UNIVERSITY OF BIRMINGHAM

Borderline personality disorder and emotion information processing

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Doctorate in Clinical Psychology

School of Psychology

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A thesis submitted in partial fulfilment of the regulations for the degree of Clin.Psy.D

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What is the evidence and its significance?

Literature Review

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Abstract

Interpersonal difficulties, including problems in forming and maintaining relationships, figure prominently in Borderline Personality Disorder (BPD). This paper addresses whether vulnerability to troubled interpersonal relationships in BPD may be related to biases in processing emotionally salient information. It considers the predictions that prominent models of BPD would make in terms of processing emotional information and it surveys the literature to establish whether BPD individuals are characterised by an attention bias, an interpretation bias, a memory bias, or all three.

Taken together, the evidence suggests that BPD individuals preferentially attend to emotionally threatening information, but whether this is the result of hypervigilance towards threat, difficulty shifting attention away from threat, or both, is unclear since there is some ambiguity surrounding the methods employed. The range of studies examining an interpretation bias suggests that BPD individuals tend to appraise and interpret others as rejecting when the emotional information is ambiguous. Research on memory bias is still young and the findings too inconsistent to draw conclusions. The methodological limitations across the studies are considered and suggestions for further lines of enquiry are made. Establishing whether processing biases are associated with BPD is important as it may lead to a better understanding of what fuels unstable interpersonal relations. Cognitive biases may also provide clues that refine assessment and treatment.

Introduction

Interpersonal difficulties, including problems in forming and maintaining relationships, figure prominently in Borderline Personality Disorder (BPD). Individuals with BPD are particularly sensitive to separation, rejection, abandonment and their capacity to manage close relationships is compromised. Generally they have a poorer quality of intimate relationships compared to other clinical groups (such as depression or bipolar disorder) perceiving them as more hostile and lacking in cohesion (Benjamin & Wonderlilch, 1994). Their friendships can be short-lived, tumultuous and unstable (Modestin & Villiger, 1989), their relationships with work colleagues can be troubled and conflictual (Skodol, Gunderson, McGlashan et al., 2002) and it is not unusual for their relations with therapists to be challenging and tempestuous, oscillating between clinging demanding behaviour and fearful withdrawal. Individuals with BPD can experience significant problems managing their emotions, particularly anxiety and anger (Levine, Marzarli & Hood, 1997). Their volatile temperament can alienate others and lead to significant social and occupational impairment leading to increased social isolation, decreased quality of life and increased risk of suicide (Skodol, Gunderson, McGlashan et al., 2002). Suicide risk in BPD is high and problematic; the rate of death by suicide is 10%, which is 50 times higher than the general population (Skodol, Gunderson, Pfhol et al., 2002). Prevalence is also high; BPD afflicts approximately 2% of the general population, up to 10% of outpatients and up to 20% of inpatients (American Psychiatric Association, 2000). Therefore the scale of this problem is potentially large and justifiably in need of attention. Uncovering what fuels chaotic interpersonal relations in BPD may

provide an important piece of the jigsaw puzzle and perhaps bring us closer towards developing interventions that enhance the quality of social interactions and, in turn, the quality of life of BPD individuals.

Clinical anecdotes have long indicated that BPD individuals have difficulty regulating emotions often experiencing emotions as "doomsday signals" provoking a sense of impending disaster (Krystal, 1974). In the context of BPD, emotion dysregulation refers to an inability to modulate affect (for a comprehensive review of the construct of emotion dysregulation in BPD see Putman & Silk, 2005). Individuals with BPD can be described as having a "broken thermostat" (Ekstein & Wallerstein, 1954) that culminates in either an escalation of intense, out of control feelings (Linehan & Heard, 1992; Westen, 1991) or conversely, an absence or numbing of feelings when the emotion is overwhelming. This notion is corroborated by findings that individuals with BPD experience more negative affect (Yen, Zlotnick & Costello, 2002) and have more intense negative reactions to everyday life events (Levine, Marzarli & Hood, 1997) and more intense response to emotional cues in experimental conditions (Herpertz, Gretzer, Steinmeyer et al., 1997). It is also corroborated by laboratory findings that individuals with BPD can display decreased psychophysiological responses to negative emotional stimuli (Herpertz, Kunert, Schwenger et al., 1999; Herpertz, Schwenger, Kunert et al., 2000). Maladaptive behaviours in BPD further support the notion of emotion dysregulation. Substance abuse, repeated overdoses and self-laceration are conceptualised as desperate attempts to regulate intense emotional experiences but at the same time some of these very behaviours (e.g., self laceration) may be attempts to induce sensation in the absence of emotion (Linehan, 1993; Westen, 1991).

Various clinical theorists and researchers of differing orientations contend that vulnerability to difficulties in interpersonal relationships in BPD may be related to biases in processing emotionally salient information, predominantly associated with fears of abandonment and rejection within an interpersonal context (e.g., Hill, Pilkonis, Morse et al., 2008). Moreover, some hypothesise that the biases are associated with emotion dysregulation (e.g., Linehan, 1993) but whether the biases are a cause, a by-product or component of emotional dysregulation is not entirely clear. Most would agree however that the relationship at the very least is bidirectional resulting in a vicious circle. Resolving the debate about the nature of the relationship between emotion dysregulation and cognitive biases is beyond the scope of this paper. Rather, the purpose of this paper is to consider if BPD is associated with characteristic styles of processing emotional information and also to consider how a cognitive bias might contribute to vulnerability to interpersonal relationships.

Do individuals with BPD show a cognitive bias?

Cognitive biases have been observed in a range of emotional disorders and hypothesised to play a key role in the maintenance of these disorders (Williams, Watts, Matthews et al., 1988, 1997). Different emotional disorders have been shown to be characterised by different biases and this may be important because it may provide clues that refine assessment and intervention. Individuals with Post Traumatic Stress Disorder (PTSD) display heightened sensitivity to words related to traumatic experience (Foa, Feske, Murdock et al., 1991), mood-congruent memory biases have been found in

individuals with depression (Mineka & Nugent, 1995), and anxious individuals attend more to threat-relevant cues and perceive more threatening meaning in ambiguous information (Williams, Watts, MacLeod et al., 1997, Matthews & MacLeod, 2005).

Just like individuals with affective disorders, is there a particular processing style that is characteristic of BPD and could this fuel troubled interpersonal relations? Are BPD individuals constantly vigilant towards danger signals specifically representing potential rejection and abandonment or do all emotional cues represent threat? Do BPD individuals have a preference to be oriented towards negative rather than positive information? Do they find it difficult to disengage when they detect a threat signal (and does this perpetuate dysregulation)? Or is it the other way around? Does emotion dysregulation or a high state of arousal influence information processing such that salient or "toxic" stimuli are highly accessible and prioritised? Do BPD individuals have a tendency to impose a negative interpretation when confronted with socially ambiguous information? Is there selective recall for negative information and a difficulty in remembering positive events?

To consider the above questions, a narrative rather than systematic literature review will be conducted. Such reviews are useful when addressing a wide-range of questions with methodologically diverse studies (Baumister & Leary, 1997). This paper will begin by briefly looking at some theories of BPD with specific reference to what these imply about processing emotional information. It will then illustrate how these theories avail themselves of established literature in experimental psychology. It will then

review the research evidence, consider its conclusions, and make suggestions for further lines of enquiry. Finally it will consider the clinical implications.

Theories of BPD and emotional information processing

There are a number of theories that inform the developmental pathway of BPD but it is beyond the scope of this paper to review them all. This paper will only focus upon: (i) models that have influenced current thinking, namely, Object Relations and Attachment theory; (ii) models that have been influential on the treatment of BPD, namely, Mentalization- Based Treatment and Dialectical Behaviour Therapy; and (iii) models that explicitly propose that a cognitive bias is an important factor in the development and maintenance of the disorder, namely, Beckian formulations. Each model will be considered in terms of the predictions that it would make concerning information processing styles or biases in BPD.

Psychodynamic theories

Object Relations (OR)

The concept of “borderline personality organization”, based upon the principle that individuals are “object seeking” (Kernberg, 1976), has had lasting influence on the description of BPD since it was first defined in the third edition of the DSM (DSM-III; American Psychiatric Association, 1980). According to object relations theory, disturbances in "object-world" representations lead to immature cognitive-emotional

functioning in BPD (Kernberg, 1967). The term object relations (OR) refers to a shorthand constellation of cognitive and affective processes that mediate interpersonal functioning. OR theory postulates that relationships with others, beginning with the caregiver infant relationship, become internalized such that the infant forms templates for the experience of self in relation to the world and others. Kernberg (1967, 1975) proposed that BPD was associated with excessive underlying aggressive impulses, which were either innate or the consequence of negligent or frustrating caregiver experiences occurring in early development. These aggressive impulses threaten to destroy positive internal images of the self and positive images of the caregiver, and in turn lead to mental "splitting", the function of which is to protect the good "self" and "other" image from the negative or bad. This defense mechanism (i.e., splitting) leads to extreme, polarized views of others, such that the evaluated object is seen as totally good or bad (Kernberg, 1967).

From an OR perspective, the chaotic relationships that characterize borderline individuals are associated with an inability to form complex mental representations that integrate good and bad aspect of the self and others. The inability to integrate contradictory affective states leads to the perception that all negatively valenced cues are threatening, and consequently these are avoided. OR theory would predict that the aggression that underlies object-world representations, leads to hypervigilance for negative emotional information in BPD, as well as an inclination to attribute malevolence to others' intentions. Further, the tendency to split representations into "good" and "bad" produces a readiness to evaluate others in extremes.

Attachment theory

Attachment theory provides a framework for understanding the development of BPD as well as a framework for understanding how representations of attachment influence information processing related to social relationships. In his seminal paper, Bowlby (1973) describes the development of the attachment system and illustrates how an infant's tendency to seek closeness through attachment behaviour, such as clinging and smiling, is fundamental to survival as it is designed to elicit protection by the caregiver. He also illustrates how the quality of interaction between the infant and caregiver influences the infant's perception of self and others. In brief, repeated interactions with an attachment figure in the early stage of development prompt the formation of mental representations (internal working models- IWMs) that set up expectations of self and others within an interpersonal context. Essentially, IWMs are templates concerning the availability and responsiveness of the caregiver that guide and shape future relationships. Thus, infants with met needs may form assumptions that they are worthy and expect others to be caring, reliable and emotionally available. By contrast, distressed infants whose needs are typically thwarted may form assumptions that they are unworthy and expect others to be uncaring, unreliable and anticipate rejection and maltreatment.

In addition to forming assumptions about self and others, attachment plays a role in affect regulation. When the infant perceives the caregiver as unavailable to meet their needs, distress alleviation does not occur and the infant seeks alternative strategies to deal with distress. It has been hypothesized that this can result in either hyperactivating or

deactivating strategies, corresponding with attachment anxiety or avoidant attachment respectively (Brennan, Clark & Shaver, 1998). Hyperactivating strategies are characterized by an excessive longing for proximity and a preoccupation with cues of the attachment figure's unavailability, such as signs of disapproval, waning interest or impending abandonment (Mikulincer, Shaver & Pereg, 2003). Moreover, they are presumed to involve excitatory neural pathways that exaggerate threat appraisal, producing chronic activation of the attachment system (Shaver & Mikulincer, 2002). Deactivating strategies, by contrast, involve denial of attachment needs, thus threatening cues are avoided so as not to activate the attachment system. Thus the process of orienting toward or avoiding attachment –relevant information may amplify or reduce emotional experiences, and in this way serve to regulate emotions.

From an attachment framework, BPD evolves as a consequence of insecure attachment brought about by unresponsive rearing styles (for a review on attachment styles in BPD see Agrawal, Gunderson, Holmes et al., 2004; Levy 2005). Individuals with BPD are assumed to have incoherent IWMs of self and others and relationships, which increase attention towards potentially threatening attachment-relevant information (Mikulincer & Shaver, 2003) and this, in turn, renders them hypersensitive and vulnerable to rejection.

Attachment theory predicts that insecure attachment styles underlying BPD enhance hypervigilance towards threats of impending abandonment and promote an attributional bias towards perceived interpersonal rejection.

Mentalization-Based Treatment (MBT) model

Using attachment theory as a framework, Bateman and Fonagy (2003) identify an aspect of insecure attachment, namely a diminished capacity to mentalize, as a fundamental deficit associated with BPD. Mentalizing refers to an ability to understand, interpret and anticipate one's own and others' mental states; a skill which is fundamental for successful, collaborative, social relationships. A compromised capacity to mentalize disrupts the construction of stable mental representations of self and other, making it difficult for the individual to make sense of themselves and others. This leads to confusion and a difficulty in correctly interpreting one's own emotional state and that of others, and consequently an inclination to attribute negative intent to others when none is meant.

The MBT model emphasizes the role of emotion dysregulation in reduced mentalizing. In a recent paper, Fonagy and Bateman (2008) speculate that a reduced capacity to mentalize, amongst other variables, may be attributed to early excessive stress which alters neural mechanisms of arousal and leads to a relatively ready triggering of the arousal system in response to relatively mild emotional stimulation. Importantly, they assert that individuals with BPD can mentalize but are "more likely to abandon the capacity under high emotional arousal" in the context of attachment relationships (Fonagy & Bateman, 2008, p.13). Thus emotional arousal may moderate the ability to mentalize and be a key factor in determining whether BPD individuals would misread their own mind and that of others.

The MBT model predicts that a misinterpretation of interpersonally salient cues, particularly others' emotions, is more likely to occur when the individual is highly aroused, due to activation of the attachment system.

Cognitive-Behavioural Theories

Beckian formulations

Early cognitive theories of BPD stipulate that a bias in attentional focus and interpretation is central to the development and maintenance of the disorder (Arntz, 2004). These theories contend that as a result of early learning, individuals with BPD develop dysfunctional schemas and information processing biases which predispose them towards feeling apprehensive and perceiving increased threat in interpersonal relationships. Beck and associates (1990) describe this in proposing that individuals with BPD hold core beliefs of the self as powerless and vulnerable, others as malevolent, abusing and rejecting and the world as unsafe and dangerous. Believing they are powerless and vulnerable in a dangerous world where others are hostile and untrustworthy makes BPD individuals hypervigilant. Beckian formulations propose that during a hypervigilant state, schema- specific information is given priority and is difficult to inhibit, resulting in biases at the early or encoding stage. At this stage, information processing is automatic and the individual selectively focuses their attention on threat stimuli (e.g., MacLeod, 1991).

Early cognitive models predict that BPD individuals are hypervigilant toward schema-specific threat and this in turn leads to a tendency to attribute malicious intent to others. In this regard, early cognitive theories make similar predictions to OR theory, attachment theory and the mentalization model.

Dialectical Behaviour Therapy (DBT) - Biosocial model

The biosocial model views borderline individuals as sensitive appraisers of emotional cues. Linehan (1993) conceptualises BPD as a dysfunction of the emotion regulation system resulting from an interaction of an emotional vulnerability and an invalidating environment. She postulates that borderline individuals have an emotional vulnerability characterised by a high sensitivity to emotional stimuli, a high reactivity to emotional stimuli, and a slow return to baseline after emotional arousal. Therefore BPD individuals will tend to be vigilant to emotional cues (especially negative stimuli) in the environment. Moreover, they will have a low threshold for emotional reactivity, so their response will be quicker and more extreme than others. Furthermore, they will take longer to recover from their distress, producing a "kindling" effect, which will increase their vulnerability (hence reactivity) to other emotional cues in the environment and, in turn, lead to frequent experiences of negative affect.

Linehan stipulates that emotional vulnerability in isolation does not necessarily lead to a hyperreactivity to emotional cues and the development of borderline symptoms; it must be combined with an "invalidating environment". Such an environment trivializes the developing child's personal experiences and actively discourages and

punishes the expression of negative feelings. Consequently, the child doubts their perception of themselves and others, and forms the view that emotional expression is bad and to be avoided. Thus, all negative emotional material may signal danger and as a natural consequence, BPD individuals engage in emotional avoidance. Paradoxically, attempts to escape emotional arousal (i.e., the very focus of such a process) will render BPD individuals increasingly attentive to emotional stimuli, and thereby increase their sensitivity.

Linehan's theory predicts that BPD individuals would have greater sensitivity towards negatively valenced emotional stimuli, including rejection and abandonment cues. This prediction is similar to OR theory but deviates from the predictions of the attachment theory and the Beckian model in that these theories might predict that the selective attention bias would show greater content specificity (i.e., it would be directly related to the abandonment or other pertinent BPD schemata).

Links with cognitive information processing models

Despite the different emphases, whether it is on the attachment system, the cognitive system or affective dysregulation from a social learning perspective, there appears to be consensus across the theories that borderline individuals are interpersonally hypersensitive. Specifically, there appears to be an agreement that BPD individuals have overactive schemata associated with increased threat in the interpersonal arena. The term schemata, although used with varying definitions and conceptually confusing, generally

refers to a stored body of information which interacts with, and thereby influences, the processing of new information by directing attention, expectation, interpretations and memory search (Alba & Hasher, 1983).

The idea that BPD individuals have overactive schemata avails itself of the methods of experimental psychology, which over the last two decades has developed techniques to explore information processing biases in emotional disorders. This perspective examines the cognitive aspects of psychopathology within a selective information processing framework, in which a certain class of stimuli is preferentially processed over others because certain underlying schemas are activated that allocate processing priority to that type of information (Gotlib & Neubauer, 2000). Such a perspective predicts that: (i) attention will be directed towards schema-congruent elements in the environment; (ii) interpretation of ambiguous information will be consistent with the schema; and (iii) access to schema memories will be facilitated.

The clinical portrayal of BPD individuals as sensitive to loss, rejection and abandonment, together with their tendency to misconstrue socially ambiguous events as hostile, intuitively suggests that emotionally relevant stimuli are given precedence during processing. What is unclear, however, is in what way the processing of emotionally relevant information takes precedence in BPD individuals. For instance, is there priority at the encoding level and is this expressed by increased attention to “borderline” congruent stimuli? Does the priority occur at the level of interpretation and is this manifested by a tendency to resolve ambiguity in a manner that engenders the most

"borderline" congruent interpretation? Or does the priority occur in accessing information from memory and is this reflected by a superior recall for emotionally relevant information? These questions will be considered by surveying the literature to establish if there is evidence of: (i) an attentional bias; (ii) an interpretation bias or (iii) a memory bias for emotionally relevant information in BPD.

What is the evidence?

Search Strategy

An advanced search combining PSYCH LIT and MEDLINE databases was conducted with the main search terms: "borderline personality disorder" and "emotion dysregulation" and "emotion recognition" and "emotion information processing" and "selective attention" and "cognitive biases". Articles were selected if they were relevant to the topics attention bias, interpretation bias and memory bias. In addition, relevant studies cited in the articles identified above were selected. The studies reviewed are an exhaustive list of research examining cognitive biases in BPD.

Attention Bias in BPD?

Scanning the environment for threat-related information has survival value but attending to stimuli that are not really threatening can be maladaptive as it can lead to and maintain inappropriately high levels of arousal that may interfere with routine

functioning. The literature examining processing biases in emotional disorders suggests that anxious individuals, in particular, may be abnormally sensitive to threat in the environment, resulting in a pronounced attentional bias favouring threat stimuli (e.g., MacLeod & Matthews, 1991). Such a bias is believed to play a key role in the aetiology and maintenance of anxiety disorders (Williams et al., 1997). Theories of BPD imply a similar hypothesis. Namely, that the threat system in BPD is in some way disturbed, leading to increased emotional arousal and hypervigilance towards information representing danger (i.e., information signalling potential abandonment and rejection). Conceivably, selective attention to negative aspects of social interaction, such as hostility, would interfere with the capacity to establish stable relationships and thereby compromise interpersonal relations. It would also heighten emotional arousal and potentially exacerbate the problem by increasing vigilance and amplifying threat appraisal.

The emotional Stroop task is the experimental paradigm that has been most frequently used to examine selective attention for emotional cues in BPD. In this paradigm, emotional and neutral words are presented in different colours and participants are required to name the colour of the word quickly and accurately. The primary task is the naming of the colour but this is disrupted presumably by the meaning of the word; the more salient the word, the more attention grabbing, and the longer the response latency to colour naming. It has been repeatedly demonstrated that clinical anxiety is related to longer response latencies of naming colour words that are specifically relevant to pathological fears, compared to neutral or non-specific words. Presumably these effects

are due to attentional resources captured by emotional words. Stroop studies investigating an attentional bias in BPD, however, have not yielded a clear cut picture. Some suggest an attention bias whilst others do not. Of those finding an effect, some indicate a bias towards specific borderline congruent material whilst others indicate an attentional bias towards general emotional information. These studies are described below.

Sprock, Rader, Kendall and others (2000**)** employed a Stroop task with anger and sadness related words and found no differences between BPD, depressed and control groups. However, failure to find an effect may have been due to the stimulus words not being sufficiently salient to depressed or borderline individuals. Moreover, they used a short form of the Stroop that may not have been of adequate length, and their sample size was relatively small (n=18 per group).

In the same line, Domes, Winter, Schnell and others (2006) failed to demonstrate differences between BPD and control groups in the emotional Stroop. Their sample size was adequate (n=30 control; 28 BPD) but they did not include a clinical comparison group to demonstrate that the effect would be specific to BPD. Unfortunately, no example of the emotional Stroop stimuli is provided so it is difficult to comment on the degree to which their stimuli may have been sufficiently salient, and whether this might account for the lack of effect. Also, their BPD sample showed slower response times irrespective of stimulus valence and this may have masked subtle differences of stimulus valence. Interestingly, correlational data in this study revealed significant interactions with affect. State anger and state anxiety were associated with greater Stroop

interference, suggesting that emotional arousal may have an influence on the processing of aversive material in BPD. Given the association with emotion dysregulation, it might be that biases only become apparent under conditions of increased arousal as explicitly suggested by the mentalization model.

In addition to the Stroop, Domes and others (2006) employed a Negative Priming task as another measure of selective attention. In this paradigm, participants are typically shown two target words simultaneously and instructed to name one whilst ignoring the other. When the ignored target on the first trial becomes the target on the next trial, the participant takes longer to respond. Negative priming refers to this slowed down response and the effect supposedly occurs because inhibition associated with the previously ignored probe carries over to processing of the stimulus probe in the next trial. Selective encoding is inferred on the basis of the extent to which the distracter interferes with the primary task. Contrary to their Stroop results, the negative priming task revealed a tendency (although the effect was small) towards a difficulty in automatically inhibiting attention towards irrelevant aversive words for the BPD group compared to the control. These findings might indicate that BPD individuals have difficulty disengaging from threatening stimuli, but since the effect was small the authors point out that the results should be interpreted with caution.

Paying special attention to the type of word stimuli, Arntz, Appels and Sieswerda (2000) examined hypervigilance to BPD danger signals by employing a Stroop task including three classes of BPD relevant words that were related to malevolence, rejection

by others and abuse, and a class of generally negative words (e.g. murder; cancer). They were particularly interested in whether BPD individuals would display hypervigilance towards borderline specific stimuli or whether the hypervigilance would cover negative emotional cues generally. They found that hypervigilance in BPD individuals was not restricted to borderline-specific stimuli and so concluded that BPD individuals show a general emotional bias, in accordance with both Linehan's and Kernberg's view that all affective material may signal danger. Noteworthy is that this effect was not unique to BPD, as Cluster C individuals also demonstrated a bias towards general emotional cues. Further, it was not clear if the bias was only applicable to negatively valenced emotional stimuli or to emotional stimuli in general, since positive emotional stimuli had not been included.

