely depressed participants, those with Beck Depression scores in excess of 29 (Beck, Steer & Brown, 1996), exhibited a significantly abnormal pattern of startle response. Their startle amplitudes were greater in response to pleasant slides and showed inhibition to unpleasant slides, a pattern opposite to the typical linear valence effect. Allen et al., (1999) proposed that increased startle to pleasant stimuli might reflect the effects of negative mood on one's capacity to experience positive affect and correspondingly retardation of an appetitive/approach motivational system. Conversely, inhibition of startle to unpleasant slides might signify a reduction in the fear response and reduced sensitivity of the aversive/withdrawal defensive system under fear conditions. Severe levels of depression may therefore be associated with a dampening of the brain's behavioral motivational systems, phenomena that may be manifested behaviorally by such symptoms as loss of motivation for and interest in activities. Cook, Hawk, Davis & Stevenson (1991) found a positive relationship between MMPI

Depression scale scores and startle valence modification in their first study though they did not replicate this finding in studies with larger samples. Cook et al. (1992) observed enhanced valence modification for individuals who reported low positive affectivity (a characteristic of depression) under conditions of high-arousal imagery.

Anxiety

Highly fearful or apprehensive individuals as well as those diagnosed with various anxiety disorders may be particularly vigilant and reactive when presented with novel or unusual situations that trigger fear or anxiety. The typical linear valence pattern has been observed for anxious participants but with a marked enhancement of startle potentiation to unpleasant stimulus conditions. In most cases, inhibition of startle to pleasant stimuli is no different for high anxious compared to low anxious individuals.

A number of studies have examined startle reactivity related to high trait anxiety. Cook et al. (1991, 1992, 1997) observed significantly higher startle amplitudes to unpleasant stimuli in individuals with high trait fearfulness without diagnosis of anxiety disorder. Similar results were observed in response to affective slides and during aversive imagery. Startle amplitudes increased monotonically with fearfulness scores. However, baseline startle has not been shown to differ as a function of high versus low fear (Grillon et al., 1993). These studies demonstrated a significant relationship between fear-potentiated startle response and high levels of trait fearfulness. Enhanced startle amplitudes were not observed among participants with high trait anxious apprehension, which is characterized by worry about the future (Nitschke et al., 2002)

Phobic participants have also shown increases in startle potentiation to aversive stimuli but only under conditions where they viewed pictures of their phobic objects (Sabatinelli, Bradley, Cuthbert & Lang, 1996) or were actually confronted with the feared objects (deJong, Arntz, & Merckelbach, 1993; de Jong, Visser, & Merkelbach, 1996; Merckelbach, de Jong, Leeuw, & Van den Hout, 1995). In response to pictorial stimuli, the valence patterns for phobics showed a linear valence effect but with greatly increased magnitudes to unpleasant pictures than those typically observed. It was noted that, while phobics displayed hyperreactivity of the fear response to specific objects, their fear response did not appear to generalize to other aversive situations. In contrast, when confronted with the actual phobic object during a behavioral approach test, phobic patients produced higher magnitudes of startle response to all stimulus categories with absence of the linear valence effect. Following treatment for their phobia, the expected linear trend emerged and magnitudes were comparable to those of non-phobic participants.

The relationship between Panic Disorder and fear-potentiated startle has been studied very little. In one published study, among a large heterogeneous group of anxiety patients, only those patients with higher scores on anxiety and depression (i.e., Panic Disorder and PTSD) showed significantly larger baseline startle magnitudes compared to controls. Patients with lower depression and anxiety scores (i.e., simple and social phobics) showed no such startle pattern (Cuthbert, Drobes, Patrick & Lang, 1994).

Only one published study has focused on startle reactivity in Obsessive Compulsive Disorder. Kumari, Raven, Gray & Checkley (2001) presented film clips that varied in affective valence to OCD patients and healthy participants. Patients with OCD produced significantly greater magnitudes of startle and shorter startle latencies to unpleasant affective films but demonstrated the linear valence effect. The pattern of startle reactivity was similar to that of participants diagnosed with high trait anxiety.

Heightened physiological reactivity to trauma related cues is characteristic of individuals who suffer from Post-traumatic Stress Disorder and the majority of startle literature has focused on this population. Diagnostic criteria for PTSD include chronic increases in autonomic arousal, among other physiological indicators an exaggerated startle response. Although studies in baseline startle have shown mixed results (Grillon, 1996; Ornitz & Pynoos, 1989; Prins, Kaloupek & Keane, 1995), studies using fear-potentiated startle have shown consistent findings. Metzger et al (2000) reviewed 12 studies that examined emotion-modulated startle reactivity in PTSD and found evidence of enhanced startle potentiation to unpleasant stimuli. However, significant results produced a moderate effect size suggesting that not all individuals with PTSD show this effect. As noted by Orr and Roth (2000) in their review, substantially larger responses have been observed during imagery of trauma-related experiences compared to imagery of other stressful experiences. This suggests that, similar to phobics, enhanced startle in PTSD patients may be contextually specific. Shalev et al (2000) studied habituation of startle among individuals with PTSD with and without depression. The groups showed comparable physiological responses at one week post-trauma. At 1 and 4 months post-trauma, those with PTSD showed reduced habituation of startle to aversive slides. Startle magnitudes did not appear to be influenced by comorbid depression nor were they explained by the severity of the traumatic event or intensity of initial symptoms. The authors concluded that PTSD is associated with a progressive neuronal sensitization. Kuczen (2002) observed startle responding in women who had suffered traumatic rape. Women with history of recent rape with and without PTSD were compared to eighteen

female controls. No significant differences were found between the three groups in startle magnitudes. The findings were inconsistent with those observed among combat veterans with PTSD.

In summary, two patterns of startle-valence effect have emerged from studies that have focused on relationships between state and trait mood on startle reactivity. One pattern reflects the dampening of the brain's behavioral motivational systems reflected in a potentiation of startle to pleasant stimuli and an inhibition of startle to aversive stimuli. This pattern has been observed in individuals who are rated as severely depressed. The second pattern reflects a hyperreactivity of the aversive/withdrawal related motivational system and is manifest by an accentuation of the fear-potentiated startle to unpleasant pictorial slides and aversive imagery. This pattern has been observed in individuals rated as high in trait anxiety, or diagnosed with specific phobia, Panic Disorder, OCD, or PTSD. Participants diagnosed with social phobia and anxious apprehension show no such pattern. The import of these findings to the examination of startle reactivity in BPD lies in the potential confounding effects of state and trait mood on startle magnitudes.

Emotional Intensity in BPD

In recent years, Herpertz and colleagues conducted a number of studies using the startle procedure to explore irregularities in affective intensity among borderline patients. In a 1999 study, Herpertz, Kunert, Schwenger, Eng & Sass compared startle magnitudes of borderlines to healthy individuals and found no differences in startle reactivity regardless of stimulus valence. Borderline participants did show longer startle response latencies, heart rate acceleration, and less positive self-ratings of affect than the comparison group. The authors suggested that borderlines experience less pleasant emotional reactions to positive stimuli but experience similar levels of negative emotion to unpleasant events as healthy persons.

In a second study, Herpertz et al. (2000) employed electrophysiological measures and self-reported ratings of affect to compare the emotional reactivity of borderlines to those of individuals diagnosed with Avoidant Personality Disorder and healthy controls. As noted by the researchers, the tendency of avoidant individuals to experience high fearfulness such as social inhibition and exaggerating dangers would be reflected in intense reactions to emotionally unpleasant stimuli. It was predicted that borderlines as well would show high emotional reactivity to negative events and that the affective responses of both clinical groups would be more intense

than those elicited by the control participants. Furthermore, patients with BPD were expected to react more strongly to pleasant stimuli, a pattern not predicted in either the APD or healthy participants. However, the results again showed similar patterns of emotional reactivity among borderlines and healthy participants. Significant differences in skin conductance and heart rate change did differentiate BPD patients but suggested low as opposed to heightened somatic arousal. The authors speculated that low arousal may interfere with the anticipation of signal stimuli and may explain the exaggerated openness borderlines show to stimuli, particularly in interpersonal situations.

Herpertz et al. (2001) recently compared the intensity of emotional responding in BPD with that of psychopaths. Studies on psychopaths have shown a marked attenuation of fear-potentiated startle reflex to both aversive and pleasant stimuli (Patrick, Bradley, & Lang, 1993) with deficiencies in startle potentiation linked to affective and interpersonal features of the psychopathic personality and unrelated to levels of antisocial behavior. In contrast, the affective style of the borderline is characterized by emotional lability and intense emotional reactivity. The goal of the study was to examine whether criminal offenders diagnosed as psychopathic or borderline and who share an impulsive nature, tend to differ in their affective responsivity. Results showed that startle patterns of borderlines were both dissimilar to those of psychopaths and similar to those of control participants. The authors inferred, for borderlines, an adequate processing of emotional stimuli though absence of emotional hyperreactivity. However, we cannot conflate one physiological response profile with a specific psychological experience. Self-report and clinician ratings of affect in borderlines tell us that the emotional reactivity and poor emotional regulation are there. However, how this reactivity and dysregulation are instantiated in identifiable physiological substrates is a different matter.

Interestingly, the pattern exhibited by the psychopathic participants in the Herpertz et al. (2001) study revealed a linear trend and only minor lessening of fear-potentiated startle to aversive stimuli. This pattern of emotion-modulated startle response was notably different than that obtained in an earlier study by Patrick, Bradley & Lang (1993). It is noted that Herpertz et al. had eliminated nine psychopathic participants who failed more frequently to respond to the startle stimuli irrespective of valence whereas only one BPD and two control participants were eliminated due to non-responding. In the Patrick et al. study, reduced responsivity to emotionally evocative stimuli characterized the psychopathic sample of individuals whose deficiency in startle reactivity may reflect deficits in neurophysiological systems modulating the fear behavior endemic

to the disorder.