A later study examining BPD schema-related biases addressed whether BPD individuals are also sensitive to positive emotional cues. Sieswerda, Arntz, Mertens and others (2006) employed negative and positive stimulus types related to hypothesised BPD schema as formulated by Pretzer (1990) (e.g., powerless, powerful; unacceptable, worthy; malevolent, reliable), as well as negative and positive schema unrelated stimuli (e.g., stingy; joyfulness) and neutral words related to science and business (e.g., abstract; practical) . They revealed that compared to groups of Axis 1 disorder patients, normal controls and individuals with cluster C personality disorder, BPD individuals showed a bias specifically towards negative emotional stimuli. Moreover the bias was specific to schema-related stimuli as opposed to general emotional cues.

Interestingly, however, a bias towards schema-specific stimuli was not replicated in a further study using the very same stimuli (Sieswerda, Arntz, & Kindt, 2007). The findings of this study were consistent with an earlier study (i.e., Arntz et al., 2000, see above), which found evidence supporting an attentional bias for negative emotional stimuli in general. The authors explain that the discrepancy between this study and that of Sieswerda and others (2006) might reflect differences in sampling. The participants in this study (as in Arntz, Appels & Sieswerda., 2000) were mainly outpatients, whereas those showing specificity in Sieswerda and others (2006) were mainly inpatients. The authors speculate that specific biases might only be evident in severe BPD. They also point out that the majority of participants in this study had depressive disorder (71%) compared to a minority (41%) in Sieswerda and others (2006) study. Since depressive mood has been shown to interfere with Stroop effects (e.g., Bradley, Mogg, White et al., 1995), the authors surmise that depression might interfere with content-specific effects.

Sampling issues might further explain the inconsistent results found across the Stroop studies on BPD generally. Almost half the studies used small numbers (under 20) and some used inpatients whilst others used outpatients. It is also possible that the divergent findings might be attributable to the stimulus material. The choice of emotional words may not have been sufficiently emotionally evocative or potent to produce a reliable effect. For example, Arntz, Dreesan, Schouten and others (2004) indicate that it is self-rejecting beliefs rather than beliefs about powerlessness that are toxic to individuals with BPD. Moreover, word stimuli may introduce a confound, since borderline individuals might be more familiar with threat-relevant words as they might be

more frequently used (e.g., they may be more likely to report thoughts of social threat). Furthermore, word stimuli in themselves may not fully capture real-life danger representations in BPD, so the Stroop may not be the optimal paradigm to gauge stimulus specificity in BPD.

In addition to whether word stimuli are sufficiently potent, there is the very important question of what the Stroop actually taps into. Whilst many researchers have used it as an index of attention, others have argued that it is not a pure measure of attention as it is more likely to be a measure of inhibition, or interruption or suppression of a response (Williams, Watts, MacLeod et al., 1997). Such a debate makes it difficult to interpret whether the Stroop results reflect hypersensitivity towards threatening information (e.g., Arntz et al., 2000) or a difficulty in suppressing a predominant response, (i.e., disengaging from threatening information; e.g. Domes et al., 2006). It is plausible that BPD individuals are both hypersensitive to, and unable to shift their attention away from, threat but it is difficult to disentangle which processes are involved from the Stroop paradigm.

Neuroimaging studies investigating reactivity to negative images provide some convergent evidence that BPD individuals may be hypersensitive to emotionally relevant cues. Furthermore, in using images, these studies overcome some of the problems associated with verbal stimuli; where a threat-related word may be an arbitrary symbol, images and in particular facial expressions are ecologically valid and salient. Threatening faces, for example, have been demonstrated to be innate stimuli that are detected

automatically since they are mediated by a biologically prepared mechanism that is sensitive to threat (LeDoux, 1995).

Herpertz, Dietrich, Wenning and others (2001) used functional magnetic resonance imaging (fMRI) with a sample of six female BPD patients with no other major psychiatric disorder and six age-matched female controls to investigate response to emotionally aversive images (e.g., crying children) and neutral images (e.g., plants). They reported heightened activation in the amygdala and the fusiform gyrus in the perceptual cortex in the BPD group, and proposed that the perceptual cortex was modulated via the amygdala, leading to increased attention to emotionally relevant cues.

On a similar line but with a larger sample, Donegan, Sanislow, Blumberg and others (2003) used fMRI with 15 BPD and 15 controls to examine amygdala responses to neutral, happy, sad and fearful facial expressions. They found that individuals with BPD demonstrated greater left amygdala activation to facial expressions (including neutral) compared to controls and surmised that an over reactive amygdala predisposes BPD individuals to be hypervigilant and over reactive to potentially threatening social stimuli. More specifically, they suggested that amygdala activation elicited by facial expressions rendered BPD individuals emotionally vulnerable within an interpersonal context, which is consistent with the mentalization model. The lack of clinical comparison group in both these imaging studies, however, calls into question whether other clinical groups would have manifested similar amygdala responses, and as such merely reflects a tendency towards greater emotional reactivity in clinical populations.

Summary of findings and suggestions for future research

Despite the methodological limitations (such as small samples and variation in test stimuli) and mixed findings, there is some evidence that BPD individuals are attentive towards emotionally threatening or salient information, but whether this is the result of hypervigilance towards threat, difficulty shifting attention away from threat, or both, is unclear. Moreover, it is unclear whether the attention bias is specific to borderline -congruent information or whether it is generalised to all negative emotional cues. Further, it is unclear whether an attention bias towards emotional information is unique to BPD or whether it also characterises other emotional disorders.

Future studies employing less ambiguous measures of attention, such as the "attentional blink" (AB) paradigm, might help clarify whether BPD individuals are characterised by an attention bias towards emotional information. In brief, the AB paradigm (Raymond, Shapiro & Arnell, 1992) uses a method known as Rapid Serial Visual Presentation (RSVP) in which stimuli such as letters, digits, words or pictures appear successively in a single location, at rates of about 10 per second on a computer screen. Typically participants perform two tasks whilst viewing a stream of about 30 letters, which constitute a trial. For example, in the original procedure participants had to identify the only white letter (first target ; T1) in a stream of black letters (distracters) as well as report whether the letter X (second target ; T2) had appeared. The manner in which attention is allocated is gauged by overloading the system; when targets are presented singularly at 100ms, they can be reported accurately, but when two targets are presented consecutively within a short interval of each other (100-300ms) the ability to

identify T2 is impaired. This phenomenon is referred to as the "attentional blink". It is assumed that in the face of serial competition, attention is preferentially assigned to the earlier stimulus.

Of relevance for the study of an attention bias in BPD is evidence that T2 can interfere with the correct identification of T1 when the stimulus for T2 is sufficiently salient to attract processing resources that would otherwise be accrued to T1 (Potter, Staub & Conner, 2002). Based on this finding, it could be hypothesized that if emotional stimuli (such as emotional facial expressions) received preferential processing, then emotional stimuli at T2 would attenuate the AB effect and possibly impair T1 identification. Such designs have been used by investigators examining attention processing in social anxiety (e.g., de Jong, Koster, van Wees & Martens, 2009). Accordingly, similar versions of this procedure might prove fruitful in determining if BPD individuals are indeed hypervigilant towards emotional information. The question of whether the bias is content specific might be addressed by incorporating general emotional stimuli (e.g., images of injured animals) and "borderline-specific" stimuli (e.g., images of disapproving facial expressions). Furthermore, the inclusion of clinical comparison control groups related to comorbid conditions such as PTSD and social anxiety may help clarify the extent to which an attentional bias is unique to BPD.

Interpretation Bias in BPD?

Irrespective of an attention bias, individuals with BPD may be prone to interpret others' intent as malevolent, especially when the information is ambiguous. As outlined,

various theories posit that BPD is associated with an attributional style of anticipating rejection and maltreatment within an interpersonal context. The theories propose that when confronted with the prospect of abandonment and abuse, cognitive processing becomes restricted and BPD individuals resort to extreme modes of thinking (e.g., splitting, dichotomous thinking), which may influence the appraisal of ambiguous social cues in such a way that hostility or negativity may be perceived when it does not exist.

Two studies investigating how individuals with BPD perceive others in emotional situations offer some evidence that BPD individuals may resort to restricted modes of thinking, and be inclined towards attributing negative intent to others. Using film clips centering on BPD relevant themes such as abandonment, rejection and abuse, Veen and Arntz (2000) asked participants to rate their response to the film personalities along visual analogue scales with opposite trait descriptions (e.g., happy-unhappy; reliable-unreliable). Consistent with the notion that BPD is characterised by thinking in extremes, BPD individuals gave more polarised evaluations to the film personalities than did individuals with cluster C personality disorder and normal controls. Their response to neutral and non-specific emotional film clips, however, was as moderate as both control groups. In a later study using the same film clips with a less structured format, Arntz and Veen (2001) asked participants to describe the film personalities by spontaneous written responses. Consistent with the notion that BPD individuals view others as malevolent, BPD individuals construed the film personalities' actions and intentions more negatively than did the normal control and Cluster C groups.

Two other studies examining appraisals to socially ambiguous cues and situations amongst college students with Personality Disorder features (as assessed by SCID-II screening questionnaire- SCID-II –SQ; First, Gibbon, Spitzer et al, 1997) provide less compelling evidence since they imply that similar biased appraisals may characterise other clinical groups. In an earlier study Meyer, Pilkonis and Beevers (2004) examined appraisal to neutral faces in students with Borderline, Avoidant and Schizoid features by showing participants a series of neutral facial photographs. They asked participants to rate how they viewed these faces on a series of bipolar scales with opposing character qualities (e.g., unfriendly, friendly; inviting, rejecting) and revealed that although individuals with Borderline features tended to rate faces as less friendly and more rejecting than did those with Schizoid features, individuals with Avoidant features demonstrated the same tendencies. In a later study Meyer, Ajchenbrenner and Bowles (2005) examined appraisal of ambiguous social situations in students with Avoidant and Borderline features by using vignettes presenting three potentially rejecting scenarios. They found that although Borderline features were linked to a misinterpretation of ambiguous social cues (favouring a rejection-implying bias), this tendency was less pronounced compared to Avoidant features. The obvious shortcoming with both of these studies is the use of a non-clinical sample. Also, the vignettes used in the later study may not have been sufficiently BPD salient.

Studies investigating appraisal of facial expressions circumvent the problem of whether stimuli are sufficiently salient since facial expressions are ecologically valid, social cues (Bradley, Mogg, Millar et al., 1997; Ekman, 1993) and the ability to decode

information from facial expression is crucial for successful social interaction (Blair, 2003). Research investigating whether BPD individuals exhibit a negative bias to facial emotion is based on the premise that anticipating rejection and maltreatment may guide the perception and evaluation of subtle cues of facial affect. The assumption is that a bias will be evident when facial expressions are open to interpretation, so these studies hypothesize that individuals with BPD will attribute negative intent to neutral faces as well as to faces displaying ambiguous blends of emotion. Typically the methodology involves the presentation of facial stimuli displaying the six basic emotions characterized by Ekman and Friesen (1976, 1984); some use photographs with 100% prototypic expression, whilst others use a more sophisticated morphing technique in which faces are presented at differing emotional intensity. The results of these studies, although not entirely consistent, generally suggest a biased appraisal; these are summarized below.

Using an updated slide set of the Ekman emotional faces, at 100% prototypic expression, Wagner and Linehan (1999) found that in comparison to 20 healthy controls and 21 women with histories of sexual abuse with no diagnosis, 21 BPD women demonstrated a decreased accuracy in the appraisal of neutral faces and increased rate of false alarm rates for fearful stimuli. From this, they surmised that individuals with BPD are sensitive to fear and are characterized by a negative bias when interpreting social cues.

Refining upon the methods of the previous study, Barnett-Veague (Unpublished) included similar comparison groups (i.e., 14 women with a history trauma but no BPD

and 15 women with no history of abuse) but used a morphing technique in which faces were presented at differing emotional intensity on a computer screen. Relative to the comparison groups, BPD women (n =15) were more likely to misidentify anger in male faces that did not contain anger cues.

Also using a morphing technique with a slightly larger sample (n=20 per group) but no clinical comparison group, Lynch, Rosenthal, Kosson and others (2006) reported that compared to healthy controls, BPD individuals did not over identify anger in non-anger trials. However, this study does not rule out the possibility that BPD individuals are inclined to attribute negative affect to neutral faces since the authors acknowledge that there was "no neutral endpoint" in their design (p.653). Moreover, they found that BPD individuals exhibited a lower threshold towards identifying anger, implying the possibility of preferential processing towards hostility.

In addition to the morphing technique, Domes, Czieschnek, Weidler and others (2008) included a mixed-emotion forced choice task in which pictures of facial affect showed two blends of two basic emotions (e.g. 90% anger 10% fear; 80% anger 20% fear etc.). In line with Barnett-Veague (Unpublished) , they found that in comparison to healthy controls (n=25), BPD individuals (n=25) were biased towards the perception of anger but not towards fear as reported by Wagner and others (1999). However, the stimuli used by Wagner and Linehan (1999) were presented at 100% prototypic expression and therefore may not be comparable to those used in the later studies.

Arguing that time-unlimited tasks might not represent what happens in a naturalistic environment since everyday life requires rapid recognition of facial emotion, Dyck, Habel, Slodczyk and others (2009) compared a facial emotion recognition task with a time-limit to an emotion recognition task without a distinct time limit. In the time-limited task, participants made quick decisions on two response categories (negative vs. neutral) on the Fear Anger Neutral (FAN) test. In the Emotion Recognition (ER) task without a distinct time limit, participants identified one of five emotions but unlike previous studies using black and white stimuli, this task contained colour facial stimuli. Interestingly, the results revealed that relative to controls (n=19), BPD individuals (n=19) misinterpreted neutral facial expressions as negative only during fast discrimination on the FAN test but since this study failed to include a clinical comparison group, it cannot be concluded that a negative bias is unique to BPD. Noteworthy is that the authors point out that the administration of the tests was not counterbalanced; the ER test always followed the FAN, so it is possible that the better performance may have been due to practice effects. They also acknowledge that the time-unlimited ER task had not been validated so replication of these results is required before these findings can be interpreted with confidence.

Post hoc reports from an imaging study examining amygdala reactivity by Donegan and others (2003) (described in the previous section) further reinforce the notion that BPD individuals tend to misread neutral faces as negative. Post-scan debriefing revealed that BPD individuals ascribed negative attributes to neutral expressions in comparison to controls. From these observations the authors deduce that

BPD patients interpret neutral faces as negative or angry and so anticipate rejection or threat. Moreover, they propose that the inclination to anticipate threat is reflected by the enhanced emotional response in the limbic system, including the amygdala.

A potential limitation of most of the studies examining appraisal of facial affect is the failure to include non-emotional comparable facial control tasks. In the absence of such control tasks it is unclear if BPD individuals have general deficits in face perception or if the difficulty is specific to reading facial emotion. Of the studies reviewed, only one (Dyck et al., 2009) included a non-emotional facial task (the Benton Facial Recognition Test – BFRT; Benton, Sivan, Hamsher et al., 1983) and their findings did not suggest a deficit in face perception. Of relevance however is that an earlier study, which investigated accuracy of recognition of facial affect (as opposed to testing for biased appraisals per se), indicated that BPD individuals had a problem in recognising facial features compared to normal controls (Mizenberg, Poole & Vinogradov, 2006). So the question of whether BPD individuals have a potential problem in face perception remains.

Summary and suggestions for future research

Taken together, the range of studies examining biased interpretations suggest that BPD individuals demonstrate a negativity bias towards emotionally ambiguous cues, but since a substantial proportion of the studies fail to include adequate clinical comparison groups it remains unclear if this tendency would also typify other clinical populations. Studies using emotion recognition paradigms offer a sophisticated method of examining

biased appraisal of socially salient stimuli because they provide greater ecological validity (whilst maintaining experimental control) but a potential criticism of the existing literature is the failure to include adequate facial stimuli control tasks. It could be argued that BPD individuals have difficulty in the perception of faces and not specifically in reading facial emotion; in the absence of a control task this possibility cannot be excluded. Future studies including non-emotional facial control stimuli may overcome this limitation. Moreover, since it has been advanced that emotional arousal may be an important factor that moderates appraisal of other's intent, future research employing emotion recognition paradigms with mood elicitation procedures may help clarify the impact that arousal has on emotion recognition.

Memory Bias in BPD?

Even if individuals with BPD were no more inclined to attribute negativity than certain other clinical populations, they may have a preference towards recalling information that is emotionally relevant. Bower (1981) proposed that emotionally salient material aids retrieval of items or events associated with it. Accordingly, BPD individuals might be expected to remember more emotionally congruent material during recall tasks and conversely might show more interference in recall tasks with emotional interference.

In an experiment examining the influence of emotion on memory recall in BPD, Sprock and others (2000) manipulated the affective content in a story-recall task by incorporating positive, negative and neutral elements. They also included a verbal recall task with neutral interference (counting backwards from 100 by 7s) and emotional

interference (telling a story about a Thematic Apperception Test card evoking accounts of rape and murder). Contrary to what Bower (1981) would have predicted, they found no difference in the performance of any of these memory tasks, even those involving emotional stimuli, between BPD (n=18), depressed (n=18) and controls (n=18). A lack of effect, however, may have been due to the test stimuli not being sufficiently interpersonally salient to activate BPD-specific schemas.

Using interpersonally salient word stimuli (e.g., abandon, reject) with a Directed Forgetting paradigm, Korfine and Hooley (2000) examined the ability of BPD individuals to suppress "borderline" salient words in comparison to neutral and positive words. One of the capacities that this task purportedly gauges is the ability to deliberately ignore task irrelevant information from awareness. This might be significant since a capacity to dispel emotionally distressing thoughts may be an important component in regulating emotional arousal. Compared to controls (n=20), individuals with BPD (n=23) showed an increased recall for words that had been classified "borderline" despite instructions to forget them. These findings suggest there might be a preference for remembering more negatively salient words, and perhaps more negative memories. Although the underlying mechanisms are unclear, the authors speculate that individuals with BPD might be unable to inhibit rehearsal of specifically salient stimuli, and since the disinhibition was unique to interpersonally-salient stimuli, they attribute this interference to an activation of negative emotion rather than a weakness in working memory.

Also using Directed Forgetting, Domes and others (2006) examined the capacity of BPD individuals to ignore task irrelevant material. Consistent with Korfine and Hooley (2000), they demonstrated that compared to controls (n= 30), individuals with BPD (n=28) displayed enhanced recall of aversive information. Additionally, their data indicated that enhanced recall of negative information was not just limited to borderline-specific stimuli but generalised to all negatively valenced material, consistent with Kernberg's and Linehan's models. Further, they found that BPD individuals had difficulty remembering positive words, suggesting a compromised ability to process positive information. Taken together, their findings may offer a glimpse into the challenges that BPD individuals face in their attempts to counteract negative affect. A difficulty in disengaging from aversive memories or threatening information might contribute to emotional hyperarousal or dysregualtion and, in turn, perpetuate vulnerability. Moreover, deficits in focussing on and retaining positive information may exacerbate dysregulation by compromising ability to redirect attention on information relevant to safety and relief (Derryberry & Rothbart, 1997).

The absence of clinical comparison groups from the above studies, however, precludes a firm conclusion that preferential processing of negative emotional information is unique to BPD. Further, the debate as to whether the effects of Directed Forgetting reflect encoding and differential processing rather than intentional inhibition (Macleod, 1998) calls into question whether the findings demonstrate an inability to suppress rehearsal of negative stimuli or a difficulty to inhibit retrieval of negative memories. So although experiments using Directed Forgetting show preferential recall

for aversive material in BPD, it is difficult to tease out which processes are involved and the question remains as to whether enhanced recall of emotionally salient information in BPD is due to elaborate encoding of emotionally relevant information or due to a dysfunction in the mechanism of forgetting.

A preference for accessing schema- congruent, “borderline” relevant information may also be exhibited by a tendency to recall general rather than specific memories; a tendency referred to as overgeneral memories (OGM). If BPD individuals engage in emotional avoidance to escape arousal (e.g., Linehan, 1993) or to prevent the activation of the attachment system (e.g., Main, 1990), they may have difficulties in recalling specific memories of personally experienced events and respond with categoric, general memories. The tendency to report OGM has been well demonstrated in Depression and PTSD (Williams, Barnhofer, Crane et al., 2007) and is indicated by a difficulty in generating specific memories to word cues on an autobiographical memory test (AMT). For example, depressed and PTSD individuals are likely to respond to the cue word “intimacy” with “all my relationships have been failures” instead of recalling a specific memory (Williams et al., 2007). The total number of memories rated as “categoric” is taken as a measure of OGM.

In both depression and PTSD, the inclination to generate negatively valenced overgeneral summaries of the past is hypothesised to lead to a negativity bias and overly categorical processing that perpetuates vulnerability. It is argued that over-generality about the past may lead to inaccurate negative generalisations about the future and exert

toxic effects by interfering with the ability to challenge beliefs and expectations. Applying this logic to BPD, it could be argued that OGM might perpetuate beliefs and expectations that others are rejecting and untrustworthy and in this way be problematic. On the flipside, it might function as a protective mechanism (as has been postulated for depression, e.g., Williams, 1996) by blocking painful memories associated with emotional upheaval.

Four studies have examined overgeneral recall in BPD, and of these, three have found no evidence of OGM. Contrary to the studies that followed, Jones, Heard, Startup and others (1999) found that borderline patients (n= 23) generated more overgeneral memories than controls (n=23). They also found that overgeneral memories were correlated with dissociation and surmised that a difficulty in producing specific memories in BPD served to avoid recalling painful events that would evoke negative emotion, which concurs with Kernberg's model, Linehan's model and Attachment theory. A potential shortcoming (as acknowledged by the authors) is that they did not include contrasting clinical groups to ascertain if the observed effect was unique to BPD. Another limitation is that they did not analyse for potential effects of comorbid conditions such as depression or PTSD, both of which are characterised by OGM and highly common in BPD.

Controlling for comorbidity, Arntz, Meeren and Wessel (2002) included three clinical comparison groups (9 depressed, 11 anxious, 10 personality disorder) and found that depression predicted overgeneral memories but no association was found with BPD (n= 9) or the anxiety disorders. Although the numbers were small, the authors argue that

the size and direction of the effect did not give much hope that larger studies would find the hypothesised relationship. The authors hypothesize that the effect found by Jones and others (1999) was due to comorbid pathology; depression being the likely candidate. They conclude that it is unlikely that BPD is related to OGM but they do not rule out the possibility that BPD individuals have difficulty in being specific about more painful, traumatic memories.