Based upon the results of their initial studies in which borderlines failed to show an emotional hyperreactivity to emotionally evocative stimuli, Herpertz, et al. (2000) modified the experimental paradigm by including contextual stimuli related to the fear of abandonment. Abandonment stressors are known to elicit strong emotional reactions in borderline individuals (e.g., "impending separation or rejection, or the loss of external structure" DSM-IV, 1994, p. 650). In an initial session, borderline and control participants provided ratings of their emotions on a 10-item scale as they listened to a short story depicting abandonment. In a second session, the participants were presented with visual stimuli in a standardized startle procedure. Results revealed that while BPD participants reported a high intensity of emotion to the story, their startle magnitudes were no greater than those of the comparison participants. Herpertz et al. concluded that heightened emotional responsivity in BPD occurs within the context of specific stressors rather than due to a generalized emotional hyperreactivity as Linehan (1993) has proposed. However, there is a methodological problem with the study in that physiological responses of participants were not recorded simultaneously with the presentation of the "abandonment" story and self-reports of emotional intensity were not obtained during the startle procedure. Therefore, it is impossible to make predictions regarding the relationship between emotional intensity to contextual stimuli and physiological emotion processes.

With the exception of the Herpertz et al. studies (1999, 2000, 2000, 2001), parameters related to the affective chronometry in BPD have not been examined. It is not known whether borderline patients differ from healthy individuals or other diagnostic groups with respect to the onset, duration, or recovery cycle of their emotional responses. Linehan (1993) proposes that they do. In fact, it is precisely the differences in time course aspects of emotion responding that form the basis of her hypotheses regarding the dysregulation of emotion in Borderline Personality Disorder. It would therefore seem useful to pursue the study of affective chronometry in this population by employing the emotion-modulated startle method and then observing the temporal pattern of emotional processing to determine whether deficits in emotion reactivity and regulation in BPD do exist.

Purpose of the Present Study

The goal of the present study was to subject certain aspects of Linehan's biopsychosocial theory to empirical investigation using the startle probe method. Namely, we sought to examine

the time course of emotional reactivity and regulation in BPD as reflected in the magnitudes of the startle response to emotionally evocative stimuli. Startle magnitudes during picture exposure were used to provide an indicator of peak emotional response (intensity), whereas startle magnitudes following offset of the slides were used to examine the recovery cycle of the emotion response (regulation) (Davidson, 1998). In this way, the patterns of startle magnitude reflecting aspects of affective chronometry were proposed to provide a psychophysiological snapshot of the hypothesized irregularities in emotional responding and regulation in Borderline Personality Disorder.

The startle method was chosen as the means to test the hypotheses because the method allows for direct observation of such phasic processes at the time of occurrence. The majority of research on the physiological correlates of BPD has focused on symptom-relevant biological irregularities, symptoms that may be associated with a variety of psychological disorders such as impulsivity, aggression, and suicidality. In contrast, the startle method gives the opportunity to examine the temporal patterns of psychophysiological processes that may be diagnostically specific.

In the present study, college students who met criteria for BPD were compared with non-borderline college students. Acoustic startle probes were presented at varying latencies following slide onset while participants' viewed pleasant, unpleasant, and neutral slides. Administration of probes during and following slide presentations provided measures of the variation in startle magnitude over time, and therefore, information regarding the time course of emotion regulation in BPD. Quantification of prevailing mood states including depression and state/trait anxiety were obtained through self-report measures during the baseline startle session. These measures were used to evaluate differences in mood and affective dispositions both within and between groups and to provide some indication of possible relationships between such mood factors and the psychophysiological findings.

Experimental Hypotheses

Based on Linehan's proposals, it was expected that, compared to non-borderlines, borderlines would show the following patterns of startle reflex response.

First, BPD individuals were predicted to exhibit greater intensity of emotional responding in general, as reflected in their higher magnitudes of startle reflex response to pleasant, neutral, and unpleasant pictorial slides and alike. Furthermore, although borderlines were expected to

present with higher levels of depression and state and trait anxiety, neither their prevailing mood state nor affective disposition were expected to account for the higher startle magnitudes.

Second, borderlines were predicted to exhibit a slower recovery of emotional responding, as reflected in the magnitudes of their startle responses at various durations following offset of the emotion elicitors. As such, the recovery cycles of borderlines would show differing patterns of emotion regulation when compared to the healthy participants and would reflect a delayed homeostatic recovery of emotional responding irrespective of slide valence. The temporal patterns of emotion regulation in the experimental groups were predicted as follows. Compared to comparisons, for unpleasant slides borderlines would show higher magnitudes of startle at longer delays following slide offset (i.e., at 7.5, 8.5, and 13 sec), indicating a sustained negative affective state. Conversely, for pleasant slides borderline participants would show lower magnitudes of startle at longer delays following slide offset, indicating a sustained positive affective state.

CHAPTER 2
METHOD

Participants

Participants were 35 volunteer female and male college students who ranged in age from 19 to 22 years, comprising the clinical (BPD) and comparison groups. All participants were right handed, and were recruited from an undergraduate Introduction to Psychology class and received course credit and monetary stipend for their participation. Informed consent was obtained from each participant both prior to interview and participation in the experimental procedure. Individuals reporting a history of head trauma, neurological disorder, or learning disability were excluded from the study. Individuals currently taking neuroleptics, anticonvulsants or mood stabilizing medications were also excluded, as were individuals who met criteria for Bipolar Disorder or alcohol or drug dependence.

Diagnostic Assessment

The borderline group participants were identified through voluntary, in-class screening and follow-up interview using the Borderline Personality Disorder section of the Structured Clinical Interview for DSM-IV, Axis II Personality Disorders Questionnaire (First, Gibbon, Spitzer, Williams & Benjamin, 1997). Screened participants who endorsed 8 or more of the 15 questionnaire items (including items for affective instability and impulsive and/or self-harming behavior) were contacted for interview. At interview, participants completed additional sections of the SCID-II questionnaire including sections for Dependent, Histrionic, Narcissistic, Paranoid, and Schizotypal personality disorders. The interview included items from the Mood Disorders (Manic Episode) and Substance Use Disorders sections of the Structured Clinical Interview for DSM-IV, Axis I Disorders (SCID-I). All positively endorsed items were queried and scored.

The SCID-I and SCID-II interview scores were used to establish DSM-IV diagnoses. The primary researcher who is well trained in the use of these instruments performed all 48 interviews. A trained independent rater provided reliability checks on a random sample (n = 23, or 48%) of the cases. Cohen's (1969) Kappa statistics were computed to measure diagnostic

agreement between the two raters. The Kappa value for inter-rater agreement of diagnosis (0 = does not meet diagnosis, 1 = meets diagnosis) was 1.0. The Kappa value for inter-rater agreement of individual diagnostic items (0 = does not meet criterion, 1 = meets criterion) was .757. To obtain a homogenous group of affectively unstable and impulsive BPD participants, the clinical sample included only those individuals who met DSM-IV criteria for the disorder including affective instability (criteria 2, 6 and/or 8) and impulsive/self harming behavior (criteria 4 and/or 5).

Comparison participants were recruited through sign-up sheets placed in the Psychology Department and then screened on the SCID-II personality disorder questionnaire prior to inclusion in the study. Similar follow up interviews as those given the clinical sample were administered to those individuals who endorsed 8 or more items on the BPD section of the SCID-II including items for affective instability and impulsive/self harming behavior. Comparison participants who met DSM-IV criteria for BPD were excluded from the comparison sample and were considered for inclusion in the borderline sample. Individuals who did not endorse the required number of items for any of the Axis II diagnoses were not interviewed prior to participation in the study.

Questionnaire Administration

Handedness was assessed with the Edinburgh Handedness Inventory (Oldfield, 1971) to assure selection of a right-handed sample. Right hand dominance is associated with hemispheric localization of certain cognitive and perceptual functions and right-hand selection allows for comparison of these lateralized functions within and across groups. Left handers show less-consistent lateralities for cognitive and affective processes. A medical screening questionnaire was used to ensure that each participant could safely participate in the study and to obtain information regarding medical and psychiatric history and currently used medications.

The Beck Depression Inventory – II and Spielberger State-Trait Anxiety Inventory, were used to assess depression and anxiety in all participants. The BDI-II (Beck, Steer & Brown, 1996) is a 21-item self-report questionnaire that is designed to measure the severity of depression. It was developed to assess symptoms corresponding to the diagnostic criteria for depressive disorder established by the DSM-IV. Each item is rated on a 4-point scale that ranges from 0 to 3 with exception of items 16 (sleep changes) and 18 (appetite changes) which provide seven options for rating (0, 1a, 1b, 2a, 2b, 3a, 3b) in order to allow for either increases or

decreases in symptoms. Scoring is accomplished by summing the ratings for the 21 items. Cut score guidelines are provided for determination of the severity of depressive symptoms and characteristics. Total scores and ranges are: 0-13 minimal, 14-19 mild, 20-28 moderate, and 29-63 severe. The BDI-II was used in this study to evaluate depressive symptoms in the clinical and comparison samples (refer to Beck, Steer, & Brown for further description).

The STAI-Y is a 40 item self-rating scale that assesses state and trait anxiety (Spielberger, 1983). Each item is rated on a 4-point scale with weighted scores of 1 to 4. Questions are designed to assess the presence or absence of anxiety. For the anxiety-present items, the highest weight score of 4 corresponds to the highest rating of anxiety. For the anxiety-absent items, the scoring is reversed. Scoring is accomplished by summing the ratings for each of the scales (S-anxiety, T-anxiety). Scores for both scales may vary from 20 to 80. Raw scores are converted to percentile ranks and/or standard scores based upon gender and normative sample (normal adults by age, college students and military recruits, general medical/surgical and prison inmates). Means and standard deviations for the college normative sample were reported as follows: S-anxiety; males 36.47 (10.02), females 38.76 (11.95), T-anxiety; males 38.30 (9.18), females 40.40 (10.15) (Spielberger, 1983, p. 5). The college norms were used in this study to determine varying degrees of state and trait anxiety in the clinical and comparison samples.

Participants completed all questionnaires during the first session prior to implementation of the experimental procedure.

Equipment and Software

Data acquisition was performed by means of a custom-built computer with a Pentium III processor with 256 MB of RAM running Windows 98 software. The computer interfaced with a stimulus computer via a Computerboards CIO/CIO 24 input/output card, which was connected to the trigger port of the Neuroscan Synamps. The stimulus computer was a Pentium III computer with 128 MB RAM and a clock speed of 550 MHZ. A Creative SB Live! sound card was used to present audio stimuli. A Matrox Millennium G400 Dual Head video card was used to present visual stimuli. The vertical retrace (refresh interval) of the stimulus monitor used was 11.766 ms. The experiment ran using DMDX software developed at Monash University and the University of Arizona (Forster & Forster, 1999). The stimulus machine simultaneously produced visual and auditory stimuli and sent trigger information to instruct the data acquisition machine to begin

EEG/EMG recording.

Stimulus Materials and Design

During the emotion-modulated startle procedure, participants viewed a series of picture stimuli that were designed to elicit positive, negative, or neutral affect. The stimuli were chosen from the International Affective Picture System (Lang, Bradley, & Cuthbert, 1999) in which picture selection for the system is based on published self-report ratings of valence and arousal (Lang, Greenwald, & Bradley, 1993). Gender-specific slide sets were chosen in order to adjust for gender differences in the distribution of valence ratings. Arousal ratings were standardized by sex. Range criteria for the valence and arousal ratings were established for the picture selection to ensure that the negative and positive pictures were both high on arousal, but opposite in valence, and that the neutral pictures were low on arousal and average on valence. Forty-two pictures were selected for each of the three valence categories: positive, negative, and neutral. Separate stimuli were constructed for woman and men, using the separate gender norms given in the IAPS manual.

Picture slides were presented in one of two counterbalanced orders, i.e. each participant was randomly assigned to either one of the two counterbalanced orders. All slide presentations were 6 seconds in duration. Slides were presented on a 19" color monitor placed 90 cm from the participant's forehead, subtending a visual angle of approximately 8.5 degrees.

Sixty-four acoustic startle probes were administered to each participant. The probes consisted of a 50 ms burst of white noise with immediate (<10 *us*) rise time. The white noise bursts consisted of broadband white noise synthesized by the Cool Edit (Syntrillium Software Corp, 1995-2000) software package synthesized at 22000 MHZ with a 16-bit resolution. Probes were presented binaurally at an intensity of 104 db, using a Creative SB Live! sound card and via Telephonics (TDH-49) balanced monaural headphones.

Six startle probe times were used: 1.5, 4.5, 6.5, 7.5, 8.5, and 13 seconds following picture onset. Since the pictures were presented for 6 seconds, the 6.5, 7.5, 8.5, and 13 second probe times followed offset of the picture. These four times were selected specifically to examine the recovery function of the elicited emotion. The 1.5 and 4.5 second probe times allowed for comparison of the degree of emotional sensitivity between groups as these two mid-picture probe times are known to produce the most robust emotion-modulated startle effects (Bradley et al., 1993). For each of the six probe times, probes occurred during 6 trials of each valence. Six

trials per valence did not contain any startle probes.

Startle Response EMG Recording

The raw blink EMG signal was digitized on-line using the Neuroscan system at 2000 Hz (60 Hz notch filter enabled). High pass filters were set at 30 Hz and anti-aliasing lowpass filters were set at 500 Hz. Blink data were amplified, rectified, and smoothed using the Neuroscan 4.2 software program. Blink responses occurring either before probe onset or following 70 ms post-probe were rejected.

Procedure

Upon arrival at the laboratory, each participant was seated in a large cloth recliner in a sound attenuated room and informed consent was obtained. The session comprised electrode placement, six baseline EEG trials, and the startle probe procedure. Participants completed self-report measures during the electrode placement in the first session.

Before electrode placement, all areas were cleaned using alcohol pads, rubbed with an abrasive paste, and wiped clean with the alcohol pad and allowed to dry. All electrodes were collared and filled with gel before placement. Participants were instructed to close their eyes when the orbicularis oculi site was cleaned to prevent stinging sensations in the eyes. The obicularis oculi electrodes were placed with the first lining up vertically with the participant's pupil and close to the bottom of the eyelid; the second placed directly next to it, in the direction of the outer corner of the eye (approximately 1 cm laterally). Electrode impedances were checked using an impedance meter at the time of electrode application.

Following electrode placement, participants viewed the pictures for 42 minutes. Instructions were given via the DMDX computer program on the computer screen and through the stereo headphones. The computer instructed the participant: "You will view a series of slides, some pleasant, some unpleasant, and some neutral. At times, you will hear a noise click that you can simply disregard. Just relax and watch the slides. Try to avoid excessive movement, as this might interfere with our recordings". Following completion of the startle probe presentation, the electrodes were removed, and debriefing was performed.

Tin electrodes were used to record the startle eyeblink response as the electrodes in the EEG cap were tin and it is not advisable to mix metals because of the creation of DC "battery" potentials. EEG was also recorded, but data analysis was deferred pending completion of the

present analyses.

Power Analysis

Power analysis was performed by means of review of effect size in studies with similar method and by estimation of appropriate sample size using repeated measures method designed by Barcikowski & Robey (1984).

The present study was a partial replication Larsen (2000), which examined the recovery cycle of emotional responding in a normal sample of individuals. The analysis contained a continuous variable and difference scores between the mean startle amplitudes at varying probe times were correlated with anterior EEG asymmetry measures. The resulting correlation coefficients provided measures of the relationship between the recovery function of the emotion-modulated startle response and anterior EEG asymmetry. Correlations from Larson's (2000) study were converted into effect size estimates. Significant correlations were obtained for the F3/F4 mid-frontal region and startle magnitude difference scores for the 7.5 and 8.5 probe times relative to the earliest probe time (1.5 seconds). Derived effect size for each difference score was .41 (power, 64) and .45 (power, 72), respectively with a sample size of 17 participants.

As the present study assessed group differences in affective recovery functions, as opposed to continuous relations as in Larsen (2000), effect sizes were reviewed in a study with similar method to determine a desired sample size based on group comparisons. Levenston, Patrick, Bradley, & Lang (2000), which looked at group differences in recovery function among 18 psychopathic and 18 non-psychopathic participants was reviewed for effect size of various significant interaction effects. Similar to the current study, Levenston et al. used repeated measures analysis of variance tests to examine the time course effects on emotion-modulated startle blink reflex in the two diagnostically distinct groups though earlier probe times were employed (300, 800, 1800, 3,000, and 4,500 ms). Significant interaction effects and reported effect sizes are given here: Group X Valence X Time for 300 versus 800 versus later interval (combined), $F(4,31)=5.93$, $\eta^2=.43$; Group X Linear Valence, $F(1,34)=17.73$, $\eta^2=.34$; Group X Quadratic Valence, $F(1,34)=6.42$, $\eta^2=.16$; Group X Linear Valence X Time, $F(1,34)=8.56$, $\eta^2=.20$.

Power tables for repeated measures designs are lacking with the exception of the single-sample case (Barcikowski & Robey, 1985). Based upon power = .80 at the .05 level and K = 6

repeated measures, Barcikowski and Robey indicated a sample size of 14 is sufficient to obtain a medium effect size (.56).

Based upon the sample sizes used in the cited studies, which produced significant interaction effects, and the sample size estimate derived by Barcikowski and Robey (1985), it was reasoned that a total sample size of 34 (equal group n = 17) would be sufficient to provide a meaningful replication of the time course findings. Calculations for predicted effect and sample size for the Group X Time interaction among borderline individuals was not possible due to the lack of such studies in the literature. Estimates of observed power for the interaction effects were performed at the time of data analysis as part of the SPSS GLM MANOVA program and are cited herein.

Data Analysis

Separate repeated measures ANOVA's were performed for each dependent measure. The significance of main and interaction effects were evaluated with a univariate *F* statistic to reduce the probability of Type I errors. Statistical significance for all tests was assessed using an alpha level of .05.

Startle Reflex Analyses

Raw startle blink magnitudes were first examined for each participant to determine whether the startle reflex response had occurred at each presentation of the startle probe. Magnitudes of 2 milivolts or less were considered to be non-startles and were therefore entered as missing data (zeros). To eliminate the attenuating effects of averaging zeros into the cell means, within participant mean amplitudes were computed for each stimulus valence and missing data were replaced by the computed means for each case. The computed means neither inflated nor deflated the cell means.

Mixed analysis of variance (ANOVA) were conducted, with startle magnitude as the dependent variable, Group (2; Borderline, Comparison) as the between participants variable, and Valence (3; pleasant, neutral, and unpleasant) and Probe Time (6; 1.5, 4.5, 6.5, 7.5, 8.5, and 13 seconds) as the within participants variables. Significant omnibus effects were decomposed with appropriate simple effect analyses and pair-wise contrasts employing the Tukey HSD for unequal n.

Emotional intensity. The statistical tests were used to examine changes in startle amplitudes as a function of the affective valence to determine whether the phasic valence effect

had been replicated. Based upon Linehan's (1993) hypothesis of emotional hyperreactivity in BPD, a Group X Valence interaction was predicted. Borderlines were expected to produce higher blink magnitudes to unpleasant emotional stimuli and lower blink magnitudes to pleasant stimuli, as compared to comparison participants. Trend analyses were predicted to yield a typical linear valence effect in both groups, with the largest blink magnitudes for unpleasant stimuli, and the smallest for pleasant stimuli. Planned comparisons of group differences in blink potentiation predicted significant differences for positively and negatively valenced stimuli. No prediction was made regarding neutral stimuli.