Investigating the influence of depression on OGM in BPD, Kremers, Spinhoven and Van der Does (2004), divided their BPD outpatient group (n=83) into sub-groups of depressed and non-depressed borderline patients and compared these groups to depressed patients (n= 26) and controls (n=30). Concordant with Arntz and others (2002), the depressed borderline group reported fewer specific autobiographical memories than controls, whereas the non depressed borderline group did not differ from controls. Attempting to explain the discrepancy between their results and those of Jones and others (1999), the authors indicate that Jones' borderline sample contained more patients with a depressive episode, and therefore these may have produced more overgeneral memories. They also claim that differences in methodology, such as scoring categories and time limit permitted for retrieval of memories, might account for the contradictory findings. Jones and others (1999) used three categories whereas Kremers and others (2004) used five; hence fewer memories were rated as categoric. Moreover, Jones and others (1999) used a time limit of 30 seconds whereas Kremers and others (2004) used a time limit of 60 seconds, which meant that participants may have had more time to recall a specific event.

Taking a different angle, Renneberg, Theobold, Nobs and others (2005) questioned if BPD individuals have a retrieval bias for negatively valenced autobiographical memories by testing if individuals with BPD (n=30) generated more negative autobiographical memories compared to depressed (n=27) and normal controls (n=30). Additionally they examined speed of recall arguing this may be an indicator of accessibility and thus related to retrieval. In line with Arntz and others (2002) and Kremers and others (2004), their results revealed that depressed individuals were more overgeneral than BPD and controls but what differentiated the BPD group from the control is that they retrieved more negative memories. Further, they found that depressed patients showed longer latencies of recall, whereas BPD did not differ in reaction time to the normal controls. From these findings, the authors suggest that BPD "is characterised by a relatively fast and easy access of negatively valenced memories, which may also be specific" (p. 352). Of clinical relevance they suggest that this retrieval style is unlikely to protect borderline individuals against emotional turmoil, and that this may partly explain the problems with emotion regulation typical for BPD.

Although studies measuring recall of autobiographical memories have ecological validity since the memories presumably originate from actual experiences, a potential problem with this method is the possibility that BPD individuals have in fact experienced a greater number of emotionally negative events. Such a possibility makes it difficult to determine whether enhanced autobiographical recall in BPD may be attributed to a selective retrieval bias or simply due to the fact that more such events have been stored in autobiographical memory. Another difficulty with the literature investigating OGM in

BPD relates to the interpretation of the phenomenon. It seems that on the one hand the presence of OGM may indicate a negativity bias, thus the absence of OGM in BPD suggests no negativity bias (at least in autobiographical memory). Yet on the other hand, the absence of OGM in BPD may imply a difficulty in emotion regulation.

Deserving mention is that a general methodological weakness across the existing literature relates to a failure to distinguish between the encoding, storage and retrieval stages of memory. This limitation is of considerable importance in the interpretation of these memory tasks as a failure to encode information, for instance, would result in a failure to retrieve the non-attended information. Another problem in the literature relates to the possibility that enhanced recall of negative information could result from a response bias rather than a genuine memory bias given that emotionally disturbed participants may in reality experience more emotionally distressing events (Williams et al., 1997).

Summary of findings and suggestions for future research

To date, research studies investigating recall of emotionally salient information in BPD are limited in number and the findings are not sufficiently consistent to draw the conclusion that BPD is characterized by a memory bias. Moreover the range of paradigms are significantly varied across the studies so it is difficult to make comparisons.

The stream of research (although small in number) examining OGM in BPD, however, provides more consistent results. It seems that autobiographical memory in BPD does not tend to be overgeneral but comorbid conditions such as depression may reduce autobiographical memory specificity. What this means in relation to BPD is not made entirely clear in the literature. On the one hand it may indicate that a bias does not operate specifically in autobiographical memory in BPD. On the other hand, it might be indicative of problems with emotion regulation. Future studies specifically examining the relationship between avoidance of aversive experiences and OGM in BPD may be informative in elucidating the function that OGM might serve in BPD; particularly if it plays a role in emotion regulation.

The question of whether there is a difficulty in remembering positive events and what this may imply in BPD remains unanswered since only one study (i.e., Domes et al., 2006) addressed this. Although this study demonstrated that BPD individuals had a difficulty in remembering positive words, further studies are needed to determine if BPD individuals have a compromised ability to process positive information and whether this might create difficulties in their attempts to counteract negative affect.

As noted, a general methodological weakness across the existing literature concerns the failure to distinguish between the encoding, storage and retrieval stages of memory. This limitation could be of considerable importance in the interpretation of the memory tasks. Methodologies tapping into implicit memory (e.g., Mathews, Mogg, May et al., 1989) may circumvent this problem. Implicit memory is considered to be an

automatic process unaffected by learning. The method of measuring usually involves gauging the extent to which prior exposure to stimuli facilitates the capacity to later identify these stimuli at very brief exposure durations. Importantly, participants are not informed that the items that are to be identified have already been presented. Well designed versions of these tasks incorporate valenced – matched stimuli not presented during encoding and this not only helps to distinguish which aspect of memory is being assessed but it also reduces the probability of a response bias, since it can be argued that elevated recall of negative information may reflect an inclination to make negative guesses. Noteworthy is that the purity of implicit memory measures has been questioned (Conrey, Sherman, Gawronski et al., 2005; Jacoby, 1991) since it cannot be guaranteed that explicit processes are not involved. However, the use of the Process Dissociation Framework introduced by Jacoby (1991), which makes estimates concerning the contribution of conscious processes to retrieval performance, may overcome this interpretative difficulty (e.g. McNally, Otto, Hornig et al., 2001). Hence, future studies employing methods assessing emotional bias in implicit memory in BPD may prove useful in establishing if BPD individuals have a preference for recalling information that is emotionally relevant.

Overview and Conclusion

The studies reviewed largely suggest that BPD individuals preferentially process emotionally-salient interpersonal cues, and in this regard support the proposition that BPD individuals are hypersensitive towards interpersonal rejection as hypothesized by

the models discussed earlier. However, it has not been established if similar processing biases might be shared by other clinical populations. Further studies including relevant psychopathology comparison groups (e.g., Avoidant PD, Paranoid PD, Social Anxiety, and PTSD) may be particularly informative in determining the degree to which this style of processing is specific to BPD. The issue of content specificity remains largely unclear. Whilst some of the evidence indicates that BPD individuals favour "borderline specific" information representing potential abandonment and rejection, thereby supporting the predictions of attachment theory, the mentalization model and Beckian formulations, other evidence suggests that BPD individuals prioritize general emotional information, which is in line with Kerberg's and Linehan's view that all emotional cues represent threat. Further investigation of this issue may provide opportunity for better targeted clinical intervention. For example, it may answer questions relating to how effective general emotion regulation training might be compared to intervention specifically focusing on interpersonal difficulties.

The mechanisms underlying processing biases are unclear. Are BPD individuals characterized by an attentional bias, an interpretation bias, a memory bias, or all three? So far the literature suggests the presence of an attention and interpretation bias but there is some ambiguity surrounding some of the methods employed, particularly in the attentional studies, which call into question what processes are involved. For instance, it is uncertain whether an attention bias in BPD reflects automatic orienting towards threatening information or a difficulty in directing attention way from threatening information once it has been detected. Further studies using less ambiguous measures that

can separate some of the processes, such as the “attentional blink”, may help clarify which processing bias typifies borderline individuals.

Research on memory bias in BPD is still young and the findings too inconsistent to draw firm conclusions. Moreover the range of paradigms used is varied so it is difficult to compare the results across the studies. Future research examining selective retrieval of emotional information in BPD need to employ methods which: (i) reduce the possibility of a response bias; and (ii) take into account the possibility that borderline individuals have experienced more negative events. Methodologies designed to break such confounds (e.g., implicit memory measures) may prove useful in determining whether a memory bias characterizes BPD, and may also provide additional information relating to whether such processes operate automatically (i.e., outside of awareness).

Studies investigating if BPD individuals have a compromised ability to process positive information might provide some insight into how such a deficit may be linked to difficulties in regulating emotion. Furthermore, research specifically examining the relationship between avoidance of aversive experiences and OGM in BPD may shed some light on whether OGM plays a role in emotion regulation.

Finally, an important line of investigation concerns the manner in which affect or arousal may shape or moderate information processing. As noted in the introduction, the direction of the relationship between emotion dysregulation and cognitive biases is complex and not well understood. For instance, the extent to which arousal influences the

interpretation of ambiguous social cues (such as the emotional state of others) is unclear. Future studies examining the impact of this variable (e.g., via emotion recognition paradigms incorporating mood elicitation procedures) may offer fresh insights into the role of emotional arousal and processing biases.

Clinical Implications and Questions

If future research clearly established that BPD individuals are characterized by a cognitive bias, what would be the clinical significance?

Firstly, it might help clinicians to appreciate more fully why individuals with BPD experience pervasive interpersonal problems. If a disproportionate amount of attention is directed toward negative aspects of social interaction, it stands to reason that this would predispose borderline individuals to evaluate the intentions of others negatively and thereby fuel and exacerbate the troubled and unstable interpersonal behaviour.

Secondly, it may have implications for assessment and outcome measures. For example, it has been suggested that anxiety disorders can be identified by an attentional bias and an interpretive bias (e.g., Matthews & MacLeod, 2002). Might this also apply to BPD? If, for arguments sake, BPD was clearly typified by an attentional bias towards threats of abandonment and an interpretative bias favouring perceived interpersonal rejection, such a bias might serve as an indice that would help clinicians identify this

difficult-to-recognize disorder more quickly and reliably. Potentially, such advancement would benefit service users who more often that not experience a long and protracted period of not knowing or understanding what drives their emotional and social disturbances. Furthermore, a cognitive bias might serve as an index of treatment outcome. For example, the extent to which the bias was reduced might provide information concerning the likelihood of future relapse (see MacLeod, Koster & Fox, 2009).

Thirdly, it may have implications for treatment, or at least raise many questions in relation to it. Here are just some: Should a bias be one of the main targets of treatment or just an adjunct? Could it be remediated and would this reduce vulnerability to interpersonal problems in BPD? If automatic, would a bias be amenable to psychological treatments which largely use conscious intervention techniques? Would it matter where the bias was in the cognitive system? That is, would it be relevant if the bias was attentional, interpretative or memorial? To illustrate, would addressing an attentional bias potentially impact on an interpretative bias? And conversely, would addressing an interpretative bias have beneficial effects on an attentional bias? For instance, if an attention bias in BPD facilitated the detection of threatening stimuli (i.e., signs of disapproval or impending abandonment) at the expense of other information (that would be valuable in challenging the view that others are hostile and rejecting), would attentional training aimed at increasing the flow of new and adaptive information (e.g., Wells, 2000) reduce the tendency to misinterpret socially ambiguous events?

Finally, what would be the best route of intervention? If BPD individuals have a biased perception towards social rejection and abandonment, would direct intervention on cognitive biases such as Cognitive Bias Modification (CBM) procedures (see MacLeod, Koster & Fox 2009 for a review) be sufficiently powerful to alleviate difficulties such as chaotic interpersonal relationships in BPD? Or might other intervention targeting emotion dysregulation and interpersonal difficulties such as DBT (Linehan, 1993) or MBT (Bateman & Fonagy, 2004; Fonagy & Batemen, 2008) be equally or perhaps even more effective at ameliorating interpersonal strife? Further still, if emotion dysregulation plays an integral role in the processing of emotional information, would emotion regulation training alone be just as beneficial? Investigating these questions may lead to the development of more effective and focused therapeutic strategies. Considering that not long ago therapeutic expectation was pessimistic, since most clinicians deemed BPD untreatable, the range of potential treatment possibilities (which future researchers will hopefully put to the test) is both promising and welcome.

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Emotion Recognition in Borderline Personality Disorder

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Abstract

This study investigates recognition of facial emotion among individuals with BPD (n=23) compared to two other groups: a mixed clinical group without BPD (n=23) and a normal control group (n=23). It examines whether individuals with BPD are inclined to interpret perceived emotion in others as hostile when the information is ambiguous. Additionally, it considers the impact of heightened emotional arousal on emotion recognition. Facial emotion recognition is assessed by a computerized, adapted version of the Ekman faces, in which participants identify five emotions (anger, sadness, fear, surprise and disgust) presented at four varying intensities (25%, 50%, 75% and 100%). Impact of emotional arousal is examined by using film clips eliciting either an aroused mood or neutral to pleasant mood. To exclude a generalized face perception deficit, a non-emotional, facial age perception task is included.

BPD participants showed no deficits in emotion recognition or face perception. Further, the mood condition did not reveal effects. However, BPD participants did exhibit a specific response bias towards disgust when the information was ambiguous. This finding may be interpreted as a negativity bias towards social rejection and is compatible with prominent theories of BPD. Clinical implications for assessment and treatment are discussed.

Introduction

Borderline Personality disorder (BPD) is a severe and disabling chronic clinical condition that is not adequately managed by mental health services generally (Lieb, Zanarini, Schahal et al., 2004), and therefore associated with substantial social costs (van Asselt, Dirksen, Severens et al., 2007). Individuals with BPD pose a suicide risk of almost 50 times higher than the general population (Skodol, Gunderson, Pfohl et al., 2002) and are amongst the most frequent consumers of mental health services (Zanarini, Frankenberg, Khera et al., 2001). Prevalence of the condition is high, ranging between 1.5 -2.5% within the general adult population, and over 50% in clinical inpatient populations (American Psychiatric Association, 2000). Despite the innumerable articles and books that have been written about BPD, this disorder is not easily identifiable, nor is it well understood. Making matters more complicated, individuals with BPD can be difficult to engage and they can often make considerable demands on the emotional resources of the therapist or mental health professionals responsible for their care (American Psychiatric Association, 2002). Not surprisingly, clinicians reportedly find this client group one of the most difficult and testing to treat, with a substantial proportion admitting they do not feel equipped to work with this clinical population (Levine, Marziali & Hood, 1997; Waldinger, 1987). Given the complications of managing this group, developing more reliable and effective ways of identifying and treating BPD is paramount.

Diagnosing BPD is not straightforward. The criteria are wide-ranging and diagnosed individuals show huge variability in their presentation to the extent that experts have proposed that the BPD diagnosis is highly heterogeneous (e.g., Skodol Gunderson, Pfohl et al., 2002). Notwithstanding these challenges, emotion dysregulation within the context of interpersonal relations has come to be recognised as a central and distinguishing feature of BPD (e.g., Conklin, Bradley, & Westen, 2006; Koenigsberg, Harvey, Mitropoulou, et al, 2001, 2002; Linehan, 1993). In particular, there is growing consensus that emotion dysregulation is at the heart of the diagnostic criteria accounting for the variability of symptoms, which range from self-injurious behaviour to uncontrollable anger, impulsivity, hostility, mood swings and interpersonal difficulties (e.g., Linehan, 1995; Sanislow, Morey, Grilo et al , 2002; Westen, 1991). The identification of such a core clinical disturbance could facilitate the process of recognising this complex, multifaceted disorder.

Emotion dysregulation as applied to BPD has been given different definitions, but generally it has been articulated as a predisposition to experience negative affect due to a deficit in affect modulation; hence emotions spiral out of control, overwhelm reasoning and are expressed in an intense and unmodified form (for a review of the construct see Bradley & Westen, 2005; Putman & Silk, 2006). Emotion dysregulation is conceptualised as stemming from a transaction between biological irregularities or vulnerabilities and an adverse environmental upbringing. It is hypothesised that this combination of factors alters the developing neural structures that underly or mediate emotion regulation.

Consequently, the individual is more sensitive and reactive to stress (for a review see Bradley & Westen 2005; Putman & Silk, 2006).

Emotion dysregulation and interpersonal dysfunction in BPD

Clinical observations have long suggested that individuals with BPD have problems regulating emotion since they are overwhelmed by intense negative states (Gunderson, 1984), have difficulty discriminating and identifying emotions in themselves and others (Noy, 1982; Westen, 1991), and have a tendency to misinterpret seemingly innocuous behaviour and gestures as hostile (Benjamin, 1996). Conceivably such tendencies, especially the propensity to misunderstand others, render social interaction (including with therapists and care professionals) problematic. Therefore, an understanding of the processes and mechanisms by which BPD individuals may misrepresent the innocuous gestures of others could provide clues to more effective clinical management.

Prominent theoretical accounts of BPD have linked emotional dysregulation to a hypersensitivity to interpersonal cues (particularly those signalling threat of rejection and abandonment) and an expectation of hostility from others. For example, Linehan's biosocial model argues that problems in modulating affect may disrupt effective interpersonal functioning by increasing a tendency to look for sources of social threat, such as hostility from others, in the environment (Linehan, 1993). Fonagy and Bateman's mentalizing model (2008) proposes that emotion dysregulation disrupts interpersonal functioning by undermining the formation of mentalization (i.e., the ability to imagine the

feelings, intentions and wishes of others). According to this model, increased stress reduces the ability to mentalize, and in turn leads to the tendency to misconstrue other minds or mental states (e.g., Fonagy, Gergley, Jurist et al., 2002).

These theories assume that BPD individuals are inclined toward interpreting others' emotions malevolently, and importantly, that heightened arousal (associated with emotion dysregulation) compromises the appraisal of interpersonal cues.

Facial affect as a measure of emotion dysregulation and interpersonal dysfunction in BPD

The hypothesis that BPD individuals are emotionally dysregulated with an associated propensity towards interpreting others' emotions malevolently has been investigated by using emotion recognition paradigms. Measuring the ability to recognise facial affect is considered to be a relevant method for examining emotion dysregulation for the following reasons. Firstly, recognition of facial expressions of emotions has been theoretically linked to an ability to regulate emotion, for instance through *social referencing* (defined as the process of attending to the emotional information of another person in order to make sense of, and respond to, an experience or situation; Campos, 1984; Walden 1991). Secondly, numerous imaging studies have corroborated the notion that emotion dysregulation is linked to difficulties in facial emotion recognition (for a review see Domes, Schulze & Herpertz, 2009). For example, studies examining neural responses to emotional faces in BPD have indicated that the negative attributional bias of BPD individuals may be related to abnormalities in limbic circuits mediating affect

regulation (Domes, Schulze & Herpertz, 2009; Mizenberg, Fan, New et al., 2007). Thirdly, and importantly for the interpersonal domain, the ability to accurately interpret facial expressions of emotions is crucial for successful social relations as these are amongst the most fundamental external cues that provide key information about others' mental states (Erikson & Schulkin, 2003).

Studies examining emotion recognition in BPD

There are relatively few studies investigating recognition of facial expression of emotion in BPD and these have yielded mixed findings. Some have indicated impaired recognition ability and biased appraisals whilst others have shown the opposite.

Two studies (Bland, Williams, Scharer et al., 2004; Levine, Marziali & Hood, 1997) measured the ability to identify discreet emotional states by employing 21 photographs from the Ekman and Friesen (1976, 1984) faces displaying the six basic emotions (anger, fear, disgust, surprise, sadness, happiness) and a neutral face, with a self-paced, multiple choice format. These studies demonstrated that relative to controls, BPD individuals were poorer at identifying expressions of sadness, fear, anger and disgust. Moreover, the results of these studies suggested that arousal compromises accuracy since one study found that individuals with BPD showed more intense emotional responses on the Affect Intensity Measure (AIM; Larsen & Diener, 1987) (Levine et al., 1997), whilst the other found that negative affect in BPD was inversely correlated with recognition accuracy (Bland et al., 2004).

Employing a slightly different method, Wagner and Linehan (1999) used an updated slide set consisting of 56 of the Ekman emotional faces and a different set of instructions in which participants described the emotional state instead of choosing an answer from a list of possible responses. Mindful that traumatic experience was potentially a confounding variable, since a substantial proportion of BPD individuals experience high rates of physical, sexual and emotional abuse, they included two comparison groups: women with histories of childhood sexual abuse with no diagnosis of BPD and women with no history of sexual abuse. Contrary to the above studies, their results indicated that compared to the other two groups, the BPD group perceived others' emotion accurately, with a heightened sensitivity to recognising fear in others. Moreover, the BPD individuals were less accurate in appraising neutral faces, implying a bias. Linking emotion dysregulation to emotion recognition, they proposed that borderline individuals may be influenced by mood state and that under conditions of emotional arousal, BPD individuals may show enhanced recognition ability and a response bias towards negative emotion, such as fear.

Consistent with Wagner and Linehan (1999), a neuro-imaging study investigating amygdala responses to neutral, happy, sad and fearful facial expressions (Donegan, Sanislow, Blumberg et al., 2003) also suggested the possibility of a response bias towards negativity in BPD. Using functional magnetic resonance imaging (fMRI), these investigators found that individuals with BPD demonstrated greater left amygdala activation to facial expressions compared to controls. From these results they surmised that a hyper-reactive amygdala predisposes BPD individuals to be hypervigilant and over

reactive to potentially threatening social stimuli. Adding to these results, post-scan debriefing revealed that BPD individuals interpreted neutral expressions as negative or threatening.

A design limitation shared by the above studies, however, is the use of relatively gross stimuli. Faces were presented at 100% prototypic expression, raising the possibility that differences between the groups may not have been detected since the emotions were highly recognisable. Improving upon these methods, later studies have used morphing techniques in which photos of facial affect are electronically morphed from a neutral expression to 100% prototypic expression. These are described below.

Barnett-Veague (unpublished) presented pictures of facial affect that were morphed at 10% intervals between neutral and 100% anger, fear or happiness. Similarly to Wagner and Linehan (1999), she used two comparison groups: (i) women with a history of childhood trauma but no BPD, and (ii) women with no significant emotional trauma. She found that relative to the comparison groups, BPD participants needed a lower threshold of emotional intensity to identify anger in male faces but they were also more likely to misidentify anger in male faces that did not contain anger cues. Consistent with Wagner and Linehan (1999), she concluded that women with BPD may not have difficulty identifying emotions; instead the difficulty may be in interpreting ambiguous, emotional information.

In a similar vein, Lynch, Rosenthal and Kosson (2006) used a morphing technique but in their paradigm the shift from neutral to 100% prototypic emotion expression occurred over 39 stages. In line with studies suggesting that individuals with BPD have superior ability in detecting facial expressions of emotion (i.e., Wagner & Linehan, 1999; Barnett-Veague, unpublished), they found that compared to normal controls, participants with BPD were able to identify facial expressions of emotion at lower intensities. By contrast, however, their BPD group did not over identify anger in non-anger trials or fear in non-fear trials, so these authors surmised that individuals with BPD do not show biased appraisal towards negative stimuli.

In addition to the morphing technique described above, Domes, Czieschnek, Weidler and others (2008) employed a mixed-emotion forced choice task in which pictures of facial affect showed blends of two basic emotions. They found that in comparison to healthy controls, BPD individuals were biased towards the perception of anger but not towards fear. Contrary to studies implying enhanced recognition, their results did not show increased sensitivity at a lower detection threshold. They concluded that BPD individuals demonstrate a negativity bias but they did not find evidence of greater detection accuracy.

Despite the implementation of more refined methods, a potential limitation shared by these later studies is the failure to include non-emotional, comparable facial control tasks. In the absence of such control tasks it is unclear if BPD individuals have general

deficits in face perception or whether the difficulty is specific to reading facial emotion. Two studies, within this body of literature, appear to have addressed this limitation.