Time Course Effects. The statistical tests were used to examine the hypothesis that Borderline Personality Disorder is associated with a delayed recovery of emotional response. A Group X Valence X Time interaction was predicted. Borderlines were expected to produce higher blink magnitudes across probe times to the unpleasant slides, and lower magnitudes across probe times to the pleasant slides. Sustained potentiation and inhibition of startle would reflect corresponding delays in emotion regulation. Planned comparisons were predicted to show significant group differences across later probe times
(7.5, 8.5, and 13 seconds). Trend analysis was performed to compare changes in startle reactivity over time for each group. Comparison participants were expected to show a linear trend across probe times reflecting the recovery cycle of emotional responding. Two potential trends were predicted in the BPD group. A non-significant trend would reflect the sustained potentiation and/or inhibition of startle (i.e., delayed recovery), whereas increased potentiation and/or inhibition would signify increasing emotional intensity over time (i.e., emotion escalation).

Self-report measures

Self-report measures were analyzed using ANOVA tests to assess group differences in levels of depression and state/trait anxiety. Borderline participants were predicted to show higher levels of depression and anxiety consistent with DSM-IV descriptors and current literature. The nature and intensity of their ongoing mood state was not expected to increase or decrease the potentiation of the startle magnitudes greatly, since potentiation and inhibition of startle represent phasic, as opposed to tonic emotional responding. To assess this prediction further, startle magnitudes were also examined across groups as a function of level of depression and state/trait anxiety. Non-significant effects of mood and affective disposition on startle magnitude were predicted.

CHAPTER 3
RESULTS

Descriptive Statistics

Demographics

A total of 42 participants were originally selected for the study with 23 in the borderline group and 19 in the comparison group. Two comparison participants failed to complete the study. One comparison and four BPD participants were dropped because of aberrant startle responses, neurological disorder, or beginning antipsychotic medication during the course of the study. The final cohort included 19 borderline and 16 comparison participants. All participants were between the ages of 19 and 22 years and all were undergraduate students at Florida State University. The gender distribution by group consisted of 5 males and 14 females in the borderline group and 5 males and 11 females in the comparison group. There was no significant relationship between group and gender, $\chi^2(1, N=35)=.01$, $p = .7475$; $Phi^2=.00296$.

Self-Report Measures

For the Beck Depression Inventory-II, based on raw scores, the ANOVA results revealed a main effect for Group, $F(1,31)=8.48$, $p=.006$, indicating higher ratings of depressive symptoms among borderline participants relative to comparisons (Means/SD: BPD = 15.84/10.45; Comparison = 8.25/9.06). No main effect for Gender was observed, $F(1,31)=.1282$, $p=.723$, and a Group X Gender interaction only approached significance, $F(1,31)=3.716$, $p=.063$.

Severity of depression was determined using the BDI-II ranges established by Beck, Steer and Brown (1996). The borderline group, on average, reported greater severity of depression compared to the comparison group. Seven borderline participants (36.8%) met criteria for moderate to severe Major Depressive Disorder. Five comparison participants (31.3%) also met criteria for Major Depressive Disorder, with symptoms in the mild or moderate range (see Table 1).

Table 1. Frequency of Major Depressive Disorder By Group.

Group	Frequency/Number Diagnosed
Borderline Group	
Major Depressive Disorder:	36.8% (7)
Mild	0% (0)
Moderate	21% (4)
Severe	15.8% (3)
Comparison Group	
Major Depressive Disorder:	31.3% (5)
Mild	18.8% (3)
Moderate	12.5% (2)
Severe	0% (0)

State-Trait Anxiety Inventory raw scores were converted to standard scores based on gender for the college student normative sample (Spielberger, 1983). For STAI (State-anxiety), ANOVA results revealed that borderlines and comparison participants reported similar levels of state anxiety (Means/SD: BPD = 52.00/10.07; Comparison = 50.18/11.75). S-anxiety scores did not differ by group, $F(1,31)=.528$, $p=.473$ or by gender, $F(1,31)=.832$, $p=.368$. The Group X Gender interaction was also non-significant, $F(1.31)=.608$, $p=.441$.

For STAI (Trait-anxiety), the ANOVA results revealed higher ratings of trait anxiety among borderlines relative to comparisons (Means/SD: BPD = 61.79/10.08; Comparison = 50.00/7.09), a Group Main Effect, $F(1,31)=25.943$, $p<.01$, though males and females overall did not differ significantly on the degree of trait anxiety reported, $F(1,31)=1.141$, $p=.293$. A Group X Gender interaction was observed, $F(1,31)=7.30$, $p=.011$, and follow-up analyses revealed significantly higher trait anxiety among male borderlines relative to both comparison males, $t(31)=$, $p<.001$, and comparison females, $t(31)=$, $p=.005$. Refer to Table 2 for means, standard deviations and score ranges by group and gender for all self-report measures.

Table 2. Self-report Measures, by Group and Gender: Means, Standard Deviations, and Score Ranges

Group/Gender	n	Mean/S.D.	Range
Beck Depression Inventory-II			
Entire sample	35	12.37 (10.43)	0 - 34
Female	25	12.80 (9.88)	1 - 30
Male	10	48.50 (12.24)	37 - 78
Comparison	16	8.25 (9.06)	0 - 27
Borderline	19	15.84 (10.45)	1 - 34
State-Trait Anxiety Inventory State Anxiety			
Entire sample	35	51.17 (10.74)	35 - 85
Female	25	52.24 (10.16)	35 - 85
Male	10	48.50 (12.24)	37 - 78
Comparison	16	50.18 (11.75)	35 - 85
Borderline	19	52.00 (10.07)	37 - 78
State-Trait Anxiety Inventory Trait Anxiety			
Entire Sample	35	56.40 (10.56)	42 - 79
Female	25	55.60 (8.00)	52 - 73
Male	10	58.40 (15.63)	43 - 79
Comparison	16	50.00 (7.09)	42 - 67
Borderline	19	61.79 (10.08)	46 - 79

Note: Means (standard deviations) and range scores are expressed in the following units of measurement: BDI-II, raw scores; STAI (state and trait) standard scores.

Fifteen borderline participants (78%) met criteria for comorbid Axis II diagnoses. Refer to Table 3 for distribution of comorbid diagnoses. Comparison participants were not assessed for Axis II disorders other than BPD. Although the majority of all participants reported experimentation, occasional use and or abuse of alcohol and drugs, no participants met criteria for alcohol or drug dependence.

Table 3. Frequency of Comorbid Axis II Diagnoses in the Borderline Group

Diagnoses	Frequency/Number
"Pure" BPD	21% (4)
BPD/Narcissistic	31.6% (6)
BPD/Paranoid	26.3% (5)
BPD/Histrionic	10.5% (2)
BPD/Dependent	5.3% (1)
BPD/Narcissistic/Schizotypal	5.3% (1)

Startle Reflex

Startle reactivity

Examination of the raw data revealed a higher number of total startle blink responses in the borderline group than in the comparison group. Each participant was given 108 startle probes across the slide session. The 19 borderline participants produced a total of 1031 startle responses to 2052 startle probes (50.2%). The 16 comparison participants produced 498 responses to 1728 probes (28.8%), which means that borderlines were close to twofold more likely to show a startle response on a given probe trial than were comparison participants. There was a significant relationship between group and total number of startles, χ^2 (1,N=35)=171.07, p<.001; F(1,33)=6.635, p=.015. A Group X Gender interaction was significant, F(1.31)=4.73, p=.037. Follow-up pairwise comparisons revealed that female borderlines, rather than borderlines per se, were more highly reactive to the startle blink probes relative to borderline males, F(1,17)=6.849, p=.018, and comparison females, F(1,23)=10.288, p=.003. Differences in total number of startles approached significance for borderline females relative to comparison males, F=(1,33)=3.57, p=.067 (see Figure 1).

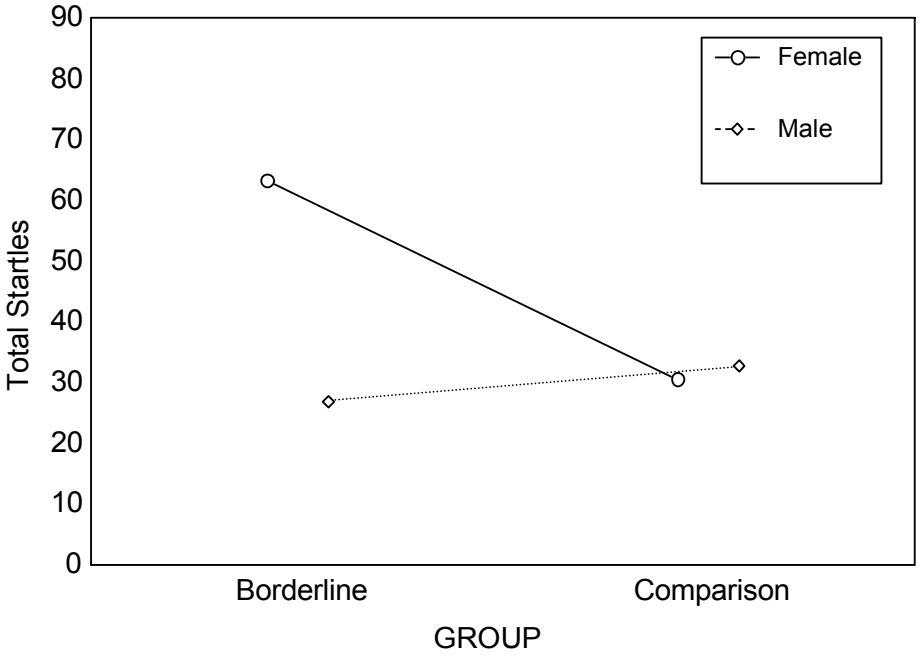

Figure 1. Total startles for borderline and comparison groups by gender.