Using a more varied methodology, Mizenberg, Poole and Vinogradov (2006) investigated emotion recognition in BPD by using pictures of facial affect and heteromodal tasks combining two sensory features (visual and prosodic/auditory). Additionally, they included the Benton Facial Recognition Test (BFRT; Benton, Sivan, Hamsher et al., 1983) to rule out general difficulties in face perception. Interestingly, they demonstrated that compared to controls, the BPD group exhibited impaired recognition when the facial and vocal emotion were combined, but not when these expressions were presented in isolation. Moreover, and importantly, the BPD group showed problems in the recognition of facial features suggesting a potential problem in face perception.

Dyck, Habel, Slodczyk and others (2009) also administered the BFRT to exclude deficits in face perception in their investigation of emotion recognition in BPD but contrary to the above study, their findings did not suggest any such deficit. These researchers were specifically interested in the role of speed in accuracy of facial emotion recognition in BPD; hence they compared a facial task with a time-limit to a facial task without a limit. The time-limited task required quick decisions on two response categories (negative vs. neutral) on the Fear Anger Neutral (FAN) test, whilst the time-unlimited emotion recognition task involved identifying one of five emotions from pictures of colour facial stimuli. Their results revealed that relative to controls, BPD

individuals misinterpreted neutral facial expressions as negative only during fast discrimination on the FAN test.

In summary, studies examining facial emotion recognition in BPD have yielded partially contradictory results. In relation to recognition accuracy, two studies have indicated that individuals with BPD were poorer at recognising emotion (Levine et al., 1997; Bland et al., 2004), three have suggested that individuals with BPD are better at identifying emotion (Wagner & Linehan, 1999; Barnett-Veague, unpublished; Lynch et al., 2006;), and one found that BPD individuals exhibited impaired recognition when the facial and vocal emotion were combined (Mizenberg, Poole & Vinogradov, 2006). In relation to biased appraisals, four suggest that BPD individuals are inclined to attribute negative intent to neutral faces (Domes et al., 2008; Donegan et al., 2003, Wagner & Linehan, 1999; Barnett-Veague, unpublished), one did not (Lynch et al., 2006), whilst another revealed that BPD individuals misinterpreted neutral facial expressions as negative only during fast discrimination (Dyck et al., 2009).

The disparate results across these studies might be explained by differences in methodology. As exemplified, some studies used static facial stimuli (e.g., Levine et al., 1997; Bland et al., 2004) whilst others used more sophisticated dynamic, ambiguous stimuli designed to elicit subtle differences between groups (e.g. Domes et al., 2008; Lynch et al., 2006). Some used forced-choice response formats (e.g., Levine et al., 1997), others used free response (e.g., Wagner & Linehan, 1999), and others permitted participants to change their response as often as they needed (e.g. Lynch et al., 2006);

therefore the influence of guessing is likely between studies. Some used more severely affected groups (e.g., Bland et al., 2004) raising the possibility that differences might only be apparent with increasing clinical severity. Differences in rates of comorbidity also make it unclear how these may have influenced the findings.

A significant limitation is that a substantial proportion of the studies failed to include adequate clinical comparison groups. Therefore, it remains unclear if patterns of responses manifested by BPD individuals are specific to this clinical group or if they reflect non-specific symptoms also found in other clinical populations. Another potential limitation, as already mentioned, is the failure of the majority of studies to include non-emotional facial control tasks to rule out the possibility of general deficits in face perception. This is pertinent given that one of the two studies examining this factor suggested that BPD individuals may exhibit difficulties in facial perception (Mizenberg et al., 2006).

A further potentially significant limitation is the failure to systematically address the extent to which emotional arousal may influence emotion recognition biases. Although a few studies (e.g., Bland et al., 2004; Levine et al., 1997; Wagner & Linehan, 1999) imply an association between emotional arousal and emotion recognition, it remains unclear how arousal might affect recognition accuracy and how it might influence a negative response bias. Given the premise that emotion dysregulation is linked to emotion recognition in BPD, the degree of arousal may be an important

variable. Arguably, differences in processing biases might be more apparent under conditions of heightened arousal.

Hence, the current study is designed to: (i) take into account the impact of heightened emotional arousal on emotion recognition in BPD; (ii) control for the possibility of general deficits in face perception; and (iii) consider the extent to which any deficits in emotion recognition exhibited in BPD might also characterise other clinical groups.

The present study

This study investigates whether individuals with BPD are inclined to interpret perceived emotion in others as hostile, and specifically examines the impact of heightened emotional arousal on emotion recognition. The predictions of this study are linked to the notion that emotion dysregulation is at the core of most of the diagnostic criteria for BPD (Clarkin, Hull & Hurt, 1993; Linehan, 1993; Westen, 1991), and tie in with a number of models such as the biosocial theory (Linehan, 1993) and the mentalization model (Bateman & Fonagy, 2008).

The study sets out to investigate whether: (i) individuals with BPD are able to accurately identify emotion; (ii) individuals with BPD have a tendency to interpret perceived emotion in others as hostile or in some way negative; and (iii) the ability to evaluate emotion is dependant on mood state and thus compromised when the individual is distressed.

To investigate whether BPD individuals are inclined towards misreading facial affect as hostile, this study will employ an emotion recognition paradigm since this is an established, ecologically valid, measure. To examine whether emotional arousal influences the appraisal of facial affect, it will use film clips since these have been demonstrated to be a powerful technique in eliciting different mood states in a laboratory setting (Westerman, Spies, Stahl et al., 1996). To differentiate between a specific emotion recognition deficit and a generalised face processing impairment, the study will include a non-emotional, facial age perception, control task. Finally, to ascertain whether patterns of deficits in emotion recognition exhibited in BPD also characterize other clinical groups, it will include a mixed clinical comparison group in addition to a normal control group.

It is hypothesised that individuals with BPD will be able to recognise emotions accurately when presented at 100% prototypic expression but they may be inclined to interpret perceived emotion in others as hostile when the emotional information is ambiguous. Since some of the literature suggests that borderline individuals have problems predominantly with the perception of anger and fear, it is predicted that compared to the control groups, the BPD group would be more likely to over-identify anger and fear in non-anger and non-fear trials at lower intensities of facial emotional expression.

It is also hypothesized that the propensity towards interpreting others' emotions as malevolent will be exacerbated by emotional arousal. Thus BPD individuals undergoing negative mood elicitation would be expected to demonstrate a greater bias towards fear and anger at lower intensities of facial emotional expression. That is, they will be expected to over-identify a greater number of fear targets in non-fear trials and anger targets in non-anger trials compared to BPD individuals who have undergone the neutral mood elicitation.

Method

Design

Sixty nine participants (23 BPD; 23 Mixed Clinical [MC]; 23 Normal Control [NC]) underwent one of two counterbalanced mood elicitation procedures in which they watched one of two 3-minute film clips designed to induce either emotional arousal or a neutral to pleasant mood. They then undertook a computerized Facial Emotion Recognition (FER) task consisting of a series of faces expressing emotions in which they were required to indicate: (i) the perceived emotion from a selection of five emotions and (ii) the perceived level of intensity of that emotion. Participants determined the presentation of the facial emotion stimuli at a self-paced rate. Each participant also performed a comparable Facial Age Perception (FAP) control task in which they were required to judge the perceived age of photos of faces by indicating which age bracket, from a selection of ten, the face came under.

This study employed a 3 (Group: BPD, MC, NC) X 2 (Mood: Aroused, Neutral/Pleasant) X 5 (Emotion: Sad, Anger, Surprise, Fear, Disgust,) X 4 (Intensity: 25%, 50%, 75%, 100% prototypical intensity) mixed between and within subject analysis of variance design. There were two between subject factors (group and induced mood) and two within subject factors (type of emotion and level of intensity). Hence, the complete design for the emotion recognition data involved four factors (group, mood, emotion and intensity) with repeated measures on target emotions and intensity. The main dependent variables were proportion of accurately identified emotion, proportion of incorrect endorsements, and perceived intensity ratings (level of threshold).

This study also employed a 3 (Group: BPD, MC, NC) X 30 (Plate: facial age plates) mixed between and within design for the facial age perception (comparable control) task. The between subject factor was Group (BPD, MC, NC) and the within subject factor was facial age plates. Hence, the complete design for the facial age data involved two factors (group, facial age). The main dependant variable was perceived age bracket, ranging from 1-10, for the 30 plates.

Participants

BPD Group

The BPD group consisted of 23 individuals (16 females and 7 males with a mean age of 36.0 years) who were recruited from three services across Central and North West London (CNWL) Foundation Trust through negotiation with the Responsible Medical Officers, key workers and treating psychologists. The individuals who were identified

for the study had a diagnosis of BPD but to further ensure that they met criteria, they were screened with The Revised Diagnostic Interview for Borderlines (DIB-R; Gunderson & Zanarini, 1992) by the main researcher, RI, a consultant clinical psychologist. Additional selection criteria included an ability to understand and read English. Individuals were excluded if they scored below the suggested cut-off on the DIB-R (described below). They were also excluded if they had a diagnosis of schizophrenia, were currently on neuroleptic medication or attending drug and alcohol services for treatment of substance misuse. Of the 29 who were eligible and tested, six participants (5 females; 1 male) were excluded.

MC group (clinical comparison)

The clinical comparison group consisted of 23 individuals (16 females, 7 males with a mean age of 39.6 years) who were receiving psychological treatment from the Outpatient Psychology department of an inner city metropolitan hospital. These individuals had responded to a flyer placed on the notice board in the waiting area in the psychology department. The advertisement targeted individuals who had experienced PTSD, anxiety, panic and abuse who were interested in participating in research examining emotion recognition. Inclusion criteria included an ability to understand and read English. Individuals were excluded from the analysis if they: endorsed more than two diagnostic criteria of BPD; had a current diagnosis of schizophrenia; were currently on neuroleptic medication or attending drug and alcohol services for treatment of substance misuse. Of the 33 individuals that were eligible and tested, 10 participants (8 females; 2 males) were excluded from the analysis because their scores on the screening

measures (described below) suggested problems in anger and interpersonal relations, which are potential features of BPD.

NC Group

The normal control group were primarily recruited via poster advertisements on the general hospital notice board of the hospital. Advertisement for the control group targeted individuals interested in participating in research on emotion recognition that would help develop treatment for BPD. The control group consisted of 23 individuals (15 females, 8 males with a mean age of 37.6 years) who were able to understand and read English and did not have a history of a significant psychological disorder. Participants were excluded if they reported psychological distress; endorsed more than two diagnostic criteria of BPD; had a current diagnosis of schizophrenia; were currently on neuroleptic medication or attending drug and alcohol services for treatment of substance misuse. Of the 34 who were eligible and tested, 11 participants (7 females; 4 males) were excluded since the self report measures indicated potential emotional difficulties such as depression, anger and relationship problems.

(See Appendix 3 for details of cut-offs for each of the screening measures).

Screening measures

The Revised Diagnostic Interview for Borderlines (DIB-R; Gunderson & Zanarini, 1992).

This was used to further assess the presence of symptoms of BPD in those who had been identified as potential participants for the BPD group. This is a semi-structured

interview consisting of 97 items addressing the manner in which the individual has felt, thought and behaved during the past two years. It gathers information in four areas believed to be of diagnostic significance for BPD: affect; cognition; impulse control; and interpersonal relations. It usually takes less than an hour to complete and clients reportedly find it relevant and acceptable. It compares well with clinicians' judgements and has good test-retest reliability and inter-rater reliability (Zanarini, Frankenberg & Vujanovic, 2002). A score of eight or above is indicative of BPD but for the purposes of this study the cut-off was a score six. The cut-off was changed for pragmatic reasons so as to have sufficient numbers for statistical power. Given that all participants identified for the BPD group already had been given a diagnosis of BPD, this modification seemed, on balance, an acceptable compromise.

To reduce participant burden, the two control groups were not screened with DIB-R. Instead the background questionnaire and a battery of self-report measures (described below) were administered to rule out general psychopathology in the NC group, and to exclude potential BPD symptoms in the MC comparison group.

Background Questionnaire (see Appendix 2)

All participants completed a background questionnaire detailing: (i) demographics (age, gender, ethnicity, education); (ii) psychiatric and psychological history (presence or absence of diagnosis of major mental illness, presence or absence of abusive or traumatic childhood history, previous psychological, psychiatric intervention, medication); and (iii) presence of drug and alcohol difficulties.

Participants completed this questionnaire, along with a battery of other questionnaires (described below) at the end of the experimental procedure so as to ensure that this activity did not influence their performance on the FER and FAP tasks.

Self -report measures

A battery of self-report measures were administered to : (i) to gauge the degree of homogeneity of the BPD sample; and (ii) screen for hostility and interpersonal difficulties in the NC and MC sample as these are potential symptoms of BPD. A rationale for the inclusion of each self-report measure is provided below.

Positive and Negative Affect Scale (PANAS; Watson, Clark & Tellegen, 1988).

This 20-item self-report questionnaire was used to assess baseline affect at the time of testing. These scales were chosen because they have been found to be sensitive to intra-individual mood fluctuations (Watson, et al., 1988). Ten adjectives such as "interested" and "enthusiastic" are used to measure Positive Affect (PA) and ten adjectives such as "irritable and "upset" are used to measure Negative Affect (NA). Various temporal periods may be used as a reference point. This study employed the phrase "as you feel today" and "as you feel on average". Internal consistency for the "today" and "general" time-frames is high (Today: α = .90 for PA scale and α = .87 for NA scale; General: α = .88 for PA scale and α = .87 for NA scale) (Watson, et al., 1988). Normative data has yielded the following means and SDs for the "Today" time-frame: PA = 29.1 (8.3); NA= 16.3 (6.4), and the "General" time-frame: PA= 35.0 (6.4);

NA =18.1 (5.9). High scores on the NA scales indicate a variety of negative mood states including anger, contempt, disgust fear and nervousness. Low scores on the PA scales reflect sadness and lethargy.

Beck Depression Inventory II (BDI-II; Beck, Steer & Brown, 1996)

This scale was selected for its sound psychometrics as well as its quick and easy administration. It is a widely used 21-item self-report inventory measuring state-specific depressive features. It is an amended version of the original BDI with good construct validity (Beck, Steer, Ball et al., 1996); for example, it is distinguished from the anxiety subscale of the SCL-90, but highly correlated with the depression sub-scale (Steer, Ball & Ranieri et al., 1997). The cut-offs are as follows: 0-13 = minimal depression; 14-19 = mild depression; 20-28 moderate depression; 29-63 = severe depression.

Inventory of Interpersonal Problems (IIP; Horowitz, Rozenberg, Baer, Ureno & Villasenor, 1988)

This self-report inventory measures the level of distress associated with a difficulty in relating to others. Since disruptions in social relationships are one of the core features of BPD, it was used as an additional measure to differentiate the extent of interpersonal problems amongst the three groups. This questionnaire consists of 127 items which assess ongoing interpersonal problems apparent to the respondent and those with whom they socialise. Items include statements such as: “It is hard for me to trust others”, and “Sometimes I fly off the handle for no good reason” which are rated on a 5-point scale ranging from 0 (not at all) to 4 (extremely distressing). There are 8 sub-scales

and high *T* scores (defined as 70 or above) suggest a problem area. Estimates for internal consistency for sub-scales are adequate (α = .82- .94), and test-retest reliability estimates are also adequate ranging from (α = .80-.90).

Buss-Perry Aggression Questionnaire (BPAQ; Buss & Perry, 1992).

Since anger and hostility may be a feature of BPD, this measure was included to gauge the degree of anger problems across the three groups. The BPAQ is one of the most widely used trait measures of aggression and hostility (Archer & Webb, 2006; Vigil-Colet, Lorenzo-Seva, Codorniu-Raga et al., 2005). It is an updated and psychometrically improved version of the Buss-Durkee Hostility Inventory (Buss & Durkee, 1957), and has four subscales: physical aggression, verbal aggression, anger and hostility, which are rated on a 5-point scale ranging from "Never or hardly applies to me" to "Very often applies to me". The internal consistency for the four scales is adequate and is as follows: physical (α = .82), verbal (α =.75), hostility (α =.80) and anger (α = .85). There are different norms for males and females, hence different cut-offs were assigned to females (physical = 25; verbal =18; anger = 27; hostility 23) and males (physical= 33; verbal = 20; anger = 23; hostility = 28). Scores falling above these cut-offs suggested anger dyscontrol problems.

Mood Induction

Participants were allocated to one of two mood conditions (Neutral-pleasant or Aroused-emotional) on an alternate basis. Film clips were used to induce the different mood states since they have been demonstrated to be (i) a powerful technique in

eliciting emotion in a laboratory setting (Westerman, Spies, Stahl et al, 1996); and (ii) a reliable means of eliciting emotion in an ethically acceptable fashion (Rottenberg, Ray & Gross, 2007). The film clips were presented on a Toshiba Satellite A100-201 Laptop computer with a 15.4" monitor.

The Neutral to pleasant state was induced by a 3-minute film clip from "Alaska's Wild Denali" (Summer in Denali, Hardesty, 1977). This clip was chosen because it has been recommended in the literature as a baseline condition that is well tolerated, relaxing and engaging (Rottenberg et al., 2007). The clip features nature scenery, animals, and uplifting music.

The Arousal state was induced by a 3-minute film clip with themes centering on rejection, identity confusion and despair. A similar procedure with film clips has been used with good effect in previous studies that have manipulated mood in BPD individuals (e.g., Arntz, Klokman & Sieswerda, 2005). A clip from the film "Girl Interrupted" (Mangold, 1999) was chosen since it had been gauged from clinical sessions that individuals with BPD find the themes emerging from this movie emotionally relevant. The clip was piloted on a small group comprising of individuals working in the psychology department (3 secretaries, 3 psychologists, 3 research assistants) and five service users with a diagnosis of BPD. Results of the pilot suggested the film clip was sufficiently emotionally arousing, inducing feelings of fear, anxiety and sadness (see Appendix 4).

Immediately after watching the film clip, participants rated how they felt by completing a modified version of a post-film questionnaire developed by Rottenberg et al, 2007 (see Appendix 5)

Stimulus materials and equipment

Facial Emotion Recognition – FER (Experimental Task).

FER tasks based on the Ekman and Friesen (1976) faces have been used widely to investigate an individual's ability to identify emotion (e.g., Lennox, Jacob, Calder et al., 2004). The Ekman and Friesen faces set has been extensively validated and normed (Pictures of Facial Affect; Ekman & Friesen, 1976), and the task typically involves participants making judgements on six facial emotions (happiness, sadness, fear, anger, surprise and disgust) that are universally recognised (Ekman, 1972).

The Ekman faces have been adapted to produce a blend of different emotion at different intensity and published as computerised neuropsychological tests called *Facial expressions of emotion: Stimuli and tests* (FEEST; Young, Perret, Calder, et al., 2002). The stimuli employed in this study were developed at Birmingham University and taken from the FEEST set (Young et al.; 2002). A continuum of emotional intensity was constructed through morphing a model's neutral pose in increments of 25%. For the purpose of the study, eight actors (4 females and 4 males) were selected expressing five emotions (sadness, anger, fear, disgust, surprise). Happiness was excluded as this has been found the easiest to recognise (Hess, Blairy & Kleck, 1997). The emotional intensities used for this study were: 25%, 50%, 75% and 100% prototypical expression.

The emotional expression at 25% was barely perceptible but it became more easily identifiable as it approached 100% (see Appendix 6).

Participants were presented 160 facial stimuli in random order on a Toshiba Satellite A100-201 Laptop computer with a 15.4" monitor. On presentation the participant was required to indicate what the emotion was from a selection of the five emotions, and then indicate the level of intensity of the emotion on a 1-10 scale. This provided a measure of the participant's ability to correctly identify the emotion as well as their ability to judge the intensity of the emotion that was displayed. It also provided a measure of incorrect endorsements. This task took approximately 30 minutes to complete.

Facial Age Perception-FAP (Control task)

To differentiate between a specific emotion recognition deficit and a generalised face processing impairment, a FAP task was included as the comparison control. This task was deemed comparable to the emotional facial expression task, as the respondent needed to attend to the featural and configural information of the face to obtain social information.

Participants were presented a series of 30 male faces perceived by a group of independent observers to span a range of ages from approximately 17-65 years old. These faces had been constructed for a previous study conducted at Birmingham University by Tomlinson, Jones, Meade and others (2006). The faces were greyscale photographic

images that had been edited in Photoshop. Most of the hair, except fringes, had been cropped around the ears so as not to influence age ratings. Each face was presented on individual A4 sheets of paper and the image was approximately 10cm by 8.5cm (see Appendix 7).

Participants were required to judge how old they perceived the face to be. To simplify the task, participants were instructed to indicate which of the ten, 5-year age, brackets the target came under. The age brackets were numbered 1-10 as follows (1: 15-19; 2: 20-24; 3: 25-29; 4: 30-34; 5: 35-39; 6: 40-44; 7: 45-49; 8: 50-54; 9: 55-59; 10: 60+). This method has been found to be the most sensitive and valid manner of determining facial age (Burt & Perrett, 1995). A card listing of the age brackets was given to the participant during the task and the experimenter recorded the participants' ratings on a rating form (see appendix 7). This task took approximately 5 minutes to complete.

Procedure

Ethics approval was obtained from Ealing and West London Mental Health Trust Research Ethics Committee (see Appendix 8).

Prospective participants contacted the primary researcher via email or phone and were given a full description of the study and an opportunity to ask questions about it. If interested, they were sent an information leaflet (see Appendix 9) and a time was scheduled for testing. Testing was primarily conducted in the Psychology Department but

also conducted at two other centres within the Trust. The BPD group attended two sessions: in the first session they were screened with the DIB-R to ensure they met diagnostic criteria for BPD (this took approximately 60 minutes), and in the second session they underwent the experimental procedure (on average this took about an hour but some participants took longer, completing it in 75 minutes). The trauma and control groups were not screened with the DIB-R so these groups attended only one session (i.e., the experimental session, which took between 60-75minutes to complete).

To ensure that participants fully understood what the study was about and what the tasks would involve, participants were asked if they had read the information sheet and if they had any further questions about the study prior to commencing the experimental procedure. Following written, informed consent (see Appendix 9), participants were alternately allocated to one of the two mood conditions: Aroused-emotional state or neutral-pleasant state. Depending on the allocated mood condition, participants either watched the 3-minute film clip featuring despair (Arousal condition) or the 3-minute clip featuring nature (Neutral condition). Immediately after watching the film clip, they rated how they felt by completing the Post Film Questionnaire (PFQ).

Next, participants were given a practice trial on the FER task. An instruction screen explained the format of the task as follows:

> **In this task you will see a series of faces one at a time. For each face you will be asked to make 2 judgements; what emotion you think the face is displaying and how intense you think the emotion is. Please do not spend too long thinking about this judgement. There is no right or wrong answer; we are just interested in what you think. Please try this practice trial so that you can become familiar with the task.**
>
> **Each button has a keyboard short-cut (i.e., the underlined character of each key). Please ask the researcher if you have any questions at any point during the task.**

Once the participants had demonstrated that they understood the instructions and were able to perform the exercise, they moved onto the experimental task. The first screen presented participants with the following instruction: "**What emotion is this face showing?**" Participants had the option of using the mouse or five keys (1= sad; 2=disgust; 3=surprise, 4=fear, 5=anger) on the keyboard to indicate which emotion the face was displaying. Although there was no time limit within which to make a decision, participants were encouraged not to deliberate. The second screen directed the participant to rate the intensity of the emotion on a 1-10 point scale, ranging from "*not at all"* to "*very much so*" with the following instruction: "**How intense is the emotion?**" Again, participants had the option of using the mouse or the arrow keys on the keyboard to move along the 10-point scale.