Effects of Mood State and Trait Anxiety on Startle Magnitudes

Repeated measures analysis of variance (ANOVA) tests were performed on raw startle blink magnitudes to examine the possible effects of depression and state and trait anxiety on startle response. As predicted, neither prevailing mood state nor trait anxiety was related to magnitudes of startle response. Non-significant effects on startle magnitudes were observed for BDI-II raw scores, $F(20,14)=.803$, $p=.68$; range of depression (minimal, mild, moderate, and severe), $F(3,31)=.377$, $p=.77$; state anxiety, $F(23,11)=1.476$, $p=.254$; and trait anxiety, $F(24,10)=1.12$, $p=.447$. Although both groups reported higher levels of state anxiety as compared to the college normative sample, state-anxiety was not found to be associated with startle reactivity (e.g., total number of startles evoked) $F(1,33)=.042$, $p=.839$. Based upon these non-significant findings, self-report measures of mood and affective disposition were not included as factors in the remaining analyses.

Emotional Valence

ANOVA tests were performed on startle blink magnitudes to assess for the predicted

phasic valence effects. As predicted, borderlines and comparisons differed significantly in the magnitude of their elicited startle blinks across valence categories, a Group X Valence interaction, $F(2,62)=3.353$, $p=.041$, with borderlines exhibiting greater overall magnitudes of startle as compared to comparison participants. No gender differences were found in this effect, $F(1,31)=.0667$, $p=.797$. Observed power for the Group X Valence interaction was .714. Planned pair-wise comparisons revealed that borderlines and comparison participants did not differ significantly in their blink magnitudes for any of the valence categories; (Pleasant) $F(1,33)=1.932$, $p=.173$, (Neutral) $F(1,33)=2.758$, $p=.106$, (Unpleasant) $F(1,33)=.165$,$p=.686$. Refer to Table 4 for distributions of the means and standard deviations of startle magnitudes by group.

The pattern of blink potentiation for the comparison group showed a significant quadratic valence effect, $F(1,33)=6.904$, $p=.020$ with observed power for the quadratic trend of .686. Comparisons showed greater startle inhibition to neutral slides as compared to pleasant and unpleasant slides. Trend analyses for the BPD group were all non-significant (see Figure 2).

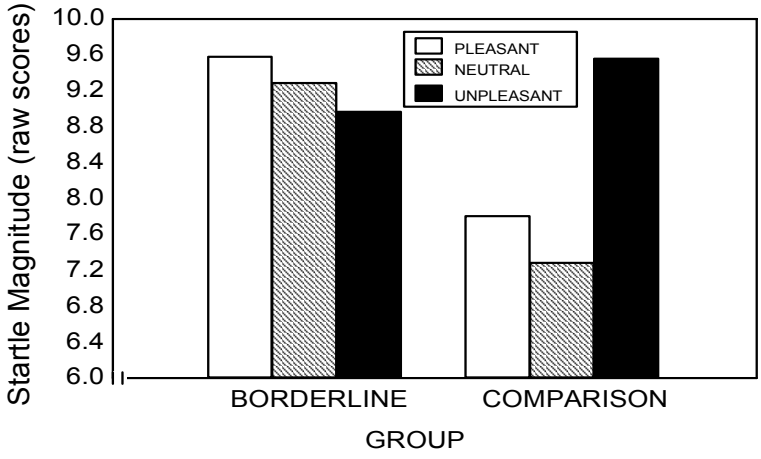

Figure 2. Mean blink magnitudes for borderline and comparison groups as a function of slide valence.

Table 4. Startle Reflex Magnitude as a Function of Slide Valence and Probe Time Means and Standard Deviations

	Valence		
	Pleasant Mean/SD	Neutral Mean/SD	Unpleasant Mean/SD
BORDERLINE			
1.5 sec	8.69 (3.74)	8.09 (3.16)	8.23 (4.51)
4.5 sec	9.10 (5.23)	9.38 (5.12)	9.43 (4.39)
6.5 sec	8.63 (4.64)	8.31 (5.05)	9.31 (4.50)
7.5 sec	11.33 (6.76)	9.42 (5.11)	8.32 (3.61)
8.5 sec	9.89 (5.92)	8.53 (5.09)	8.99 (4.69)
13.0 sec	9.29 (6.47)	11.97 (6.29)	9.50 (4.92)
COMPARISON			
1.5 sec	6.31 (3.95)	6.31 (3.71)	7.24 (5.26)
4.5 sec	6.66 (3.24)	8.02 (4.49)	9.56 (6.49)
6.5 sec	7.97 (5.44)	7.39 (4.64)	8.93 (5.37)
7.5 sec	7.89 (5.11)	6.49 (3.08)	8.99 (6.40)
8.5 sec	9.45 (8.42)	6.20 (3.47)	11.91 (8.46)
13.0 sec	8.61 (6.64)	9.35 (5.26)	10.69 (5.98)

Time Course Effects

ANOVA tests were performed on startle magnitudes to examine blink modulation over time as a measure of emotion regulation. Results revealed a main effect for Probe Time, $F(5,155)=2.499$, $p=.033$, with a significant linear trend across groups, $F(2,32)=99.08$, $p<.001$ (see Figure 3). Observed power for the Probe Time main effect was .948.

Pair-wise comparisons of the time course effect for the entire sample showed a progressive increase in startle magnitudes over time. Probes at Time 6 (13 seconds) produced the highest magnitudes with significant differences in magnitudes for the following comparisons: Time 6 greater than Time 1 (1.5s), $F(1,33)=13.36$, $p<.001$; Time 6 greater than Time 2 (4.5s), $F(1,33)=3.91$, $P=.05$; Time 6 greater than Time 3 (6.5s), $F(1,33)=5.18$, $p=.029$; Time 6 greater

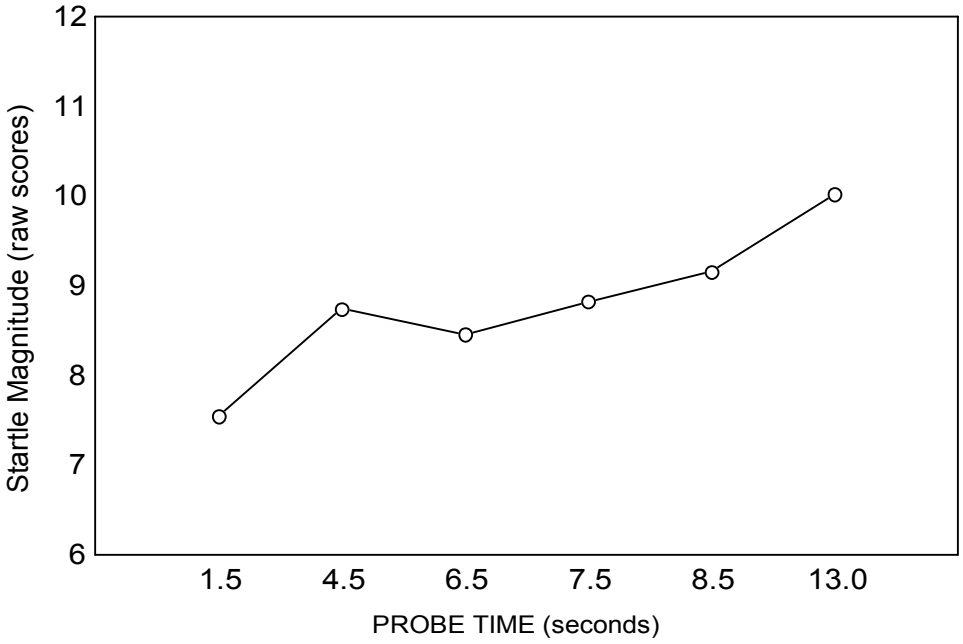

Figure 3. Mean blink magnitude as a function of probe time.

than Time 4, *F*(1,33)=5.48, *p*=.025. Time 6 magnitudes did not differ significantly from Time 5 (8.5s) magnitudes. The predicted Group X Valence X Time interaction was non-significant, F(10,310)=.688, p=.736. Borderlines did not differ significantly from comparisons in the magnitude of their blink responses across later probe times (7.5, 8.5, 13s), *F*(1,33)=.429, *p*=.516. The comparison group showed a positive linear trend in blink potentiation over time, *F*(1,33)=12.611, *p*=.003. Compatible with predictions, borderlines produced non-significant trend across probe times, suggesting a sustained blink potentiation over time (see Figure 4).

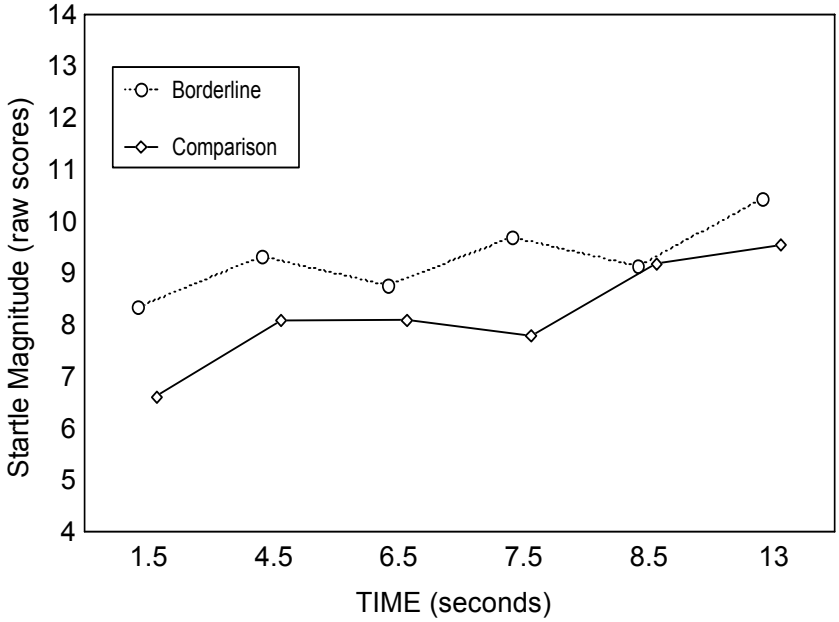

Figure 4. Mean blink magnitudes for borderline and comparison groups as a function of probe time.

CHAPTER 4
DISCUSSION

As predicted, Borderline Personality Disorder was associated with higher overall magnitudes of startle reflex response to pleasant, neutral, and unpleasant pictorial slides. Furthermore, those with BPD showed a higher probability of startle on a given trial. Taken together, these findings provide partial support to Linehan's hypothesis, namely, that those with BPD would show a higher level of reactivity to emotionally evocative stimuli. In this instance, they appear to have shown just such a response to the startle probe itself.

Follow-up comparisons failed to show significant group differences in startle amplitudes for any of the three individuate valence categories. Borderlines also failed to show a linear valence effect. Although this was specifically predicted, as will be discussed later, the findings may be indicative of a more general failure of emotion-modulation in those with Borderline Personality Disorder.

Borderline participants reported significantly higher levels of depression (number of symptoms and range of depression) and trait anxiety than comparisons. Furthermore, self-ratings of state anxiety were significantly greater in both groups as compared to Spielberger's normative college sample (1983). Nevertheless, neither mood state nor affective disposition were found to be associated with the magnitude of startle response, suggesting that the effects observed are relatively unique to Axis II psychopathology and not to severity of anxious or depressive symptoms.

Finally, although borderlines did not show the evidence for a deficiency in emotion regulation as was predicted, the fact that they showed higher overall startle magnitudes and the absence of a valence effect, may nevertheless be indicative of the kind of emotional dysregulation that has been proposed by Linehan. The Probe Time main effect indicated that borderlines produced similar magnitudes of startle as comparison individuals across probe times. Trend analysis showed different group-dependent patterns of startle modulation over time. Borderlines exhibited sustained potentiation of blink response across probe times, whereas

comparison participants showed a progressive increase in potentiation from 1.5 to 13 seconds post-stimulus.

Emotional Intensity in BPD

Emotional intensity, as described by Linehan (1993), refers to the degree or amount of emotion generated by a system and/or felt by an individual. Linehan has proposed that borderline individuals experience both positive and negative emotions that are extreme by degree. If we consider the general increase in startle magnitude across valence categories as a measure of emotional intensity, then the current findings would support Linehan's theory. Although borderline participants did not demonstrate augmented potentiation of startle blink response to unpleasant slides or enhanced inhibition of startle under pleasant conditions, they may still experience the full range of intensity as Linehan suggests, but be unable to regulate in a way that would be reflected in startle modulation. The absence of a startle valence effect among borderline participants, as shown by the equal magnitudes of startle for pleasant and neutral slides as compared to unpleasant slides, might be interpreted several ways.

One possibility is that the valence pattern among borderline participants might signify a pervasive negative affectivity regardless of the valence characteristics of eliciting stimuli. Correspondingly, this pattern may indicate a reduction in the intensity of positive emotion in response to appetitive cues. As such, borderlines may show heightened defensive emotional reactivity to both threatening and non-threatening stimuli (i.e., false alarms) and, conversely a reduction in pleasurable emotions to pleasant events. Thus, the absence of a linear trend in emotion-modulated startle response for borderlines may reflect basic irregularities in the operation of appetitive/approach and/or aversive/withdrawal motivational systems (Davidson, 1995; Gray, 1994; Lang, Bradley, & Cuthbert, 1990), which may have both affective and behavioral implications. This interpretation would be consistent with the affective criteria put forth by the DSM-IV (1994), which describes the affective style of the borderline as reactive, pervasively negative, and lacking in positive emotion. While Linehan predicts that borderlines have difficulties regulating positive emotions, she aptly points out that regulatory deficits are more pronounced in their negative emotions.

Another interpretation of the results involves contextual factors that may have influenced the way in which borderlines experienced the startle procedure and, in turn, the elicitation of various affective states. First, borderlines may experience the startle procedure as more aversive than comparison individuals. As such, the experimental context may have served to

evoke a pervasive negative emotional state among BPD participants that resulted in a propensity toward defensive responding regardless of slide valence. Admittedly, the experimental task involved aversive procedures including abrading of the skin for EMG electrode placement, sitting in a chair for about two hours, and having to avoid excessive movement throughout the experimental session. In prior work, Blackhart, Kline, Donohue, LaRowe and Joiner (2002) observed a shift toward a negative mood state in college-age participant's following a similar EEG preparation, which was perceived as mildly aversive. However, for male participants, negative mood post-preparation predicted relative right frontal activation. Reduced alpha in the right frontal region has been associated with negative mood states. Conversely, female participants showed relative left frontal activation, a pattern that has been related to the elicitation of positive emotions. The researchers suggested that women who were more engaged with the entire experimental context, including interactions with the experimenter, may have been more willing to openly express their negative emotions regarding the aversive context, resulting in a relationship between left frontal activation and negative mood in women.

Second, as noted in the Blackhart et al. (2002) study, the experimental session also provides an interpersonal context, which is created through the interactions between participant and experimenter. The diagnostic interview and electrode application procedures provide ample opportunity for the development of rapport in which participants may experience the experimenter as understanding and empathic. However, the shift between connection and interaction with the experimenter to the isolation of the experimental procedure may evoke strong negative reactions in borderline participants. Unfortunately, this was not assessed in the present study, and should be in future work. Nevertheless, borderlines tend to be highly sensitive to interpersonal stressors and may interpret minor provocations as signs of rejection or abandonment. Such stressors may elicit strong negative emotions and may be tied to the borderline's intolerance of being alone (DSM-IV, 1994).

It is also plausible that borderline participants experienced emotional "carry-over" effects as a result of deficiencies in emotion regulation. Linehan (1993) argues that borderlines cannot easily regulate their negative affective states and that these states may therefore endure over time. If this is true, then negative emotions elicited by the presentation of unpleasant slides may persist across the slide-viewing period, thereby over-riding the elicitation of subsequent positive

emotional responses to pleasant or neutral slides. As opposed to activation of defensive responding to pleasant events, the higher magnitudes of startle to appetitive stimuli may simply reflect the more enduring effects of negative emotions, due to deficits in emotion regulation. This interpretation would support Linehan's (1993) contention regarding the pervasive effects of emotional states "on a number of cognitive processes, which in turn are related to the activation and reactivation of emotional states" (p. 44).

Neither depressed nor anxious mood could account for the between-group differences in startle magnitudes. In addition, the valence pattern among borderlines was notably dissimilar to those observed in other studies that have looked at startle modulation as a function of depressed mood (Allen et al., 1999; Cook et al., 1991; Cook et al., 1992), high trait anxiety (Cook et al, 1991; 1992; 1997), specific phobia (de Jong et al., 1993; de Jong et al., 1996; Merckelbach et al., 1995; Sabatinelli, et al., 1996), panic disorder (Cuthbert et al., 1994), obsessive-compulsive disorder (Kumari et al., 2001), PTSD (see Metzger et al., 2000 and Orr & Roth, 2000 for review), or psychopathy (Patrick et al., 1993). As such, and as will be discussed below, this pattern may reflect the fundamental irregularities in emotional experience, regulation, and expression that are part and parcel of BPD.

Emotional Hyperreactivity in BPD

Relative to comparison participants, borderlines showed a greater number of total startles across the viewing session, which would suggest increased "startleability" among these individuals. Hypersensitivity to emotion elicitors may reflect increased reactivity of neural circuitry associated with defensive responding. This circuitry might include the operation of the amygdala, which is involved in the encoding of stimuli (e.g., as threatening, safe, or appetitive), as well as other subcortical structured associated with the startle reflex circuitry. Irregularities in functioning of these subcortical systems may result in failure to habituate, i.e., inhibit the startle response to aversive probes, resulting in a hypersensitivity to threat cues. However, the suppression of negative emotion might occur through the inhibitory connections from prefrontal cortical regions such as the obitofrontal cortex to the amygdala (i.e., top-down regulation of emotional responding). Animal studies have shown that when lesions are made to the prefrontal cortex, the amygdala is released from inhibition and extinction of aversive responding is slowed greatly (see Davidson, Putnam, & Larson, 2000). According to Davidson et al. "too much or too little activation of the amygdala may give rise to either excessive negative affect or decreased

sensitivity to social cues that regulate emotion, respectively" (p. 598). At a higher level of analysis, hypersensitivity may be observed in the borderline's affective instability and marked reactivity of mood characterized by frequent episodes of dysphoria, irritability, anger, anxiety, etc. (DSM-IV, 1994).

It is a mistake to conclude in the absence of more direct measures of neural functioning within specific regions of the brain (e.g., fMRI, PET) that failure to modulate startle amplitudes in response to emotion elicitors reflects the hyperreactivity of specific neurophysiological systems. As pointed out by Gale and Edwards (1983), ceiling effects may also account for group differences in physiological responding. Consistent with the Law of Initial Values (Wilder, 1957, 1967, 1976), the prestimulus level of a system being measured will affect the physiological response to a given stimulus. The higher the initial level of response, the smaller the increase in the physiological response. Though not assessed in this study, higher baseline startle reactivity might result in smaller magnitudes of startle to emotionally evocative stimuli, thereby masking any between group valence effects. The actual magnitude (intensity or reactivity) of emotional responding would not be revealed because the system is already "ramped up" to a high level.