Following completion of the FER task, participants were given a practice trial on the FAP task. During the practice trial, participants were shown three faces, one at a time, and asked to make a judgement about which age bracket the face came under. Once they demonstrated they understood this exercise, participants were presented the 30 faces, one at a time, and the experimenter recorded their ratings on a form.

After performing the FER and FAP tasks, participants completed the battery of questionnaires described above. At the end of the experimental procedure, participants were given an opportunity to ask questions. They were also given an opportunity to debrief but none of the participants required this.

Results

Group characteristics

Demographic information

The demographic characteristics of the groups are reported in table 1. As can be seen, the three groups (BPD, MC, NC) did not differ significantly in age ($F_{2,66} = 0.65$; p= 0.53) , education ($F_{2,66} = 0.67$; p= 0.51), gender mix ($\chi^2 = 0.13$; p= 0.91), or ethnicity ($\chi^2 = 20.30$; p= 0.68).

Table 1: Demographic information for BPD, MC and NC groups

Variable	**BPD** (n=23)	**MC** (n=23)	**NC** (n=23)
Age			
M (SD)	36.00 (8.75)	39.57 (11.66)	37.61 (11.32)
Education			
M (SD)	14.50(4.20)	14.96 (3.96)	15.78 (2.94)
Gender			
(% female)	69.6	69.6	65.2
(% male)	30.4	30.4	34.8
Ethnicity			
% Caucasian	82.6	73.9	73.9
% Black	0.0	4.3	0.0
% Asian	13.0	8.7	8.7
% Other	4.3	13.0	17.4

Clinical characteristics

The clinical characteristics are summarised in tables 2 and 3. As expected, the BPD group reported significantly more depression on the BDI- II ($F_{2,66}$ = 48.64; p=0.00), and more negative affect on the PANAS-N "felt today" scale : ($F_{2,66}$ = 9.67; p=0.00); and on the PANAS-N " felt on average" scale ($F_{2,66}$ = 46.68; p=0.00). The BPD group also reported greater anger ($F_{2,66}$ = 26.35; p=0. 00), hostility ($F_{2,66}$ = 31.37; p=0 .00), physical aggression ($F_{2,66}$ = 18.93; p=0.00) and verbal aggression ($F_{2,66}$ = 8.04; p=0.01) on the BPAQ (see table 2). Further, they reported significantly more interpersonal difficulties on the IIP (see table 3). On each of these clinical measures the same rank order was evidenced. The BPD group reported the greatest level of distress, followed by the MC group and the least levels of distress were associated with the NC participants.

No significant differences between the groups were observed for the PANAS-P "felt today scale" suggesting they were experiencing a similar degree of positive affect on the day of testing ($F_{2,66}$ = 1.49; p= 0.23). However a significant difference between the groups was observed for the PANAS-P "felt on average" scale ($F_{2,66}$ = 10.12; p=0.00). Both the BPD and MC groups reported less positive affect compared with NC, suggesting that typically the NC group experience more positive emotion

Table 2: The clinical characteristics of the BPD, MC and NC participants: Means, SDs and F-values for the BPAQ, BDI-II and PANAS

Measure	Group	N	Mean	SD	F	Sig.
	BPD	22	23.77	4.57	26.35	0.00
	MC	23	18.22	5.04		
BPAQ Anger	NC	22	14.41	3		
	BPD	22	28.55	8.16	31.37	0.00
	MC	23	21.83	6.09		
BPAQ Hostility	NC	22	13.73	3.51		
	BPD	22	26.45	8.49	18.93	0.00
	MC	23	18.96	6.69		
BPAQ Physical Aggression	NC	22	14.59	2.94		
	BPD	22	17.32	5.87	8.04	0.01
	MC	23	13.43	4.76		
BPAQ Verbal Aggression	NC	22	11.86	2.78		
	BPD	23	34.78	11.39	48.64	0.00
	MC	23	20.83	13.17		
BDI-II	NC	22	4.27	3.98		
	BPD	23	25.57	8.92	1.49	0.23
	MC	23	25.39	8.68		
PANAS – Positive Extent felt today	NC	22	29.59	9.97		
	BPD	23	23.61	9.63	9.67	0.00
	MC	23	16.61	7.29		
PANAS – Negative Extent felt today	NC	22	13.77	5.74		
	BPD	23	25.30	7.22	10.12	0.00
	MC	23	25.22	9.67		
PANAS – Positive Extent felt on average	NC	22	35.10	8.21		
	BPD	23	35.10	7.17	46.68	0.00
	MC	23	25.44	8.96		
PANAS – Negative Extent felt on average	NC	22	14.10	5.15		

Table 3: The clinical characteristics of the BPD, MC and NC participants: Means, SDs and F-values for the IIP.

Domain	Group	N	Mean	SD	F	Sig.
IIP- Domineering/Controlling	BPD	22	66.26	13.03	12.88	0.00
	MC	23	55.30	10.47		
	NC	22	49.95	9.10		
IIP- Vindictive/Selfish	BPD	22	70.65	10.26	31.46	0.00
	MC	23	56.09	14.36		
	NC	22	45.46	5.35		
IIP- Cold/Distant	BPD	22	67.78	10.25	24.48	0.00
	MC	23	59.35	12.25		
	NC	22	47.05	6.43		
IIP- Socially Inhibited	BPD	22	72.22	11.92	31.97	0.00
	MC	23	65.13	13.41		
	NC	22	46.00	7.82		
IIP- Non Assertive	BPD	22	65.61	11.66	7.47	0.01
	MC	23	63.22	12.49		
	NC	22	53.82	8.19		
IIP- Over Accommodating	BPD	22	67.57	10.66	9.75	0.001
	MC	23	63.22	14.08		
	NC	22	52.36	10.41		
IIP- Self Sacrificing	BPD	22	69.52	10.16	11.22	0.00
	MC	23	63.57	12.42		
	NC	22	53.55	11.55		
IIP- Intrusive/Needy	BPD	22	70.91	11.84	14.58	0.00
	MC	23	60.17	12.9		
	NC	22	52.86	8.57		

Data preparation

The significance of the deviation from normality in the sample distribution of accuracy rating for each of the five emotions, the four intensity ratings and total false identifications was assessed using a One-Sample Kolmogorov-Smirnov Test. None of the accuracy or intensity ratings evidenced significant deviation from normality (see Appendix 10). Accordingly, these data were considered suitable for parametric analysis.

Does mood condition influence response to facial emotion?

To determine whether the arousal induction procedure was effective (i.e., produced negative affect), independent t-tests were carried out on mood ratings obtained immediately subsequent to the mood induction procedure. As shown in table 4, these ratings indicated that those who were allocated to the arousal condition reported more negative emotion, such as anger, anxiety, disgust, fear, sadness and shame, compared to those in the neutral condition. Moreover, those in the neutral condition reported more positive emotion, such as happiness and amusement, compared to those in the arousal condition. This suggests that the arousal induction procedure produced, at the very least, an immediate effect on mood.

To identify the effects of the mood induction, independent t-tests were carried out on the accuracy and intensity ratings for the five emotions. As shown in table 5, no significant differences were observed between ratings of participants in the emotional arousal condition and those in the neutral condition with respect to accuracy of emotion identification or rating of emotional intensity. Independent t-tests were also performed for the BPD group only, since theories of BPD suggest that emotional arousal influences emotion processing. As shown in table B, Appendix 11, no significant differences were found between BPD participants in the arousal condition and neutral condition in relation to recognition accuracy and intensity ratings.

Accordingly, emotional activation was not included in subsequent analysis of these variables.

Table 4: The effect of mood induction on immediate mood: Post Film Questionnaire (PFQ) ratings.

Emotion	Arousal (n= 42) Mean (SD)	Neutral (n= 27) Mean (SD)	t	df	Sig. (2-tailed)
Amusement	1.24 (2.16)	2.59 (2.44)	-2.41	21	0.02
Anger	1.74 (2.24)	0.07 (0.38)	3.81	21	0.00
Anxiety	4.15 (2.57)	0.93 (1.71)	5.75	21	0.00
Disgust	1.94 (2.55)	0.00 (0.00)	3.94	21	0.00
Fear	3.74 (2.44)	0.19 (0.68)	7.36	21	0.00
Happiness	0.43 (1.11)	5.59 (1.47)	-16.58	21	0.00
Sadness	5.40 (2.46)	1.02 (1.99)	7.76	21	0.00
Shame	2.20 (2.70)	0.07 (0.38)	4.0	21	0.00

Table 5: The effect of mood induction on accuracy and intensity rating for each of the five emotions

Emotion	Arousal (n= 42) Mean Accuracy (SD)	Neutral (n=27) Mean Accuracy (SD)	t-value	df	Sig. (2-tailed)
Surprise	23.12 (3.85)	23.30 (3.96)	-0.19	67	0.85
Fear	17.93 (4.54)	18.88 (3.56)	-0.93	67	0.36
Disgust	17.71 (4.90)	18.11 (5.63)	-0.31	67	0.76
Anger	19.10 (3.87)	19.93 (3.10)	-0.94	67	0.35
Sadness	21.17 (5.81)	22.56 (3.70)	-1.11	67	0.28
Intensity Level	**Mean Rating (SD)**	**Mean Rating (SD)**			
25%	4.36 (1.13)	4.47 (1.16)	-0.38	67	0.71
50%	5.99 (0.97)	5.92 (0.95)	0.29	67	0.78
75%	7.06 (0.91)	7.01 (0.88)	0.24	67	0.81
100%	7.69 (1.01)	7.64 (0.96)	0.19	67	0.85

Do the groups differ in their ability to accurately identify emotion?

In order to assess the relative emotion identification accuracy of the BPD, MC and NC participants, a mixed between and within subject ANOVA was calculated. The

between subjects factor was group (BPD vs. MC vs. NC) and the within subjects factors were emotion (surprise vs. fear vs. disgust vs. anger vs. sadness) and intensity level (25% vs. 50% vs. 75% vs. 100%). The dependent measures of performance were mean number of accurately identified emotions at each of the different intensities. The three way interaction between group by emotion by intensity did not reach statistical significance ($F_{24, 43}$=1.09; p = 0.35) and is shown diagrammatically in Figure 1, page 103. (See Appendix 12, table D, for mean accuracy scores and SDs). The three groups evidenced similar rates of accuracy for identification of the five emotions ($F_{8, 59}$=1.01; p = 0.43) and evidenced a similar response to variation in the intensity of the facial emotion ($F_{6,60}$=0.32; p = 0.93).

Do the groups differ in their perception of intensity?

To establish whether the groups differed in their perception of the intensity of the emotional stimuli, a mixed design ANOVA was employed. The between subject factors were group (BPD vs. MC vs. NC) and the within subject factors were emotion (surprise vs. fear vs. disgust vs. anger vs. sadness) and intensity (25% vs. 50% vs. 75% vs. 100%). The dependent variable was mean intensity rating scores of each of the emotions. (See Appendix 12, table E, for mean intensity ratings and SDs).

No significant effects were observed for the three-way interaction between group vs. emotion vs. intensity ($F_{24, 42}$=1.02, p= 0.44). As shown in Figure 2 (see p.104), the three groups did not significantly differ in their perception of intensity of the five emotions ($F_{8, 59}$ = 0.75; p= 0.66) nor did they differ in their response to variation of intensity to facial affect ($F_{6, 60}$= 1.21; p= 0.30).

Do the groups show differences in bias in false classifications?

The frequency of false rating of each emotion at each intensity was calculated (e.g., number of anger responses given to non-anger trials presented at 25% intensity; number of anger responses given to non-anger trials at 50% intensity; number of anger responses given to non-anger trials at 75% intensity and so on). These data might represent a bias towards the endorsement of particular emotions and this bias might be most apparent when the target stimuli are most ambivalent. (See Appendix 12, table F, for mean false identifications and SDs)

These data were evaluated using a mixed between and within subject ANOVA. The between subjects factor was group (BPD vs. MC vs. NC) and the within subject factors were emotion (surprise vs. fear vs. disgust vs. anger vs. sadness) and intensity level (25% vs. 50% vs. 75% vs. 100%). A significant Mauchley Sphericity Test was observed for both emotion (χ^2 =23.25; p <0.01), intensity (χ^2 =20.01; p <0.01) and the interaction between emotion and intensity (χ^2 =529.74; p <0.01). Accordingly, the Greenhouse-Geisser and Huyhn-Feldt corrections were employed when considering the significance of within-subjects effects.

A trend towards significance was observed in the three-way interaction between group vs. emotion vs. intensity ($F_{24,42}$=1.08; Greenhouse-Geisser adjusted p = 0.06 and Huyhn-Feldt adjusted p = 0.05). This interaction effect is depicted in Figure 3 (see p. 105). Overall, each of the groups showed a similar pattern of errors, at all the intensity levels for anger, fear, sadness and surprise. The groups equally demonstrated a response bias of incorrect endorsement of sadness when the stimuli were ambiguous (i.e., non-

sadness trials presented at 25%). However, the BPD group exhibited a significantly greater frequency of incorrect endorsement of disgust than did the MC and the NC group when the stimuli (i.e., non-disgust trials) were ambiguous and presented at 25% intensity ($F_{2,66}$=4.95;p=<0.01) and 50% intensity ($F_{2,66}$=3.51;p=<0.04). Multiple comparisons using Tukey's HSD confirmed that the BPD group manifested the highest tendency to over identify disgust in non-disgust trials compared with the NC group (p= 0.05) and the MC group (p=0.02).

Can the groups discriminate facial age?

A mixed design ANOVA was carried out to test whether the groups differed in their perception of facial age. The between subject factor was group (BPD vs. MC vs. NC) and the within subject factor was facial age (30 plates). The dependant variable was the mean rating given for each age category based on a scale of 1-10. (See Appendix 12, table G, for mean facial age ratings and SDs).

No significant main effect of group was found ($F_{2, 65}$= 1.687, p= 0.193), demonstrating that the three groups' judgement of facial age was comparable. This suggests that the BPD group did not have generalised deficits in face perception; they responded to the featural configurations of the face in a similar manner to the other two groups (see Figure 4, p.106).

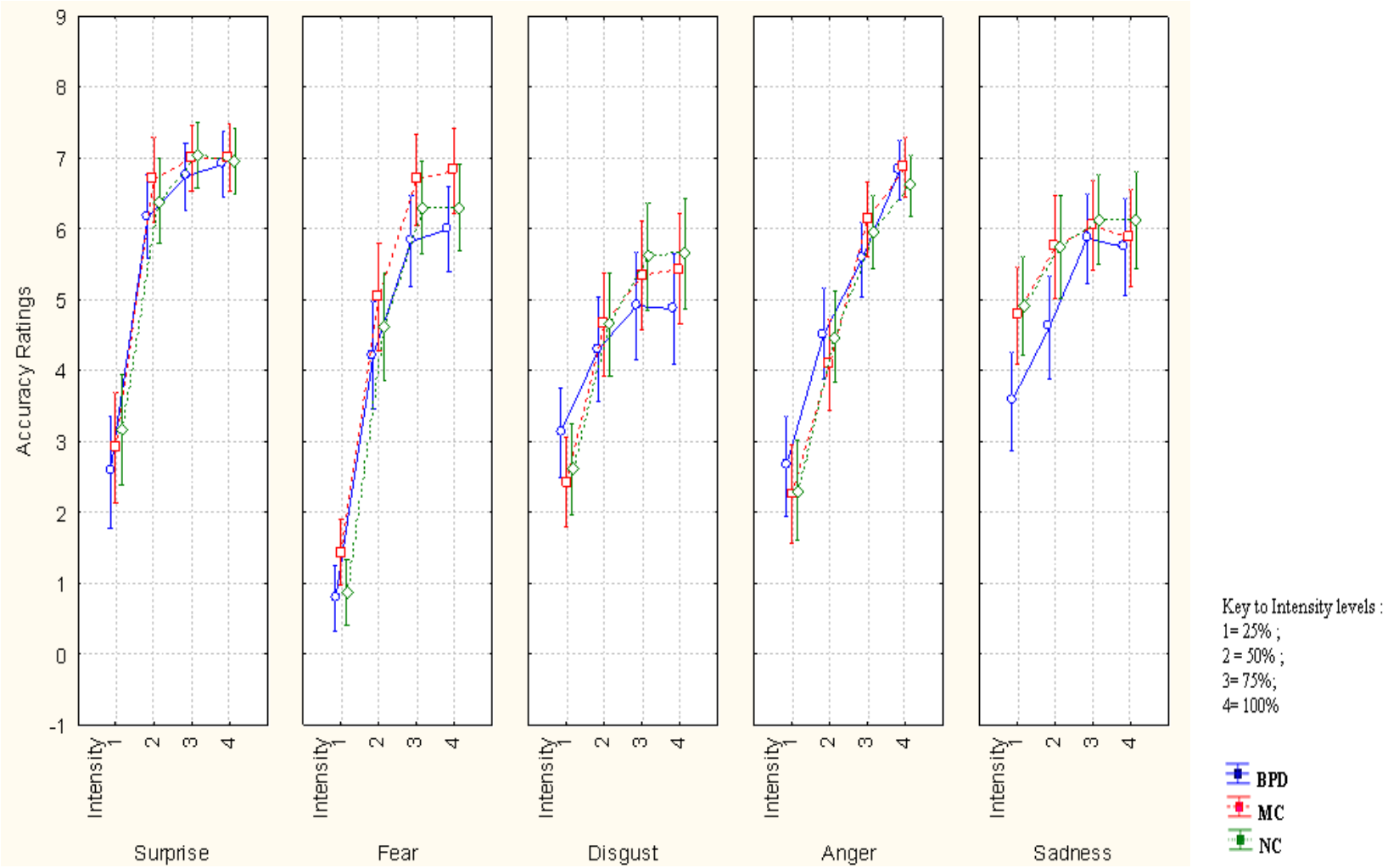

Figure 1: Mean accuracy ratings by group, emotion and intensity.

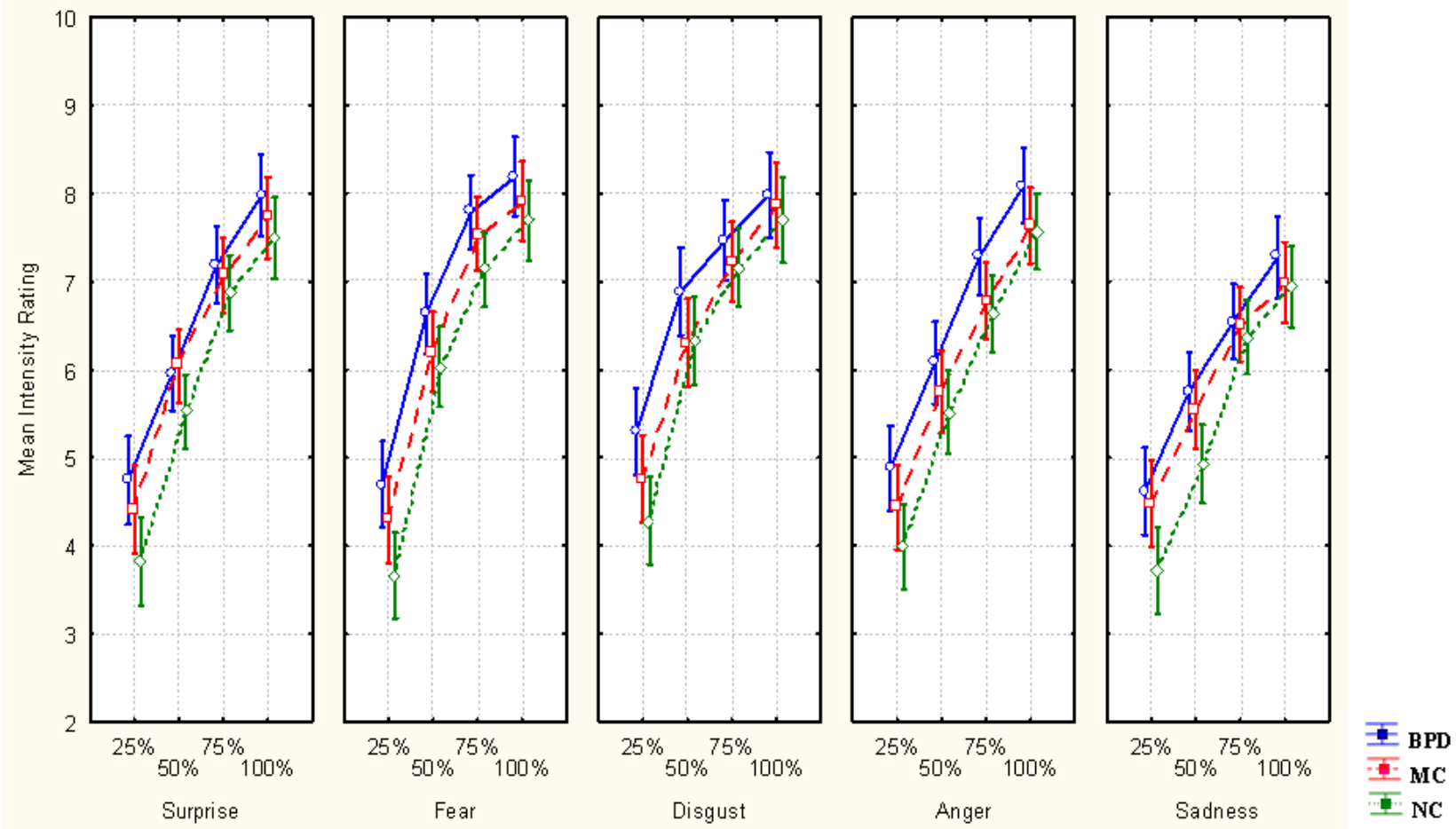

Figure 2: Mean intensity rating by group, emotion and intensity.