The Regulation of Emotion in Borderline Personality Disorder

The pattern of findings was not consistent with our initial hypotheses about delayed recovery, however, as discussed previously, the fact that those with BPD were more startleable overall, at all valences, and across probe onset times, may nevertheless be consistent with delayed emotional recovery. And, although the predicted Group by Valence by Probe Time interaction was not obtained, borderlines did show a non-significant trend toward an overall sustained increase in startle magnitude and probability across probe times. Regardless of the trend apparent on visual inspection, however, statistical comparisons did not reveal the predicted group differences in blink magnitudes at later probe times (7.5, 6.5, and 13 seconds). Surprisingly, comparison participants showed a positive linear trend over time with a progressive increase in startle magnitudes across the 13-second time period suggesting an increase in emotional responding.

While it appears that borderlines did not modulate their emotions following offset of the evocative slides, comparisons as well did not evidence recovery of their emotional responses. Of course, one explanation is that the chosen time frame for the observation of emotion regulation was insufficient to capture any changes associated with a recovery function. As such, the experimental method may have been limited in its ability to assess the typical homeostatic

changes in emotional responding reflective of regulation processes.

Trend analyses revealed an initial robust potentiation of blink reflex at 1.5 seconds for borderlines but a later "peaking" of blink magnitudes (13 seconds) for comparisons. The data would suggest group differences in the *rise time* and initial intensity of emotional responding. For borderlines, peak magnitudes occurring early in the epoch suggest a rapid onset and low threshold of emotional response. Linehan (1993) has termed this phenomenon "emotional sensitivity" and points out that borderlines may react quickly to even slight provocations. This observation provides additional support for the theory that borderlines possess an emotional hyperreactivity. Subjectively speaking, heightened emotional reactivity might be experienced as high intensity of emotion when the individual is unable to regulate painful affects that occur quickly and repetitively.

Summary and Future Directions

The current study provided mixed support for Linehan's (1993) theory regarding emotion dysregulation in Borderline Personality Disorder. One possible interpretation of the findings is that although borderlines show normal defensive responding to signals of threat or harm, they may experience increased negative affectivity to appetitive stimuli and a reduced capacity for positive emotions. On the other hand, the overall emotional reactivity among borderlines may reflect physiological reactivity and not negative affectivity per se. Of course, this may be an artificial dichotomy since the former may give rise to the latter. The valence relevant effects obtained among borderline participants were shown to be independent of their mood state or affective disposition and, as such, suggest that irregularities in emotional responding may occur at a more basic physiological level (i.e., at the level of the brain stem, or perhaps at the level of the amygdala). Future work might also consider frontal lobe function as well, especially in the context of failures in emotional regulation.

Neither group demonstrated emotion regulation across the viewing interval. The time frame for the assessment of regulatory processes may have been insufficient to capture magnitude changes associated with a more natural episode of emotion regulation. Future studies employing the startle probe method might provide information on regulatory processes through manipulation of the probe times. For example, Levenston, Patrick, Bradley, & Lamb (2000) in looking at attentional deficits in psychopaths, varied probe times to assess various stages of attentional processes related to affective functioning. Earlier probe times (i.e., prior to

1.5 sec) provided information regarding orienting and attention processes. Future work might examine emotion regulation in BPD by employing later probe times than were used in the present study or by manipulating emotional regulatory processes through instructions to participants to maintain, enhance, or suppress their responses to emotionally evocative stimuli.

Examination of the startle magnitudes across the viewing interval revealed significant group differences in participants' overall responsivity to emotionally evocative stimuli. Borderlines exhibited evidence for hyperreactivity of emotional responding in the form of increased startle probability and magnitude, regardless of valence. Hyperreactivity may reflect abnormalities in the operation of cortical and/or subcortical systems associated with the evaluation of stimuli and initiation and/or inhibition of the startle reflex to aversive stimuli. One possibility is a deficit in the ability to habituate to the startle probe. Another possibility is a disconnection between cortical and subcortical systems that relay information regarding the valence characteristics of stimuli (i.e., top-down emotional regulation). Future examination of habituation effects under baseline startle conditions and cognitive processes associated with stimulus evaluation may provide information regarding the deficits associated with heightened emotional reactivity in BPD.

Finally, other than the issues of interpersonal context discussed earlier, the current study did not specifically include stimuli that might trigger intense emotional responding to interpersonal stressors such as rejection, disapproval, or abandonment. Modification of the startle method to include interpersonal slides that depict these situations along with self-ratings of affective intensity associated with emotionally evocative stimuli might provide a stronger test of Linehan's proposals regarding heightened emotional intensity in BPD.

APPENDIX A
CONSENT FORMS

CONSENT FORM FOR SCREENING PROCEDURE

Title of Research: Individual Differences in Emotion Regulation.

Principal Investigators: John **P. Kline,** Ph.D.; Steven D. LaRowe, **M.S.;** Ginnette C. Blackhart, M.S.; Foluso Williams, B.A.: Marilyn **E.** Jennings, M.S.

I, _____, being 18 years of age or older, freely and voluntarily and without undue inducement or any element of force, fraud, deceit, duress, or other form of constraint or coercion, consent to be a participant in the screening procedure for the above named research project, to be conducted at the Florida State University from August 27, 2001 through August 26, 2002. The purpose of the screening procedure is to identify individuals who possess a specific personality style and to consider these individuals for participation in the above named research study. Individuals who possess this personality style, as measured by self-report, will be contacted shortly after completing the screening instrument to discuss their possible participation in the study. Informed Consent to participate in the study will be obtained prior to participation in the first experimental session.

Purpose of the Research: The purpose of the overall study is to research the stability of electroencephalographic **(EEG)** brain wave patterns in individuals and to study the correlation between EEG pattern, personality style, and emotions over time. The other purpose of these sessions is to investigate the body's physiological responses to auditory and visual stimuli, to examine how people process and regulate emotion.

Procedures for the Completion of the Screening Procedure: You will be asked to complete a 23-item questionnaire that assesses certain aspects of emotion and behavior. You will be instructed to read each item on the questionnaire and to indicate YES or NO depending upon whether the item applies to you or not. You will also be asked to rate the frequency or duration of some emotions and behaviors. The procedure will take approximately 10 minutes or less to complete. If selected to participate in the research study, at the time of the first session, you may be queried regarding some items on the questionnaire to verify the accuracy of item endorsement.

You are free to withdraw consent and discontinue participation at any time without prejudice, penalty, or loss of the benefits to which you might otherwise be entitled.

Potential Risks **or Discomforts: There** are no appreciable risks associated with participation in this screening procedure.

Potential Benefits to **You and Others:** You understand that involvement in this procedure is not likely to produce any direct, immediate benefit to you other than monetary payment should you be selected to participate in the research study. If you are chosen to participate in the study, you will receive payment of $25.00 per session for your participation in two EEG sessions.

Confidentiality: Participant data will be coded with a participant number and no names or other personal information will be identified or related to these materials in any way. Personal information will only be associated with participant numbers as needed to contact participants by phone to discuss subsequent participation in the research study. This information, however, will only be accessed by the principal investigators of this study, and no one else will have access to this information. All information gathered in this screening procedure will be kept confidential and secure to the extent allowed by law.

Your signature below indicates that you have read the above information, and that you have been given the opportunity to ask any questions you may have concerning the screening procedures and the conditions of participation, and that these questions, if any, have been answered to your satisfaction. You may contact Dr. John P. Kline, Assistant Professor of Psychology (644-9363) to discuss any aspect of this procedure in the future. Questions about your rights in relation to subject participation and/or reports of any research related injury can be directed to Dr. Kline or Heidi Hodges, Chair of the FSU Institutional Review Board for Human Subjects (644-8633).

I have read and understand the above

Signature of Participant_____Date_____

Printed Name of Participant_____Date_____

CONSENT FORM

Title of Research: Brainwaves, Thought, and Emotion: The Biology of Personality and Affect.

Principal Investigators: John P. Kline, Ph.D.; Steven D. LaRowe, M.S.; Ginette **C.** Blackhart, M.S.; Foluso Williams, B.A.; Marilyn E. Jennings, M.S.

I, _____, being 18 years of age or older, freely and voluntarily and without undue inducement or any element of force, fraud, deceit, duress, or other form of constraint or coercion, consent to be a participant in the above named research project, to be conducted at the Florida State University from August 27, 2001 through August 26, 2002. Listed below are the procedures to be followed in this research and their purposes, any risks, discomfort, and benefits associated with participation in this study, and the measures which will be taken to ensure confidentiality of the information obtained.

Purpose of the Research: The purpose of the overall study is to research both the stability of electroencephalographic (EEG) brain wave patterns in individuals and to study the correlation between EEG patterns and emotions over time. The other purpose of these sessions is to investigate the body's physiological responses to auditory and visual stimuli, to examine how people process emotion.

Procedures for the Research: In this study, you will have your EEG patterns recorded on two different occasions during the period of three weeks. You may then be contacted through mail and asked to fill out some personality questionnaires as many as three times over a period of three years after the initial EEG measures have been recorded. If you are a student, your current address will be accessed through student records.

In the first session, after you have read and signed the consent form, you will fill out some personality questionnaires. A saliva sample will then be collected from you solely for the purpose of measuring cortisol levels during stress (it will be screened for naturally occurring hormones only and will NOT be screened for drugs). After that, we will be collecting some samples of your genetic material. We will be analyzing the following genes: the 5HT *(5*-hydroxy-tryptamine) transporter gene, the dopamine transporter gene, the dopamine D-2 receptor gene, and the dopamine D-4 receptor gene. It is a quick and painless procedure that you will conduct yourself. You will be asked to abstain from eating or drinking 30 minutes before the procedure. You will then wash your hands, and rinse your mouth. You will be given a sterile cotton swab in a sterile package. You will be asked to break the seal, and brush the inside of your cheek 30 times with two swabs.