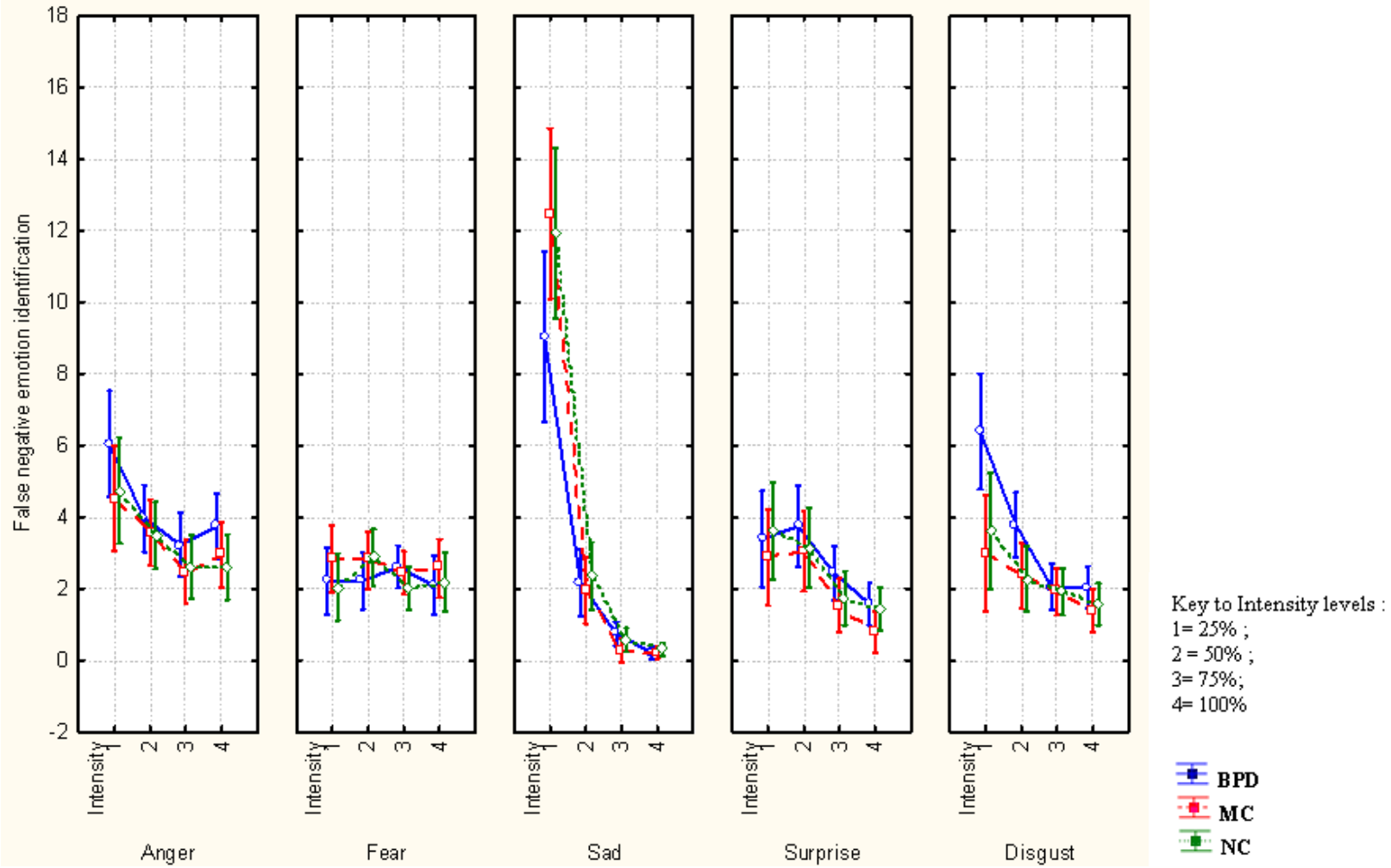

Figure 3: Mean false classification by group, emotion and intensity.

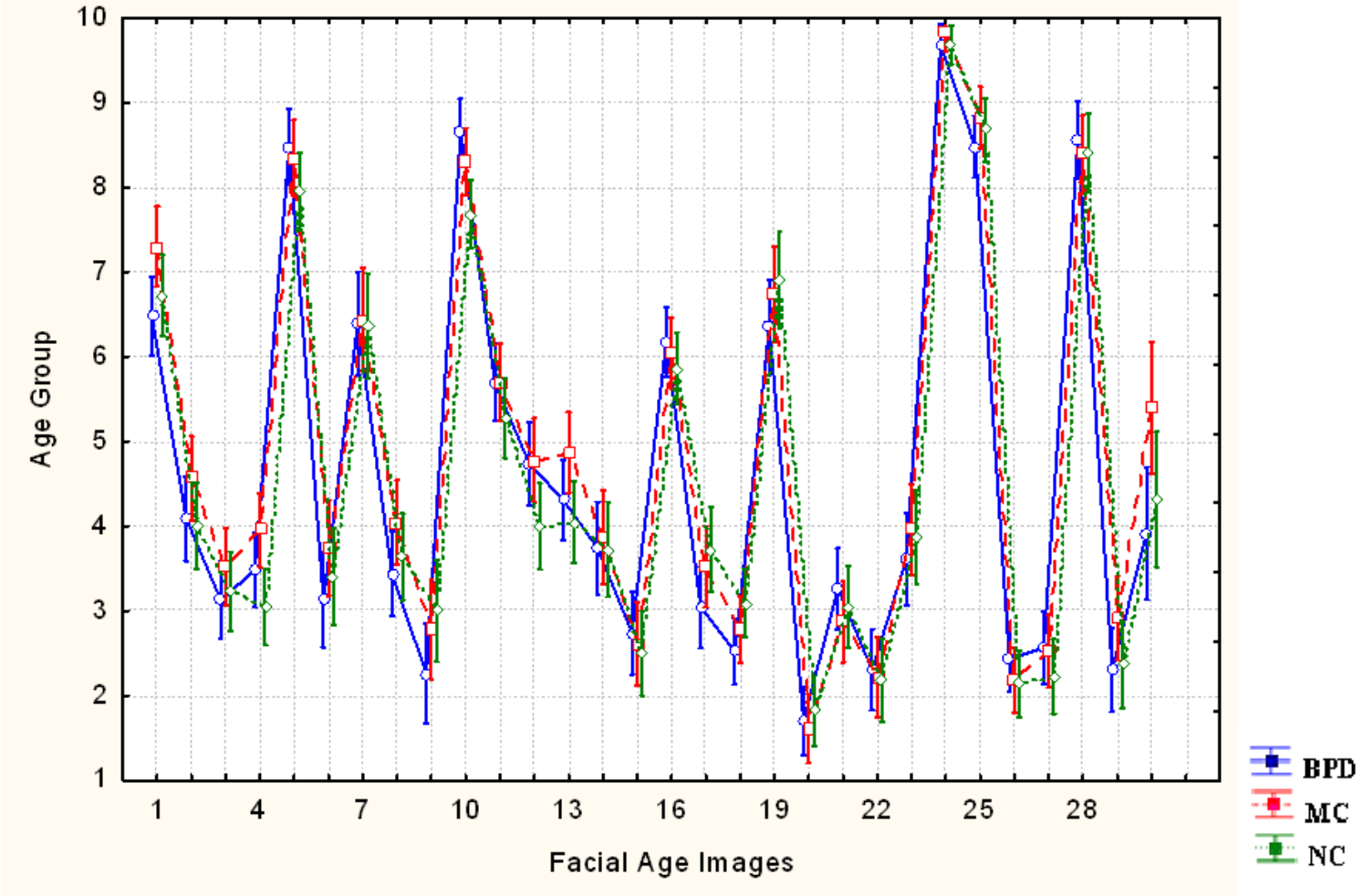

Figure 4: Mean ratings of facial age by group

Additional Analyses

Did the mood induction have lasting effects?

Given the supposition that differences in processing might be more pronounced under conditions of heightened arousal in BPD, additional analyses were carried out for the BPD group only. To ascertain whether the arousal induction procedure had produced negative affect, independent t-tests were performed on the mean ratings of the PFQ. Consistent with the results reported in table 5, these revealed that BPD participants in the arousal condition experienced more negative emotion, such as anger, anxiety, disgust, fear, sadness and shame, compared to those in the neutral condition (see Appendix 11, table A). Moreover, those in the neutral condition reported more positive emotion, such as happiness, compared to those in the arousal condition. Thus it seems that the arousal induction produced an immediate effect on the mood state of the BPD participants who had been allocated to that condition.

To establish whether the mood effect of the arousal condition was long lasting, independent t-tests were carried out on the PANAS "extent felt today" scales, which had been administered 40 minutes later at the end of testing. As shown in table C, Appendix 11, no significant differences were found. BPD participants in the arousal condition did not report more negative affect than those in the neutral condition on the PANAS-N "extent felt today" scale ($t_{21} = 1.01$; $p = 0.32$). Moreover, participants in the neutral condition did not report more positive affect on the PANAS-P "extent felt today" scale

(t_{21}= 0.54; p= 0.59). These results imply that the effect of the mood induction dissipated during the FER.

Did gender influence performance?

Since the literature indicates that females are superior to males in identifying facial expressions of emotion (Hall & Matsumoto, 2004), independent t-tests were conducted to gauge if gender influenced performance on the FER (i.e., accuracy and perceived intensity). As presented in the tables in appendix 13, no significant differences were observed between the male and female participants in this sample with regard to recognition accuracy and intensity ratings.

Discussion

The main aims of this study were firstly to examine if BPD individuals are prone to interpreting perceived emotion of others as hostile when the information is ambiguous, and secondly to examine if this inclination is exacerbated by emotional arousal. To do this, it was necessary to establish whether individuals with BPD were able to accurately identify emotion in the first instance. Additionally, it was essential to establish whether individuals with BPD had generalised deficits in face perception.

The results of this study indicate that there is considerable similarity in the way BPD, MC and NC participants rated facial emotion, intensity of emotional expression and facial age. Accurate performance on these tasks requires attention to relatively subtle

discriminative cues of facial configurations and features. These data suggest that this sample of BPD individuals were as attentive to facial information as were individuals with or without emotional distress. Therefore, there was no evidence that the BPD group had deficits in identifying facial emotion compared to the other groups. This finding was to some extent expected and concordant with that of Domes and others (2008) and Barnett-Veague (unpublished). It was also consistent with the findings of Mizenberg and others (2006), which suggest that recognition accuracy deficits are not evident in BPD individuals when they are processing emotional cues in isolation. However, it was contrary to studies that have shown both poorer recognition accuracy (e.g. Bland et al., 2004; Levine et al., 1997) and superior recognition accuracy (e.g., Lynch et al., 2006; Wagner & Linehan, 1999). Additionally, there was no evidence that BPD individuals had generalised deficits of face perception. Hence any differences found between the BPD group and the other groups were not likely to be attributable to a generalised perceptual deficit.

The specific prediction that BPD individuals would exhibit a bias towards anger and fear was not supported. Instead, the BPD group showed a specific response bias towards disgust, which was evident when the emotional stimuli were most ambiguous. Indeed, this finding has been replicated in a very recent study which reports that inpatient BPD participants over-attributed disgust to Ekman faces (Unoka, Fogd, Fuzy et al., 2011). This may be consistent with the hypothesis that BPD individuals are susceptible toward appraising others' emotion as hostile when the information is ambiguous. The evolutionary function of disgust is to avoid potentially contaminating substances (Rozin, Haidt & McCauley, 1993), but it can be argued that, within the interpersonal realm,

disgust has evolved as an adaptive process for the rejection of inappropriate partners or social contacts (Rozin, Haidt & McCauley, 1999). Thus facial expressions of disgust may convey social rejection and disapproval (Rozin, Lowry & Ebert, 1994, Marzillier & Davey, 2004). Seeing disgust in another's face may be an indication of a negative evaluation signalling that the target individual is socially undesirable and as a consequence has damaged a social connection. This may be especially relevant for borderline individuals given the supposition that "an internal feeling of well-being, stability and self–regulation in BPD is tenuous and may rely heavily on a sense of interpersonal contact and connectedness" (Stanley & Seiver, 2010, p. 24). Furthermore, disgust is closely related to contempt (Miller, 1997) and this resonates with the view that BPD individuals see themselves as inherently unacceptable (e.g., Pretzer, 1990), most likely because they have experienced an adverse emotional upbringing characterised by criticism and contempt (Rogosch & Cicchetti, 2005).

The hypothesis that the tendency to misinterpret others' emotion would be accentuated by emotional arousal was not verified. The mood condition showed no differences across the three groups. Additional analyses comparing BPD individuals undergoing the arousal induction and BPD individuals undergoing the neutral induction also failed to demonstrate effects. However there is a question as to whether the influence of emotional arousal was adequately tested. Although the arousal induction produced immediate effects, it seems that it was not sufficiently powerful to produce lasting effects. This observation is based on post briefing reports indicating that the effects of the arousal clip were short-lived, and further suggested by a measure of current subjective emotional state (the PANAS). Scores on the "felt today" scale indicated no

differences in either positive or negative mood between the arousal and neutral group, thereby suggesting that BPD participants in the arousal condition were no more emotionally distressed than those in the neutral condition. Therefore, the influence of emotional arousal on processing biases remains to be determined, and these results should be regarded with caution, pending replication.

A response bias towards disgust corroborates the assumption that BPD is associated with an anxious expectation of rejection in social situations presumably derived from feelings of unacceptability, and arguably self-disgust. Nonetheless, this specific result deviates from previous findings that indicate that BPD individuals are biased towards anger and fear (e.g., Barnett- Veague, unpublished; Dyck et al., 2008, Domes et al., 2008; Wagner & Linehan, 1999). The discrepancy between this study and previous studies may be due to variation in test stimuli and sampling.

Differences in the selection of test stimuli could explain the inconsistencies. For instance, Barnett- Veague (unpublished) only included fear, anger and happiness stimuli in her facial affect task, therefore disgust was not examined. Similarly, Dyck and others (2009) did not include disgust facial expressions in their investigation of a negative bias in BPD. They found a bias during fast discrimination on a time-limited, emotion recognition test that presented only anger, fear and neutral stimuli. Although Domes and others (2008) included disgust in their affect recognition task, the emphasis was on anger and fear. They incorporated disgust in blends of emotional expressions (e.g., 50% anger/50% disgust), but all the facial stimuli displayed blends of anger (i.e., anger to disgust, anger to sadness, anger to fear, anger to happiness etc.) and blends of fear (i.e.,

fear to disgust, fear to sadness, fear to anger etc.). Conceivably, greater exposure to anger and fear may have encouraged a set of responses favouring these emotions over disgust.

Differences in levels of clinical severity might further explain the disparities. Inadvertently, the present study mainly included BPD individuals who were well engaged in treatment. Those who were more impulsive with chaotic lifestyles did not manage to attend the experimental session, despite numerous attempts to reschedule. Such BPD individuals might be deemed more severely impaired since their level of symptoms would appear most disruptive to day to day functioning. It is therefore possible that the sample in this study does not represent the spectrum of the BPD population, many of whom are difficult to treat and non-compliant. At the same time, the sample in this study may represent a proportion of treatment-seeking BPD individuals who have been described as "attached" (Linehan, 1993). Such individuals "rarely drop out of therapy, have difficulties when their therapists go on vacation, and are afraid of termination from the beginning" (Linehan, 1993, p.130). It could be speculated that self-loathing and self-disgust might be especially pronounced in this type of individual with BPD and this may predispose them to reading disgust into others' faces when the stimuli are ambiguous.

Gender differences might account for the discrepant results. The current study included female and male participants but some studies (e.g., Barnett- Veague, unpublished; Domes et al., 2008; Wagner & Linehan, 1999) only recruited women because they have been reported to be more accurate than men at identifying emotional facial expressions (Hall & Matsumoto, 2004). However, gender is unlikely to account for disparities because the sample of men and women in the current study displayed

comparable performance in emotion recognition, perceived intensity, bias and facial age perception.

The most plausible explanation for the divergent findings relates to the heterogeneity of BPD pathology, reflected in the different clusters of symptomatology as well as the different rates of comorbidity with Axis I and Axis II disorders (Skodol et al., 2002). The heterogeneity found among those diagnosed with BPD suggests different groupings with distinctive clinical profiles (e.g., Lenzenweger, Clarkin, Yeomans et al., 2008). It might also imply different developmental routes or pathways to the disorder (e.g., Nigg, Silk, Stavaro et al., 2005), and different prognoses (e.g., Clarkin, 2006). Accordingly, it could be surmised that specific sub groups exhibit unique biases that preferentially process particular negative emotions (e.g., disgust) over others.

Limitations and future directions

A potentially serious limitation of the study is that the mood induction procedure might not have been effective. It seems likely that the arousal induction was not sufficiently powerful to produce lasting effects throughout the duration of the emotion recognition task. It is also probable that the neutral film clip may not have been amply potent to override any negative feelings the BPD participants may have been experiencing either prior to or during the testing session. Considering that individuals with BPD experience more frequent, intense and enduring negative emotions in daily life (Stiglmayr, Grathwol, Linehan et al., 2005), it is conceivable that a proportion of the BPD participants allocated to the neutral condition may have been in a state of distress prior to, and at the time of, testing. For such participants the neutral induction may have made little difference to their mood state.

Therefore, the influence of emotional arousal on processing biases remains to be established. Clarifying this issue is important given the emerging consensus that emotional arousal within an interpersonal context, is a central aspect to understanding BPD pathology (e.g., Clarkin, 2006; Fonagy & Bateman, 2008; Stanley & Seiver, 2010). It seems that negative affect invades information processing and in turn shapes the organisation of the BPD individual's interpersonal experience. It would therefore be worthwhile replicating this study using a more powerful mood induction technique. Combination mood induction procedures have been cited as the most effective ways of inducing negative mood states (Westerman et al., 1996). Future investigators might employ a piece of music that successfully induces a negative mood state (e.g., Prokofiev's "Russia under the Mongol Yoke" at half speed) in conjunction with a recall task involving a distressing, personal memory.

Time pressure was not taken into consideration in this study. This may potentially be an important factor because real life social interactions typically require very rapid recognition of facial emotional expressions. Some investigators have proposed that BPD individuals take a relatively longer time to adequately process social information (e.g., Dyck et al., 2009; Mizenberg et al., 2006). Thus it is possible that the BPD group in this sample may have taken longer than the other two groups to identify the emotion, and this may have masked the findings, resulting in fewer errors. To clarify whether a bias is more likely to be apparent under time pressure (e.g., Dyck et al., 2009), future studies might employ emotion recognition tasks that vary the processing time available to participants.

Severely impaired BPD individuals did not manage to attend the testing session so the present study mainly included BPD individuals who were well engaged in treatment, hence presumably less impaired. This could be a potential weakness because the level of severity might impact on the ability to process emotional information and thus serve as a basis for differentiation among patients for research. To ascertain if a bias is more evident with increasing levels of severity, future studies might endeavour to compare BPD individuals who are treatment –seeking to those who are difficult-to-engage. Considering the high rates of childhood abuse in BPD, it might also be useful for future studies to examine the differences between BPD patients with and without a history of childhood abuse.

To gauge whether the findings would be unique to BPD and to consider the possible effects of common comorbidities, the clinical comparison group in this study comprised individuals with a variety of clinical conditions that are comorbid with BPD (i.e., PTSD, anxiety, depression). However, future studies should endeavour to include a "cleaner" clinically relevant comparison group, such as a PTSD group or a Social Anxiety group. They should also strive to include relevant psychopathology comparison Axis II groups such as Avoidant Personality Disorder and Paranoid Personality Disorder, since these conditions may also be characterised by a tendency to attribute malevolence to others.

An inherent shortcoming of the current study, which also extends to the majority of clinical research in BPD, relates to the problem with the classification system for BPD, which uses a categorical approach. The polythetic DSM-IV definition of BPD selects a

heterogeneous group of patients. Additionally, there is extensive comorbidity on Axis I and Axis II. Consequently, the picture is confused and this hampers research since it is difficult to make valid comparisons across studies. Efforts to resolve the heterogeneity have focussed on identifying meaningful sub-types (e.g., Clarkin, Hull & Hurt, 1993). Thus it might be profitable if future studies include groupings of BPD by salient behavioural dimensions, such as dysregulated affect, impulsivity, cognitive perceptual impairment and impaired relationships (e.g., Zanarini, Gunderson, Frankenberg et al., 1990). This may help clarify questions such as whether different "sub-groups" respond differently to certain negative emotions.

Another potential shortcoming is that the cohort was relatively small, even if comparable in size with a number of studies examining emotion recognition in BPD (e.g., Donegan et al., 2003; Dyck et al., 2009; Lynch et al., 2006; Wagner & Linehan, 1999). Based on the convention of describing effect sizes (Cohen, 1988), it had been calculated that 90 participants (i.e., 30 per group) were required to detect a large experimental effect size ($1-\beta = 0.80$; $\alpha = 0.05$; mixed between and within subject ANOVA with six between cells). Although 96 individuals had been recruited and tested, only 69 participants (i.e., 23 per group), were included in the study because a substantial number of participants needed to be excluded from the analysis to ensure that the three groups were distinct (see pp. 82-83 for details). Consequently, the study may be underpowered so future studies should endeavor to recruit a larger sample.

Unlike most of the emotion recognition studies in BPD, the present study included disgust in the selection of test stimuli. Future studies, however, might further

benefit from examining a wider range of emotions that may be associated with threat to social connection. In addition to primary emotions, it may be informative to include facial expressions of secondary emotions that may be closely linked with rejection, such as contempt. An expression of contempt, for instance, signals rejection without the possibility for reconciliation; it is dismissive, and conveys hatred as well as a lack of interest in establishing a social relationship (Darwin, 1872/1998). With the advances in the neurosciences, it could be additionally informative to examine the response to the different emotions at a neural level. For instance, facial expressions of disgust have been shown to activate the insula and prefrontal cortex (Calder, Keane, Manes et al., 2000; Phillips, Young, Senior et al., 1997). Disgust sensitivity may reflect a dysfunction or over-activation of the insula or prefrontal cortex (Surguladze, El-Hage, Dalgleish et al., 2010). Thus, the pattern of over attributing disgust may serve as a behavioural index that taps into a biological irregularity.

Finally, whilst emotional facial expressions are highly salient interpersonal social stimuli since the face is the primary canvas used to express emotion (Ekman, 1965), there is also scope for research that strives towards even more naturalistic paradigms of social cognition. Everyday social interaction is multifaceted and dynamic and people rely on more than one sensory modality when making inferences about others' emotional states. Employing multimodal tasks that integrate visual and prosodic/auditory sensory features (e.g. Mizenberg et al., 2006) may enable future investigators to simulate experimental settings that more closely approximate day-to-day social exchanges.

Conclusion and clinical implications

In summary, the sample of individuals with BPD in this study exhibited a specific response bias towards disgust when the emotional information was ambiguous, compared to a mixed clinical and normal control group. That is, they misidentified disgust in non-disgust facial expressions when they were presented at low intensities. Although unexpected, this finding may be interpreted as a negativity bias towards social rejection and therefore compatible with prominent theoretical accounts of BPD that emphasise a preoccupation with abandonment and rejection. However, given the relatively small cohort and the relatively few findings of this nature, as well as the possibility that the findings are representative of a sub-group of "treatment –seeking" BPD individuals, it would be prudent if future research replicated this study with a larger sample and a different set of participants, grouped by relevant behavioural dimensions. Further, given the conjecture that differences in processing biases might be more apparent under conditions of heightened arousal, it would be important for future research to replicate this study with more effective mood elicitation procedures.

A negative response bias favouring interpersonal rejection potentially has a number of clinical implications. As a start, it might serve as a behavioural measure that facilitates the assessment of BPD. A negative attributional bias of facial affect appears to tap into a biological irregularity, emotion dysregulation, which is an important defining feature of BPD. Misreading facial affect has been linked to dysfunctions in limbic circuits mediating affect regulation and such a disturbance might be a more reliable indicator of this complex, multifaceted disorder. However, a neural disturbance would not be easily detected without access to a fMRI scanner, which would be impractical for routine

clinical assessment. Furthermore, such a procedure is expensive as well as invasive so it might not be easily tolerated by highly anxious individuals. Hence a behavioural marker, such as a negativity bias manifested by patterns of errors in reading facial affect, may be a viable alternative for every day clinical practice.

The degree of the negativity bias might also potentially serve as a behavioural outcome measure. If future research established that a negative attributional bias of facial affect was a reliable and valid behavioural test of a key biological irregularity in BPD, it could be used to gauge the extent to which psychological intervention alleviates an underlying problem, such as emotion dysregualtion.

Finally, the presence of a negativity bias toward social rejection may guide treatment focus. Interventions that focus on the labelling and differentiation of negative emotions, and on the cognitive reappraisal of emotional states in others, such as dialectical behaviour therapy (Linehan, 1993) and mentalization therapy (Bateman & Fonagy,2004), might be beneficial in enhancing interpersonal functioning in BPD. As regards the specific finding of the current study, a response bias toward disgust raises questions about the role of disgust in BPD. Besides emotions such as anger or fear, disgust may contribute to emotion dysregulation in BPD. Moreover, it may be a key emotion and target for treatment (Rusch, Schultz, Valeruis et al., 2010). Reading disgust in others may be interpreted as a cue of potential rejection, and a propensity to over-classify it might strengthen feelings of interpersonal rejection and thereby fuel and maintain turbulent relationships in BPD. Addressing self- disgust could potentially reduce sensitivity to disgust and, in turn, contribute towards ameliorating interpersonal

relationships. Thus interventions targeting a disgust-prone self concept may be an additional beneficial component in the treatment of BPD.

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List of Appendices

APPENDIX 1

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BORDERLINE PERSONALITY DISORDER AND EMOTIONAL INFORMATION PROCESSING

Background

Borderline Personality Disorder (BPD) is a severe and disabling chronic clinical condition that is not adequately managed by mental health services generally, and therefore associated with substantial social costs. Individuals with BPD pose a suicide risk of almost 50 times higher than the general population and are amongst the most frequent consumers of mental health services. Despite the sizeable empirical and theoretical attention that has been devoted to BPD, this disorder is not easily identifiable, nor is it well understood. Making matters more complicated, individuals with BPD can be difficult to engage and they can often make high demands on the emotional resources of the mental health professionals responsible for their care. Clinicians describe this client group as one of the most difficult and testing to treat, with a substantial proportion admitting they do not feel equipped to work with this clinical population. Given the complications of managing this group, developing more reliable and effective ways of identifying and treating BPD is important and necessary.

Literature review: Is Borderline Personality Disorder associated with characteristic styles of processing emotional information? What is the evidence and its significance?

Interpersonal difficulties, including problems in forming and maintaining relationships, figure prominently in BPD. This paper addresses whether vulnerability in interpersonal relationships in BPD may be related to biases in processing emotionally salient information. It considers the predictions that prominent models of BPD would make in terms of processing emotional information and surveys the literature to establish whether BPD individuals are characterised by an attention bias, an interpretation bias, a memory bias, or all three.

Despite mixed findings, taken together the evidence suggests that BPD individuals preferentially attend to emotionally threatening information, but whether this is the result of hypervigilance towards threat, difficulty shifting attention away from threat, or both, is unclear. Moreover, it is unclear whether the attention bias is specific to "borderline" congruent information or whether it is generalised to all negative emotional cues. Further research is required to clarify this issue. The range of studies examining an interpretation bias suggests that BPD individuals tend to appraise and interpret others as rejecting when the emotional information is ambiguous. Research on memory bias is still young and the findings too inconsistent to draw conclusions.

Methodological limitations are considered and suggestions for future studies are made.
The value of establishing whether processing biases are associated with BPD is that this may lead to a better understanding of what fuels and maintains turbulent interpersonal relations. Cognitive biases may also provide clues that refine assessment and treatment.

Research paper: Emotion Recognition in Borderline Personality Disorder

Aims and hypotheses: This study investigates how BPD individuals read other people's emotional facial expressions. It questions whether individuals with BPD are prone to interpreting perceived emotion in others as malevolent when the emotional information is ambiguous.

Additionally, it considers the impact of heightened emotional arousal on emotion recognition. The predictions of this study are linked to the notion that emotional dysregulation (a psychobiological dimension) is at the core of most of the symptoms of BPD and tie in with a number of prominent models of BPD (e.g. Linehan, 1993; Fonagy & Bateman, 2008) that have linked emotional dysregulation to a hypersensitivity to interpersonal cues signalling threat of rejection and abandonment, and an expectation of hostility from others.

Method: Individuals with BPD (n=23) were compared to a mixed clinical group without BPD (n=23) and a normal control group (n=23). Facial emotion recognition was assessed by using a computerized, facial emotion recognition task, in which participants identified five emotions (anger, sadness, fear, surprise and disgust) presented at four varying intensities (25%, 50%, 75% and 100%). To examine the influence of emotional arousal on emotion recognition, participants underwent one of two mood elicitation procedures in which they watched one of two 3-minute film clips designed to induce either an aroused mood or neutral to pleasant mood. To rule out the possibility of a generalized deficit in face perception, a facial age control task was included, in which participants estimated the age groups of a series of pictures of faces.

Results: BPD participants did not display any difficulties in identifying facial emotional expressions compared to the mixed clinical and normal control groups. Nor did they show any difficulties in estimating the age groups of the pictures of faces compared to the mixed clinical and normal control groups, suggesting that they did not have generalised deficits in face perception. However, the BPD participants did exhibit a specific response bias toward disgust when the information was ambiguous, compared to the mixed clinical and normal control group. That is, they misidentified disgust in non- disgust facial expressions when they were presented at low intensities. Participants in the emotional arousal condition did not perform differently to those in the neutral to pleasant mood condition, suggesting that arousal did not influence emotion recognition. There is, however, a question as to whether the influence of emotional arousal was adequately tested since analyses indicated that the mood induction may not have been effective, so these results should be regarded with caution, pending replication.

Conclusion: The results of this study are consistent with a negativity bias toward social rejection and therefore compatible with prominent theoretical accounts of BPD. A negative response bias favouring interpersonal rejection potentially has important clinical implications. It might serve as a behavioural measure that facilitates assessment by tapping into a biological irregularity, emotional dysregulation, which is an important defining feature of BPD. It might also serve as a behavioural outcome measure indicating the extent to which psychological intervention alleviates an underlying problem, such as emotional dysregulation. Finally, it may inform treatment. Interventions that focus on labelling and differentiating negative emotions, and on understanding the emotional states of others, might enhance interpersonal functioning in BPD. Further, the specific finding of the current study suggests that disgust may be a key emotion and target for intervention. Addressing self disgust may be an additional beneficial component in the treatment of BPD since it might reduce sensitivity to disgust and, in turn, contribute toward ameliorating the quality of interpersonal relationships.

APPENDIX 2

Participant number:___

BACKGROUND QUESTIONNAIRE

Please tell us the following information by filling the answer in the space provided or by drawing a circle around the appropriate answer.

1) How old are you? (in years) _____ 2) Are you male of female? _____

3) How would describe your ethnic origin? _____

4) How many years of formal education have you completed? _____

5) Have you ever been diagnosed with a major mental illness? YES/NO
(e.g. schizophrenia or bipolar disorder)

6) Have you ever received any psychiatric treatment? YES/NO
If yes, please provide details_____

_____

7) Are you currently taking medication? YES/NO
If yes, what is the name of the medication and how long have you been taking it? _____

_____

8) Have you ever received any psychological treatment? YES/NO
If yes, please provide details_____

_____

9) Have you ever experienced difficulties with your use of drugs or alcohol? YES/NO

10) Did you experience an abusive or traumatic childhood? YES/NO

11) Do you have difficulty relating to others? YES/NO
12) Do your relationships tend to be stormy? YES/NO
13) Do you get so angry you cannot control your temper? YES/NO
14) Do your family or friends say you are moody? YES/NO

15) Do you sometimes lose sight of who you are because you can change so much from situation to situation? YES/NO

16) Do you often suffer from low mood? YES/NO
17) Are you impulsive? YES/NO

Thank you for completing this questionnaire. The information provided will be treated with the strictest confidence.

APPENDIX 3

Exclusion criteria and cut-offs on screening measures

BPD GROUP:

- Score <6 on DIB-R
- No indication of anger problems on the BPAQ (see below)
- No indication of relationship problems on the IIP (see below)
- Current substance abuse (see BQ 9)

NORMAL CONTROL GROUP:

- Yes to BQ 9 and to any two of the following: BQ 10; BQ 11; BQ 12; BQ 13; BQ 15; BQ 16; BQ 17
- Anyone scoring above 13 on the BDI
- Anyone scoring above the following on the BPAQ:

	Women	Men
Physical	25	33
Verbal	18	20
Anger	27	23
Hostility	23	28

- Anyone scoring above the following cut offs on the PANAS
  Today Negative -24
  General Negative -23

- Anyone scoring score > 70 on more than 2 of the following domains on the IIP:
  Domineering/Controlling
  Vindictive/Selfish
  Cold/Distant
  Socially Inhibited
  Non-assertive
  Overly accommodating
  Self-sacrificing
  Intrusive needy

MIXED CLINICAL GROUP

- Yes to BQ 9 and to more than any two of the following:; BQ 11; BQ 12; BQ 13
- Anyone scoring above the BPAQ cut offs (see above)
- Anyone scoring score > 70 on any 2 of the following IIP domains: Domineering/Controlling; Vindictive/Selfish; Socially Inhibited; Intrusive needy

APPENDIX 4

Pilot study:
The effect of the arousal mood induction procedure

Example of Post Film Questionnaire
(Rottenberg, Ray & Gross, 2007)

The effect of the arousal mood induction: Descriptive statistics on Post Film Questionnaire (PFQ) Ratings

The effect of watching the film clip from "Girl Interrupted" was piloted on a small group comprising of individuals working in the psychology department (3 secretaries, 3 psychologists, 3 research assistants) and five service users with a diagnosis of BPD. Participants rated the extent to which they had experienced each of the emotions listed in the PFQ on a 9-point scale, ranging from 0 (not at all) to 8 (a great deal). Table A shows the mean ratings of each of the emotions experienced whilst watching the clip. As indicated, positive emotions such as amusement, happiness and joy all had a mean score below one, suggesting that these emotions were hardly experienced at all. Emotions of anxiety, confusion , fear, sadness and unhappiness all had a mean score of above four , suggesting that these emotions were experienced "some what" or above. Every participant experienced anxiety and fear with minimum scores of four and two respectively. Maximum scores of eight were recorded for anxiety, fear and unhappiness, suggesting that some participants experienced these emotions to "a great deal".

In addition to rating which emotion was felt during the clip, participants also rated the extent to which they felt "pleasant" throughout the clip, on a 9-point scale, ranging from 0 (unpleasant) to 8 (pleasant). As indicated in figure A, the mean score was 2.29, which was towards the unpleasant end of the continuum. The minimum score given was zero and the maximum was four, which is the exact midpoint in the scale between unpleasant and pleasant.

Table A – The effect of arousal induction on immediate mood: Pilot group PFQ ratings (n=14)

Emotion	Frequency	Mean	SD	Minimum	Maximum
Amusement	13/14	0.77	0.23	0.00	1.00
Anger	13/14	2.69	1.32	0.00	4.00
Anxiety	14/14	5.71	1.33	4.00	8.00
Confusion	14/14	4.07	2.30	0.00	7.00
Contempt	13/14	1.08	1.32	0.00	3.00
Disgust	13/14	1.15	1.91	0.00	6.00
Embarrassment	13/14	0.77	1.54	0.00	4.00
Fear	14/14	5.36	1.65	2.00	8.00
Guilt	13/14	1.08	2.14	0.00	6.00
Happiness	13/14	0.08	0.28	0.00	1.00
Interest	13/14	4.85	2.12	0.00	7.00
Joy	13/14	0.08	0.28	0.00	1.00
Love	13/14	0.85	1.52	0.00	4.00
Pride	13/14	0.00	0.00	0.00	0.00
Sadness	13/14	5.31	2.06	0.00	7.00
Shame	13/14	1.31	1.80	0.00	4.00
Surprise	13/14	3.46	2.37	0.00	7.00
Unhappiness	13/14	4.15	2.64	0.00	8.00

Figure A – Pleasantness scale ratings

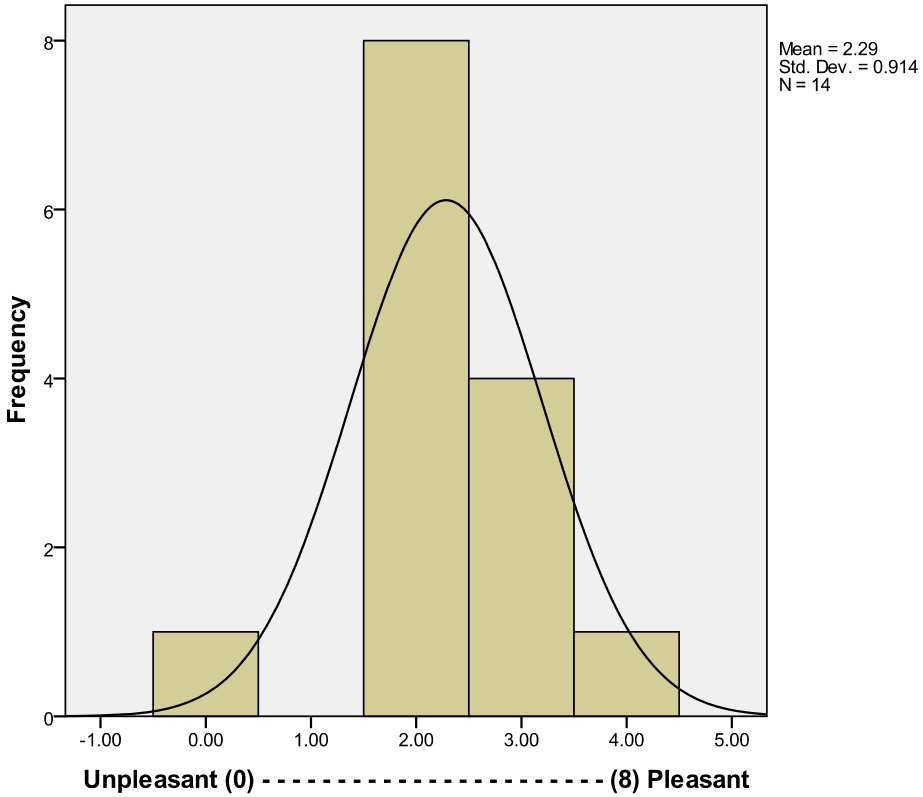


Table B, shows the frequency and percentage of how pleasantness was scored by the participants. As indicated, thirteen participants (98.2%) scored between numbers one to three on the pleasantness scale.

Table B – Ratings on pleasantness scale

Score	Frequency	Percent
1 (unpleasant)	1	7.1
2	8	57.1
3	4	28.6
4	1	7.1
Total	14	100.0

In summary, the results of the pilot suggested the film clip “Girl Interrupted” (Mangold, 1999) was sufficiently emotionally arousing, inducing unpleasantness together with feelings of fear, anxiety and sadness.

Example of PFQ by Rottenberg, Ray & Gross (1997).

POST-FILM QUESTIONNAIRE

The following questions refer to how you felt while watching the film

0	1	2	3	4	5	6	7	8
not at all/ none				somewhat/ some				extremely/ a great deal

Using the scale above, please indicate the greatest amount of EACH emotion you experience while watching the film.

_____ amusement	_____ embarrassment	_____ love
_____ anger	_____ fear	_____ pride
_____ anxiety	_____ guilt	_____ sadness
_____ confusion	_____ happiness	_____ shame
_____ contempt	_____ interest	_____ surprise
_____disgust	_____ joy	_____ unhappiness

Did you feel any other emotions during the film? No Yes

If so what was the emotion?_____

How much of this emotion did you feel? _____

Please use the following scale to rate how pleasant you found the film. Please circle your answer:

0 1 2 3 4 5 6 7 8

Unpleasant Pleasant

Had you seen this film before? No Yes

Did you close your eyes or look away during any scenes? No Yes

APPENDIX 5 - Adapted PFQ

POST-FILM QUESTIONNAIRE

The following questions refer to how you felt while watching the film clip

0	1	2	3	4	5	6	7	8
not at all/ none				somewhat/ some				extremely/ a great deal

Using the scale above, please indicate the greatest amount of EACH emotion you experience while watching the film.

_____ Amusement

_____ Anger

_____ Anxiety

_____ Disgust

_____ Fear

_____ Happiness

_____ Sadness

_____ Shame

Did you feel any other emotions during the film? No Yes

If so what was the emotion?_____

How much did you feel? _____

Please use the following scale to rate how pleasant you found the film. Please circle your answer:

0 1 2 3 4 5 6 7 8

Unpleasant Pleasant

Had you seen this film before? No Yes

Did you close your eyes or look away during any scenes? No Yes

APPENDIX 6

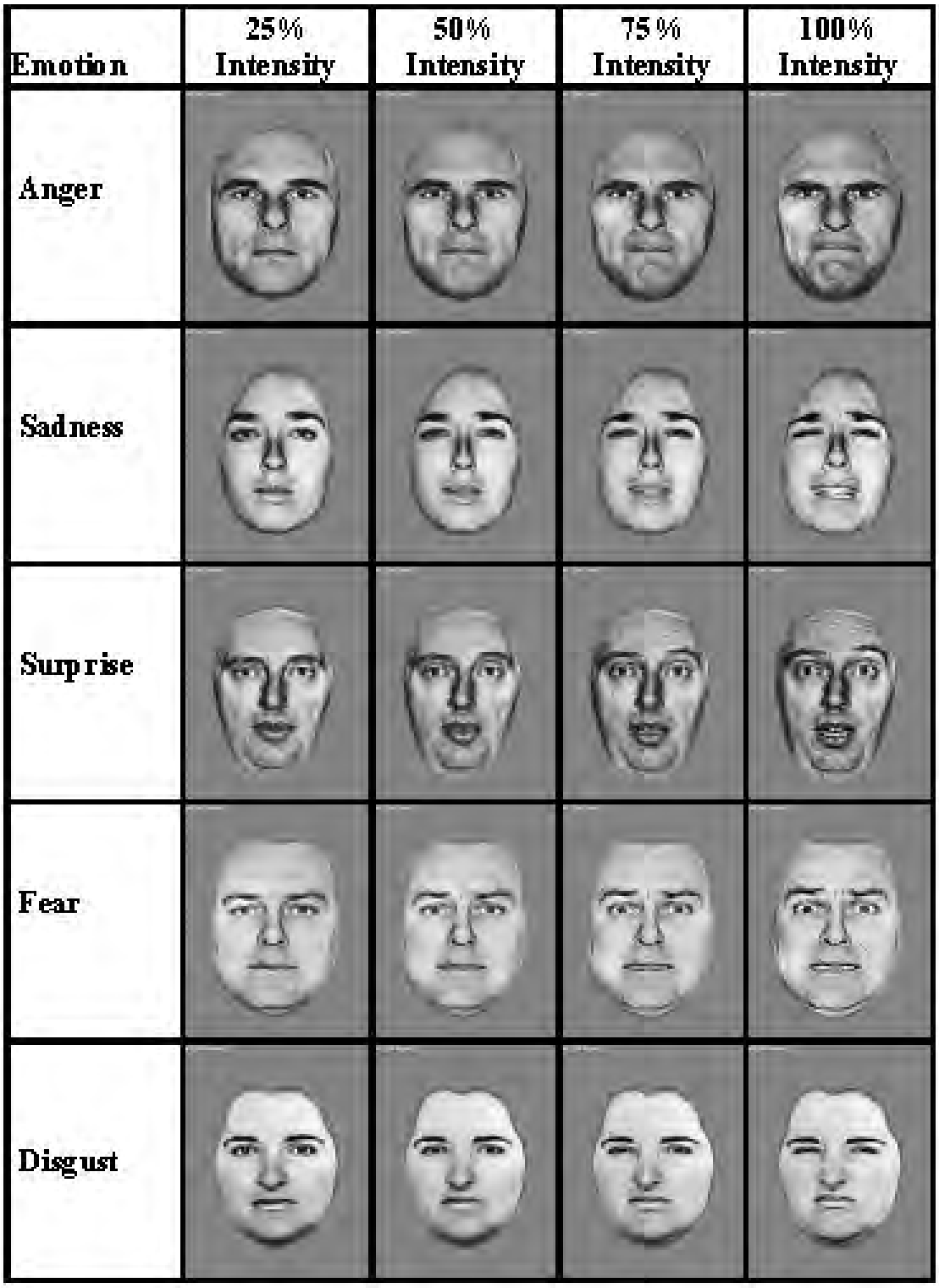


Figure A: Examples of facial stimuli for each emotion at each intensity

APPENDIX 7

Facial Age Perception (FAP) task

Example of facial stimuli

Example of card listing age brackets

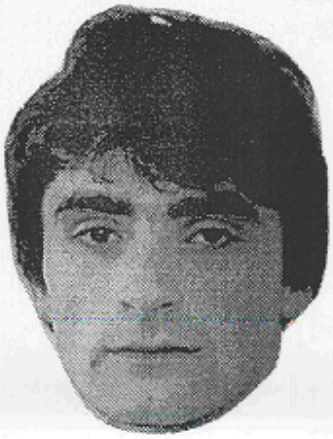
Example of rating form

EXAMPLE OF FAP STIMULI

Example of facial age stimuli - Plate 1

Example of facial age stimuli - Plate 2

Example of facial age stimuli - Plate 4



SAMPLE OF CARD WITH AGE BRACKETS

Age 15-19	1
Age 20-24	2
Age 25-29	3
Age 30-34	4
Age 35-39	5
Age 40-44	6
Age 45-49	7
Age 50-54	8
Age 55-59	9
Age 60+	10

SAMPLE OF RATING FORM

Participant number_____

FACIAL AGE

Face no.	Age bracket (0-1)
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
11	
12	
13	
14	
15	
16	
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APPENDIX 8

Confirmation of ethics approval

Confirmation of Trust Research and Development approval

APPENDIX 9

Consent form and Patient Information Leaflets

Leaflet for BPD participants
Leaflet for MC participants
Leaflet for NC participants

UNIVERSITY OF BIRMINGHAM

School of Psychology

CONSENT FORM

Study title: Emotion Recognition in Borderline Personality Disorder

Researcher: Rita Intili, Consultant Clinical Psychologist

Participant number: _____

If you agree to be part of this study please tick the boxes below and sign at the bottom.

I have read the information sheet for the above study and understand it.

I agree to take part in the study and understand that my participation is voluntary.

I understand that I am free to withdraw from the study without my treatment being affected.

I understand that I am free to withdraw from the study without my legal rights being affected.

_____	_____	_____
Participant's name	Date	Signature
_____	_____	_____
Researcher's name	Date	Signature

UNIVERSITY OF BIRMINGHAM

School of Psychology

INFORMATION SHEET

Study title: Emotion Recognition in Borderline Personality Disorder

An invitation

You are invited to take part in a study that will help us to gain a better understanding of Borderline Personality Disorder (BPD). This study aims to investigate how individuals with BPD understand emotion compared to individuals who have experienced trauma and individuals who have not experienced trauma. We are currently recruiting individuals with a diagnosis of BPD and are wondering if you would be interested in participating in this study.

Rita Intili, Consultant Clinical Psychologist, is conducting this study, as part of her doctoral research, in collaboration with the University of Birmingham and the University College London. Please take time to read this information sheet and do not hesitate to discuss this with your family, friends, key worker or doctor. If there is anything that is not clear, please feel free to request further information at any time.