You will than be fitted with an EEG electrode cap, and will have sensors applied to your face to measure facial muscular activity (EMG). After the application of the electrodes, six 60-second baseline EEG measures will then be recorded; three with your eyes open, and three with your eyes closed. You will then be asked to do two different tasks. In the first task, you will watch a series of slides with geometric shapes while listening to a series of white noise bursts of varying intensity at 74 and 104 decibels. These bursts are harmless, with the loudest of the bursts (104 db) being approximately as loud as a subway train. FF0 and

EMG measures will be recorded during these tasks. In the second task, you will be read a story in which you are to imagine the scenario in the story is happening to you. After the story has been read to you, you will be presented with a series of items on a computer screen. You will be asked to think about each of these items carefully as they are presented to you.

In the second session, you will be fitted with an EEG electrode cap, and will have other sensors applied to your face to measure facial EMG. After the application of the electrodes, six 60 second baseline BEG measures will then be recorded; three with your eyes open, and three with your eyes closed. You will then view a series of neutral, violent, aversive, and erotic slides while listening to a series of white noise bursts of varying intensity at 74 and 104 decibels. These bursts are harmless, with the loudest of the bursts (104 db) being approximately as loud as a subway train. BEG and EMG measures will be recorded during these tasks.

You are free to withdraw consent and discontinue participation at any time without prejudice, penalty, or loss of the benefits to which you might otherwise be entitled. If you choose to withdraw consent at any time, you will receive payment and/or experimental credit for the time spent in the experiment.

Potential Risks or Discomforts: There are no appreciable risks associated with participation in this research. Some of the tones you hear in the first and second sessions might be slightly annoying, and some of the slides that you may view in the second session might be slightly unpleasant or disturbing. In addition, the EEC cap and electrode application may be slightly uncomfortable. If you do experience any discomfort, measures will be taken by the researcher to increase your comfort level. Risks of injury or electrical shock are minimal as state of the art equipment and procedures will be used to ensure your safety. The cotton swabs you are given to brush the inside of your cheeks are sterile and come in a sterile tube. You open the package and swab your cheeks yourself. It is a gentle and painless procedure; it feels similar to, but less abrasive than brushing the inside of your cheek with a toothbrush.

Potential Benefits to You and Others: You understand that involvement in this experiment is not likely to produce any direct, immediate benefit to you other than monetary payment. You will receive payment of *$25.00* per session for your participation in the two BEG sessions. In addition, if you are contacted by mail in the future and asked to fill out some personality questionnaires, you will be compensated monetarily with $10.00 when the questionnaires are completed and returned. There is a reasonable expectation that this research could contribute to a better understanding of EEC stability and emotional correlates.

Confidentiality: Participant data will be coded with a participant number and no names or other personal information will be identified or related to these materials in any way. After all BEG data has been collected, personal information will only be associated with participant numbers as needed to contact participants by mail at later dates. This information, however, will only be accessed by the principal investigators of this study, and no one else will have access to this information. All information gathered in this research will be kept confidential and secure to the extent allowed by the law.

Participant swabs will be coded with a number, and no other names or personal information will be related

to them in any way. After all genetic material has been collected, the personal information will be associated with the data only if it is necessary to contact the participants in the future. The information will only be accessed by the principal investigators in the study. The list linking the name and the code numbers will be destroyed no later than one year after completion of the study. In addition, the genetic material shall be disposed of after their use in the following manner: the swabs containing the genetic information will be placed in a standard red biohazard bag, and will be retrieved by a company that will burn the swabs. Nobody else will have access to the information. All information gathered in this research will be kept confidential and secure to the extent allowed by law.

Participants in the study will be given an explanation of the research questions being addressed in each session and offered an immediate opportunity to ask questions. Participants will he contacted at the end of the study and will be given an explanation of the overall goals of the study.

Any participants indicating problems of a psychological nature or suicidal ideation will be referred to the Florida State University Psychology Clinic.

Your signature below indicates that you have read the above information, and that you have been given the opportunity to ask any questions you may have concerning the experiment and the conditions of participation, and that these questions, if any, have been answered to your satisfaction. You may contact Dr. John P. Kline, Assistant Professor of Psychology (644-9363) to discuss any aspect of this experiment in the future. Questions about your rights in relation to subject participation and/or reports of any research related injury can be directed to Dr. Kline or to Heidi l lodges, Chair of the FSU Institutional Review Board for Human Subjects (644-8633).

I have read and understand the above.

Signature of Participant _____Date_____

Printed Name of Participant _____ Date _____

APPENDIX B
HUMAN SUBJECTS COMMITTEE APPROVAL

Florida State
UNIVERSITY

Office of the Vice President
for Research
Tallahassee, Florida 32306-2811
(850) 644-5260 · FAX (850) 644-4392

APPROVAL MEMORANDUM (for change in research protocol)

from the Human Subjects Committee

Date: **December 10, 2001**

From: **David Quadagno, Chaia~~~'**

To: **John P. Kline/Marilyn E. Jennings**
MC: 1270
Dept: **Psychology**
Re: **Use of Human subjects in Research**
Project entitled: Brainwaves, Thought, and Emotion: The Biology of Personality and Affect.

The memorandum that you submitted to this office in regard to the requested change in your research protocol for the above-referenced project have been reviewed and approved. Thank you for informing the Committee of this change.

A reminder that if the project has not been completed by September 25, 2002 you must request renewed approval for continuation of the project.

By copy of this memorandum, the chairman of your department and/or your major professor is reminded that he/she is responsible for being informed concerning research projects involving human subjects in the department, and should review protocols of such investigations as often as needed to insure that the project is being conducted in compliance with our institution and with DHHS regulations. \

This institution has an Assurance on file with the Office for Protection from Research Risks. The Assurance Number is M1339.

cc:
chgapp.doc
APPLICATION NO. O1.377-R

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BIOGRAPHICAL SKETCH

DEMOGRAPHICS

Marilyn Elizabeth Jennings
Born: 5/17/44, Salisbury, England

EDUCATION

2003	Ph.D., Clinical Psychology, The Florida State University*
2002	Predoctoral Internship, Medical College of Georgia/VA Psychology Consortium, Augusta, Georgia*
1996	M.S., Clinical Psychology, The Florida State University*
1991	B.A., Highest Honors (4.0), Psychology, University of North Florida
1988	A.A., Highest Honors (4.0), Florida Community College at Jacksonville

*An APA accredited clinical program.

NATIONAL HONOR SOCIETIES

1990	Member, Phi Theta Phi National Honor Society
1989	Member, Chapter President, Psi Chi National Honor Society
1987	Member, Phi Theta Kappa Honor Society

HONORS AND AWARDS

1991	Outstanding Senior in Psychology Award (University of North Florida)
1988-1991	Dean's List (University of North Florida)
1988	Outstanding Student in Psychology Award (Florida Community College at Jacksonville)
1988	Outstanding Student in Biology Award (Florida Community College at Jacksonville)
1986-1991	2 + 2 Academic Scholarship (Florida Community College at Jacksonville/University of North Florida)
1986-1988	Dean's List (Florida Community College at Jacksonville)

PROFESSIONAL AFFILIATIONS

American Psychological Association (Student Affiliate)
Florida Psychological Association (Student Affiliate)

COMMITTEE/ORGANIZATION INVOLVEMENT

1990 – 1991	President, Psi Chi National Honor Society for Psychology (University of North Florida)
1989 – 1991	Club Coordinating Committee Representative, Student Government Organization (University of North Florida)
1989 – 1990	Honors Topic Chairperson, Phi Theta Kappa National Honor Society, University of North Florida)

RESEARCH INTERESTS

Emotion regulatory processes, Borderline Personality Disorder, electrophysiological methods, memory processes, Dialectical Behavior Therapy treatment outcome.

CLINICAL EXPERIENCE

2001 – Present	Psychological Resident, Tallahassee Memorial Behavioral Health Center.
2000 – 2001	Psychology Resident, Medical College of Georgia/Veteran's Administration Medical Center Psychology Consortium, Augusta, Georgia.
1999 – 2000	Psychological Trainee, Tallahassee Memorial Behavioral Health Center.
1997 – 1999	Assistant Director, The Florida State University Psychology Clinic.
1992 – 1999	Psychological Specialist, The Florida State University Psychology Clinic.
Jan – Aug 1997	Psychological Examiner, Easter Seals of North Florida.
Jan – Aug 1994	Psychological Trainee, Wakulla Middle School, Crawfordville, Florida.
1993 – 1994	Psychological Trainee, The Florida State University Autism Center.
1992 – 1994	Psychological Trainee, Multidisciplinary Center, The Florida State University.
1991- 1992	Psychological Trainee, Capital Rehabilitation Hospital, Tallahassee, Florida.

PROFESSIONAL PRESENTATIONS

Jennings, Marilyn E. Psychological Assessment in Applied Settings. FSU Psychology Clinic, 2/17/98.

Jennings, Marilyn E. & Auslander, Beth. Therapy of Borderline Personality Disorder: Analytic Versus Cognitive Approaches. FSU Psychology Clinic, 2/14/97.

Jennings, Marilyn E. & Stormo, Karla. Differential Diagnosis of Attention-Deficit Hyperactivity Disorder in Adults. FSU Psychology Clinic, Spring 1996.

Jennings, Marilyn E., Stormo, Karla, & Stritzke, Verner. Assessment and Diagnosis of Multiple Personality Disorder. FSU Psychology Clinic, Spring, 1996.

Jennings, Marilyn E. Assessment and Daignosis of Multiple Personality Disorder. FSU Marriage and Family Counseling Center, Fall, 1995.

CLINICAL INTERESTS

Borderline Personality Disorder, Dialectical Behavior Therapy, dissociative disorders, conversion disorders, PTSD and trauma-related disorders, individual and group psychotherapy, neuropsychological assessment.