What is the study about?

This study aims to look at how individuals with a diagnosis of Borderline Personality Disorder (BPD) understand emotions. We know from our clinical experience and from previous research that there are differences between people in the way they react to emotional facial expressions. We also know that different reactions to expressions of feeling may influence how we interact with others. Since interactions with others are a particular area of difficulty for individuals with BPD, we wonder if responses to facial expression may be related to BPD. We would therefore like to investigate this by looking at how individuals with a diagnosis of Borderline Personality Disorder respond to facial expressions compared to 2 other groups: individuals who have experienced trauma and individuals who have not experienced trauma.

The National Research Ethics Service has approved this study.

What is the potential benefit of this study?

Individuals with BPD will know that it is a complex condition and that recognising and treating it is not always straightforward. It is hoped that this study may help us to gain a better understanding of BPD, and that this in turn will lead to more effective assessment and intervention.

What if you decide to participate?
If you decide to take part in this research, you will be asked to complete and sign a consent form. Since your participation is voluntary, you may withdraw from the study at any time without explanation. If you choose not to participate there will be no consequences, as this will in no way affect your treatment. If you decide to participate, the tasks that you will perform in the study will in no way interfere with treatment.

What is involved in the study?
The study will involve coming along to 2 separate sessions, each lasting about 1 hour. In the first session you will be given an interview that will assess the presence of symptoms of BPD. In the second session you will be asked to watch a 4-minute film clip and then rate how you feel. You will then be asked to perform 2 tasks requiring you to look at a series of faces. In the first task the faces will be presented on a computer screen and you will be asked to indicate what feeling the face is expressing. In the second task you will look at photographs of faces and you will be asked how old you think the face is. Finally you will be required to complete 4 questionnaires that will ask about your mood and how you relate to others in some detail.

What happens to the information collected?
All the information that is gathered will be kept strictly confidential under lock and key. No information will have names and it will be analysed on a group rather than individual basis. If any of this material is published, your identity will not be revealed. If you are interested in the findings, you can request a copy of the research findings from the main researcher whose contact details are below.

What safeguards are in place?
There are no foreseen risks involved and the researcher will ensure that you are not exposed to any physical or emotional upheaval. You will be provided with a contact number of the researcher should you have further questions.

Contact Details
If you are interested in participating in this study, or you would like further information before making a decision, please contact Rita Intili on [redacted] or via email: [redacted]

Thank you for taking time to read this information.

Rita Intili
Consultant Clinical Psychologist
[redacted]

UNIVERSITY OF BIRMINGHAM

School of Psychology

INFORMATION SHEET

Study title: Emotion Recognition in Borderline Personality Disorder

An invitation

You are invited to take part in a study that will help us to gain a better understanding of Borderline Personality Disorder (BPD). This study aims to investigate how individuals with BPD understand emotion compared to individuals who have experienced trauma and individuals who have not experienced trauma. We are currently recruiting individuals who have experienced trauma to be part of the comparison group and are wondering if you would be interested in participating in this study.

Rita Intili, Consultant Clinical Psychologist, is conducting this study, as part of her doctoral research, in collaboration with the University of Birmingham and the University College London. Please take time to read this information sheet and do not hesitate to discuss this with your family, friends, key worker or doctor. If there is anything that is not clear, please feel free to request further information at any time.

What is the study about?

This study aims to look at how individuals with a diagnosis of Borderline Personality Disorder (BPD) understand emotions. We know from our clinical experience and from previous research that there are differences between people in the way they react to emotional facial expressions. We also know that different reactions to expressions of feeling may influence how we interact with others. Since interactions with others are a particular area of difficulty for individuals with BPD, we wonder if responses to facial expression may be related to BPD. We would therefore like to investigate this by looking at how individuals with a diagnosis of Borderline Personality Disorder respond to facial expressions compared to 2 other groups: individuals who have experienced trauma and individuals who have not experienced trauma.

The National Research Ethics Service has approved this study.

What is the potential benefit of this study?

BPD is a complex condition that is not always easily recognised or managed. With your participation, this study may help us gain a better understanding of BPD, and lead to more effective assessment and intervention.

What if you decide to participate?
If you decide to take part in this research, you will be asked to complete and sign a consent form. Since your participation is voluntary, you may withdraw from the study at any time without explanation. If you choose not to participate there will be no consequences, as this will in no way affect your treatment. If you decide to participate, the tasks that you will perform in the study will in no way interfere with treatment.

What is involved in the study?
You will initially be asked to watch a 4-minute film clip and then rate how you feel. You will then be asked to perform 2 tasks requiring you to look at a series of faces. In the first task the faces will be presented on a computer screen and you will be asked to indicate what feeling the face is expressing. In the second task you will look at photographs of faces and you will be asked how old you think the face is. Finally you will be required to complete 4 questionnaires that will ask about your mood and how you relate to others in some detail. The study takes approximately 1 hour to complete.

What happens to the information collected?
All the information that is gathered will be kept strictly confidential under lock and key. No information will have names and it will be analysed on a group rather than individual basis. If any of this material is published, your identity will not be revealed. If you are interested in the findings, you can request a copy of the research findings from the main researcher whose contact details are below.

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Thank you for taking time to read this information.

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UNIVERSITY OF BIRMINGHAM

School of Psychology

INFORMATION SHEET

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Rita Intili, Consultant Clinical Psychologist, is conducting this study, as part of her doctoral research, in collaboration with the University of Birmingham and the University College London. Please take time to read this information sheet and do not hesitate to discuss this with your family, friends, key worker or doctor. If there is anything that is not clear, please feel free to request further information at any time.

What is the study about?

This study aims to look at how individuals with a diagnosis of Borderline Personality Disorder (BPD) understand emotions. We know from our clinical experience and from previous research that there are differences between people in the way they react to emotional facial expressions. We also know that different reactions to expressions of feeling may influence how we interact with others. Since interactions with others are a particular area of difficulty for individuals with BPD, we wonder if responses to facial expression may be related to BPD. We would therefore like to investigate this by looking at how individuals with a diagnosis of Borderline Personality Disorder respond to facial expressions compared to 2 other groups: individuals who have experienced trauma and individuals who have not experienced trauma.

The National Research Ethics Service has approved this study.

What is the potential benefit of this study?

BPD is a complex condition that is not always easily recognised or managed. With your participation, this study may help us to gain to a better understanding of BPD, and lead to more effective assessment and intervention.

What if you decide to participate?

If you decide to take part in this research, you will be asked to complete and sign a consent form. Since your participation is voluntary, you may withdraw from the study at

any time without explanation. Your legal rights will not be affected should you choose not to participate in the study.

What is involved in the study?
You will initially be asked to watch a 4-minute film clip and then rate how you feel. You will then be asked to perform 2 tasks requiring you to look at a series of faces. In the first task the faces will be presented on a computer screen and you will be asked to indicate what feeling the face is expressing. In the second task you will look at photographs of faces and you will be asked how old you think the face is. Finally you will be required to complete 4 questionnaires that will ask about your mood and how you relate to others in some detail**.** The study takes approximately 1 hour to complete.

What happens to the information collected?
All the information that is gathered will be kept strictly confidential under lock and key. No information will have names and it will be analysed on a group rather than individual basis. If any of this material is published, your identity will not be revealed. If you are interested in the findings, you can request a copy of the research findings from the main researcher whose contact details are below.

What safeguards are in place?
There are no foreseen risks involved and the researcher will ensure that you are not exposed to any physical or emotional upheaval. You will be provided with a contact number of the researcher should you have further questions.

Contact Details
If you are interested in participating in this study, or you would like further information before making a decision, please contact Rita Intili on [redacted] or via email: [redacted]

Thank you for taking time to read this information.

Rita Intili
Consultant Clinical Psychologist
[redacted]

APPENDIX 10

Deviations from normality for accuracy, intensity and total false identifications ratings

		Surprise accuracy	Fear accuracy	Disgust accuracy	Anger accuracy	Sadness accuracy
Number of participants		69	69	69	69	69
Normal Parameters[a,,b]	Mean	23.1884	18.3043	17.8696	19.4203	21.7101
	SD	3.86262	4.18085	5.15898	3.59086	5.10220
Most Extreme Differences	Absolute	.089	.146	.158	.103	.136
	Positive	.073	.072	.073	.103	.084
	Negative	-.089	-.146	-.158	-.071	-.136
Kolmogorov-Smirnov Z		.742	1.211	1.310	.856	1.130
Asymp. Sig. (2-tailed)		.641	.106	.065	.456	.156

		Intensity 25%	Intensity 50%	Intensity 75%	Intensity100%
Number of participants		69	69	69	69
Normal Parameters[a,,b]	Mean	4.4054	5.9652	7.0380	7.6681
	Std. Deviation	1.13314	.95395	.89051	.98352
Most Extreme Differences	Absolute	.075	.076	.112	.062
	Positive	.061	.065	.057	.044
	Negative	-.075	-.076	-.112	-.062
Kolmogorov-Smirnov Z		.621	.632	.929	.511
Asymp. Sig. (2-tailed)		.835	.819	.354	.956

		Total incorrect classified disgu	Total incorrect classified sad	Total incorrect classified surpr	Total incorrect classified ange	Total incorrect classified fear
Number of participants		69	69	69	69	69
Normal Parameters[a,,b]	Mean	10.7681	14.3768	9.7826	14.6087	9.6812
	Std. Deviation	7.32671	8.04235	6.53243	6.99625	5.32335
Most Extreme Differences	Absolute	.088	.138	.115	.117	.131
	Positive	.088	.138	.115	.117	.131
	Negative	-.072	-.084	-.075	-.094	-.061
Kolmogorov-Smirnov Z		.732	1.146	.953	.971	1.085
Asymp. Sig. (2-tailed)		.658	.145	.323	.303	.190

APPENDIX 11

Independent t-tests for BPD group

Table A: The effect of mood induction on immediate mood: BPD group PFQ ratings.

Emotion	BPD Arousal N = 13 Mean (SD)	BPD Neutral N = 10 Mean (SD)	t-value	df	Sig. (2-tailed)
Amusement	1.85 (2.73)	1.90 (2.56)	-0.05	21	0.96
Anger	2.85 (2.48)	0.20 (0.63)	3.70	21	0.00
Anxiety	5.27 (2.62)	1.80 (2.15)	3.40	21	0.00
Disgust	3.42 (3.07)	0.00 (0.00)	4.02	21	0.00
Fear	4.46 (2.37)	0.20 (0.63)	6.21	21	0.00
Happiness	0.31 (1.11)	5.80 (1.55)	-9.49	21	0.00
Sadness	5.46 (2.54)	1.10 (2.33)	4.23	21	0.00
Shame	3.62 (3.12)	0.00 (0.00)	4.17	21	0.00

Table B: The effect of mood induction: BPD group accuracy and intensity ratings for each of the five emotions

Emotion	Arousal (n= 13) Mean Accuracy (SD)	Neutral (n=10) Mean Accuracy (SD)	t-value	df	Sig. (2-tailed)
Surprise	21.46 (5.03)	23.60 (3.69)	-1.13	21	0.27
Fear	16.15 (5.37)	17.70 (3.68)	-0.78	21	0.45
Disgust	17.15 (4.98)	17.30 (6.02)	-0.06	21	0.95
Anger	18.92 (4.59)	20.40 (3.44)	-0.85	21	0.41
Sadness	18.61 (5.17)	21.30 (3.59)	-1.40	21	0.18
Intensity Level	**Mean Rating (SD)**	**Mean Rating (SD)**			
25%	4.86 (1.22)	4.82 (0.71)	0.09	21	0.93
50%	6.31 (1.18)	6.20 (0.51)	0.29	21	0.77
75%	7.18 (1.09)	7.36 (0.65)	-0.47	21	0.62
100%	7.84 (1.22)	7.98 (0.77)	-0.30	21	0.75

Table C: BPD group ratings of current subjective mood state on the PANAS

Measure	BPD Arousal (n= 13) Mean (SD)	BPD Neutral (n= 10) Mean (SD)	t-value	df	Sig. (2-tailed)
PANAS-Negative "extent felt today"	25.38 (10.00)	21.30 (9.10)	1.01	21	0.32
PANAS-Positive "extent felt today"	26.46 (8.40)	21.40 (9.88)	0.54	21	0.59

APPENDIX 12

FER and FAP Tables

Table D **Mean (SD) accuracy scores**

Table E **Mean (SD) intensity rating**

Table F **Mean (SD) false classifications**

Table G **Mean (SD) facial age rating**

TABLE D: Mean accuracy scores (SDs) for target emotions at each intensity

Emotion	BPD (n= 23) Mean (SD)	MC (n=23) Mean (SD)	NC (n=23) Mean (SD)
Anger			
25% intensity	2.65 (1.77)	2.26 (1.76)	4.47 (1.03)
50% intensity	4.52 (2.01)	4.08 (1.38)	4.48 (1.04)
75% intensity	5.56 (1.38)	6.13 (1.18)	5.96 (1.19)
100% intensity	6.83 (0.98)	6.87 (1.22)	6.61 (0.84)
Fear			
25% intensity	0.78 (0.80)	1.43 (1.41)	0.87 (1.06)
50% intensity	4.22 (1.81)	5.04 (1.64)	4.61 (1.99)
75% intensity	5.83 (1.86)	6.70 (1.15)	6.30 (1.58)
100% intensity	6.00 (1.78)	6.83 (1.07)	6.30 (1.40)
Disgust			
25% intensity	3.13 (1.69)	2.43 (1.47)	2.61 (1.41)
50% intensity	4.30 (1.77)	4.65 (1.80)	4.65 (1.70)
75% intensity	4.87 (2.07)	5.43 (2.02)	5.65 (1.42)
100% intensity	2.65 (1.77)	2.26 (1.76)	2.30 (1.52)
Sad			
25% intensity	3.57 (1.38)	4.78 (1.51)	4.91 (1.99)
50% intensity	4.60 (1.73)	5.74 (1.18)	5.74 (2.16)
75% intensity	5.87 (1.49)	6.04 (1.64)	6.13 (1.42)
100% intensity	5.74 (1.48)	5.87 (2.07)	6.13 (1.25)
Surprise			
25% intensity	2.57 (2.04)	2.91 (1.78)	3.17 (1.80)
50% intensity	6.17 (1.56)	6.69 (1.18)	6.39 (1.53)
75% intensity	6.74 (1.09)	7.00 (1.24)	6.70 (1.26)
100% intensity	6.91 (1.08)	7.00 (1.40)	0.87 (1.06)

TABLE E: Mean (SDs) rating of intensity at each emotion

Emotion	BPD (n= 23) Mean (SD)	MC (n=23) Mean (SD)	NC (n=23) Mean (SD)
Anger			
25% intensity	4.88 (1.00)	4.43 (1.35)	3.39 (1.07)
50% intensity	6.08 (1.13)	5.75 (1.30)	5.52 (0.94)
75% intensity	7.28 (1.04)	6.78 (1.20)	6.64 (0.87)
100% intensity	8.09 (1.03)	7.64 (1.09)	7.57 (0.97)
Fear			
25% intensity	4.70 (1.88)	4.29 (1.24)	3.66 (1.09)
50% intensity	6.64 (1.01)	6.20 (1.19)	6.03 (1.07)
75% intensity	7.79 (1.08)	7.54 (1.04)	7.14 (0.89)
100% intensity	8.19 (1.07)	7.91 (1.08)	7.69 (1.08)
Disgust			
25% intensity	5.29 (1.18)	4.76 (1.17)	4.28 (1.21)
50% intensity	6.89 (1.39)	6.30 (1.33)	6.32 (0.78)
75% intensity	7.47 (1.26)	7.22 (1.15)	7.16 (0.79)
100% intensity	7.98 (1.23)	7.86 (1.21)	7.70 (1.06)
Sad			
25% intensity	4.61 (1.14)	4.48 (1.27)	3.72 (1.16)
50% intensity	5.76 (1.03)	5.55 (1.04)	4.93 (1.15)
75% intensity	6.55 (1.09)	6.51 (0.90)	6.37 (1.03)
100% intensity	7.28 (1.23)	6.99 (1.08)	6.94 (1.00)
Surprise			
25% intensity	4.74 (1.17)	4.42 (1.34)	3.83 (1.15)
50% intensity	5.96 (0.88)	6.04 (1.08)	5.52 (1.07)
75% intensity	7.19 (0.94)	7.07 (1.18)	6.87 (0.95)
100% intensity	7.97 (1.11)	7.72 (1.29)	7.49 (0.90)

TABLE F: Mean (SDs) incorrect classifications for target emotions at each intensity

Emotion	BPD (n= 23) Mean (SD)	MC (n=23) Mean (SD)	NC (n=23) Mean (SD)
Anger			
25% intensity	6.04 (4.87)	4.52 (2.92)	4.74 (2.43)
50% intensity	3.96 (2.46)	3.57 (2.41)	3.48 (1.78)
75% intensity	3.22 (2.45)	2.48 (2.15)	2.61 (1.78)
100% intensity	3.74 (2.70)	2.96 (1.99)	2.61 (1.78)
Fear			
25% intensity	2.22 (2.66)	2.82 (1.97)	2.04 (2.03)
50% intensity	2.22 (1.68)	2.78 (1.78)	2.87 (2.18)
75% intensity	2.61 (1.37)	2.43 (1.56)	2.00 (1.38)
100% intensity	2.09 (1.68)	2.57 (2.50)	2.17 (1.59)
Disgust			
25% intensity	6.39 (5.11)	3.00 (2.83)	3.61 (3.40)
50% intensity	3.78 (2.54)	2.35 (2.19)	2.26 (1.76)
75% intensity	2.04 (1.40)	1.91 (1.78)	1.91 (1.50)
100% intensity	2.04 (1.64)	1.39 (1.31)	1.57 (1.24)
Sad			
25% intensity	9.04 (5.45)	12.48 (4.66)	11.91 (6.84)
50% intensity	2.17 (2.27)	1.96 (1.80)	2.35 (2.60)
75% intensity	0.74 (0.92)	0.26 (0.45)	0.57 (0.95)
100% intensity	0.22 (0.42)	0.22 (0.42)	0.30 (0.47)
Surprise			
25% intensity	3.39 (3.22)	2.87 (3.14)	3.61 (3.35)
50% intensity	3.74 (2.60)	3.04 (2.53)	3.13 (2.93)
75% intensity	2.43 (2.33)	1.52 (1.44)	1.74 (1.51)
100% intensity	1.57 (1.34)	0.78 (1.17)	1.43 (1.73)

Table G: Mean (SDs) rating of Facial Age.

Facial Age Plate	BPD (n=23) Mean (SD)	MC (n=23) Mean (SD)	NC (n=22) Mean (SD)
1	6.48 (1.27)	7.30 (0.93)	6.73 (1.16)
2	4.09 (1.20)	4.57 (1.12)	4.00 (1.27)
3	3.13 (1.22)	3.52 (0.95)	3.22 (1.11)
4	3.48 (1.04)	3.96 (1.02)	3.05 (1.09)
5	8.48 (1.34)	8.35 (0.93)	7.95 (0.90)
6	3.13 (1.42)	3.74 (1.18)	3.41 (1.44)
7	6.39 (1.41)	6.43 (1.67)	6.36 (1.26)
8	3.43 (1.41)	4.04 (0.98)	3.63 (1.18)
9	2.26 (1.54)	2.78 (0.90)	3.00 (1.69)
10	8.65 (0.88)	8.30 (0.97)	7.68 (0.99)
11	5.70 (1.15)	5.70 (1.06)	5.27 (1.08)
12	4.74 (0.92)	4.78 (1.35)	4.00 (1.27)
13	4.30 (1.15)	4.87 (1.25)	4.05 (1.00)
14	3.74 (1.42)	3.87 (1.32)	3.72 (1.20)
15	2.74 (1.45)	2.61 (1.12)	2.50 (0.86)
16	6.17 (1.15)	6.04 (0.82)	5.86 (0.99)
17	3.04 (0.93)	3.52 (1.38)	3.73 (1.12)
18	2.52 (0.79)	2.78 (1.13)	3.09 (0.87)
19	6.35 (1.58)	6.74 (1.36)	6.91 (1.02)
20	1.70 (1.02)	1.61 (0.94)	1.82 (0.96)
21	3.26 (1.48)	2.87 (0.92)	3.05 (0.95)
22	2.30 (1.15)	2.22 (1.17)	2.18 (1.14)
23	3.61 (1.16)	3.96 (1.36)	3.86 (1.36)
24	9.70 (0.63)	9.83 (0.49)	9.68 (0.48)
25	8.48 (0.85)	8.83 (0.83)	8.68 (0.95)
26	2.43 (1.04)	2.17 (0.89)	2.14 (0.83)
27	2.57 (1.16)	2.52 (1.04)	2.23 (0.87)
28	8.57 (1.08)	8.39 (0.89)	8.41 (1.30)
29	2.30 (1.18)	2.91 (1.35)	2.36 (1.00)
30	3.91 (2.02)	5.39 (1.80)	4.32 (1.78)

APPENDIX 13

The effect of gender

Table H: The effect of gender: Accuracy and intensity ratings for each of the five emotions

Emotion	Female (n= 47) Mean Accuracy (SD)	Male (n=22) Mean Accuracy (SD)	t-value	df	Sig. (2-tailed)
Surprise	22.68 (3.89)	24.27 (3.65)	1.61	67	0.11
Fear	18.55 (4.20)	17.77 (4.19)	-0.72	67	0.47
Disgust	18.40 (5.31)	16.72 (4.72)	-1.26	67	0.21
Anger	19.19 (3.57)	19.90 (3.68)	0.77	67	0.44
Sadness	22.40 (5.44)	20.22 (4.00)	-1.67	67	0.09
Intensity Level	**Mean Rating (SD)**	**Mean Rating (SD)**			
25%	4.41 (1.10)	4.40 (1.24)	-0.02	67	0.98
50%	5.99 (0.94)	5.90 (0.99)	-0.36	67	0.72
75%	7.04 (0.96)	7.04 (0.74)	0.03	67	0.97
100%	7.63 (1.08)	7.74 (0.74)	0.43	67	0.67

Table I: The effect of gender: BPD group accuracy and intensity ratings for each of the five emotions

Emotion	BPD female (n= 16) Mean Accuracy (SD)	BPD male (n=7) Mean Accuracy (SD)	t-value	df	Sig. (2-tailed)
Surprise	22.31 (4.95)	22.57 (3.74)	0.12	21	0.90
Fear	16.31 (4.99)	18.00 (3.96)	0.79	21	0.44
Disgust	17.25 (5.40)	17.14 (5.58)	-0.04	21	0.97
Anger	19.44 (4.21)	19.86 (4.18)	0.22	21	0.83
Sadness	19.63 (5.11)	20.14 (3.76)	0.24	21	0.81
Intensity Level	**Mean Rating (SD)**	**Mean Rating (SD)**			
25%	6.55 (0.63)	6.28 (0.87)	-0.85	21	0.41
50%	6.80 (0.89)	6.90 (0.74)	0.27	21	0.79
75%	6.92 (1.00)	6.88 (1.38)	-0.08	21	0.94
100%	6.62 (0.90)	6.49 (0.87)	-0.32	21	0.75