

Interpersonal hypersensitivity and Social Cognition in Borderline Personality
Disorder

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DECLARATION FORM

I confirm that the work presented in this thesis is my own. Where information has been derived from other sources, I confirm that this has been indicated in the thesis.

ABSTRACT

Borderline personality disorder (BPD) is a serious psychiatric condition, which is characterised by interpersonal difficulties, intense fears of abandonment, affective instabilities, and impulsivity. The current research investigated some key mechanisms underlying hypersensitivity to social threats in individuals with BPD traits from developmental, cognitive, and interpersonal perspectives using a multi-method approach. Study 1, using self-report measurements, found that developmental factors including attachment anxiety and self-criticism mediated and moderated the association between rejection sensitivity and BPD features ($n = 256$). Study 2, using the similar methodological approach, found that intolerance of ambiguity and effortful control mediated and moderated the association between rejection sensitivity and BPD features ($n = 256$). Study 3 examined the impact of the activation of the attachment system on learning among people with BPD features ($n = 96$) using the Go/No-go paradigm. Study 4 investigated the impact of ambiguous social interactions on effortful control and mentalizing using a behavioural paradigm ($n = 42$). Study 5 examined the effect of expectation violation and social rejection, manipulated by the Cyberball paradigm, on effortful control and mentalizing in non-clinical participants ($n = 123$). Study 6 examined the effect of inclusive and exclusive social interactions, manipulated by the Cyberball paradigm, on mentalizing in BPD patients ($n = 22$) compared to healthy individuals ($n = 28$). Overall, results indicate that possible maladaptive coping strategies (anxious attachment, self-criticism) may be developed in response to heightened rejection sensitivity among individuals with BPD features. Furthermore, social cues perceived as threats (ambiguity, social interactions) may

activate the attachment system and impair various cognitive functions including contingency learning, effortful control and mentalizing among individuals with BPD symptoms. Future studies are needed to replicate the current findings and examine the impact of negative emotional arousal in response to interpersonal threats on cognitive capacities in larger non-clinical and clinical BPD populations.

IMPACT STATEMENT

The current research has investigated the developmental factors and cognitive functions of individuals with BPD features to understand the interpersonal hypersensitivity in BPD patients. BPD is a serious mental illness with a number of difficulties in affective, cognitive, and behavioural functions and hypersensitivities to interpersonal threats. Although a large amount of research has investigated the etiology of BPD, affective-cognitive dysfunctions, and interpersonal problems in a BPD population, it is still not well understood how the cognitive functions are affected by interpersonal stimuli. In addition, past research investigating the cognitive dysfunctions in a BPD population has mostly utilised cognitive approaches without including affective and relationship-valuing aspects. Therefore, it is critical to understand what interpersonal cues people with BPD will perceive as a threat, and how they will feel, think, and behave in response to the perceived threats. However, there has been little investigated into the change of cognitive functions in response to interpersonal threats in a BPD population.

The present research has identified the direct impact of social interactions on self-regulation and mentalizing capacities in non-clinical and clinical BPD populations. The change in learning capacities in response to the activation of the attachment system was also discovered. Finally, the current research has developed a new way of capturing hypermentalizing. Therefore there is a significant contribution to the contemporary methodology in psychology experiments for understanding social cognition.

Given that the development of Mentalization-based therapy (MBT) had a major impact on BPD patients, the current findings regarding hypermentalizing will increase further understanding of the maladaptive coping strategies that BPD patients often engage in. This is significant as the role of social cognitive capacities in individuals with BPD symptoms has not been well understood.

TABLE OF CONTENTS

Chapter I. Literature Review	13
A. Clinical Features of Borderline Personality Disorder	15
a. Diagnostic Criteria	15
b. Comorbidity	19
B. Etiological Aspects of BPD	20
a. Family Environment of BPD	22
i. Attachment in BPD	27
C. Interpersonal Hypersensitivity in BPD	30
a. Interpersonal Difficulties as core dysfunctions of BPD	30
b. Hypersensitivity to Interpersonal Threats	32
i. Rejection Sensitivity and Need to belong	33
1. Rejection hypersensitivity in BPD	37
ii. An Alarm System to Detect Threats	42
1. Negative affect of Social Pain	43
2. Intolerance of Uncertainty	45
3. Expectation Violation	50
D. Coping Strategies in BPD	53
a. Attachment Strategies	53
b. Self-Critical Perfectionism	57
c. Self-Harm Behaviours	60
i. Physical Pain and Psychological Pain	61
E. Cognitive Disturbance in BPD	65
a. Social Cognition	65
i. Developmental Aspects of Mentalizing	67
ii. Epistemic Trust, Attachment, and Mentalizing	68
iii. Impaired Mentalizing in BPD	70
iv. Unimpaired/Enhanced Mentalizing in BPD	72
v. Unbalanced Mentalizing in BPD	73
b. Learning and Epistemic Trust	76
c. Effortful Control	79
i. Affect Dysregulation in BPD	82

ii. Cognitive Dysregulation in BPD	83
iii. Behaviour Dysregulation in BPD	89
F. Present Study	93
a. Aims and Objectives	95
Chapter II. Current Studies	99
1. Rejection Sensitivity and BPD: A Moderated Mediation Model of Attachment Anxiety, Need to Belong, and Self-Criticism	
1.1. Introduction	99
1.2. Methods	102
1.3. Results	108
1.4. Discussion	117
2. Rejection Sensitivity and BPD: A Mediational Model of Effortful Control and Intolerance of Ambiguity	
2.1. Introduction	122
2.2. Methods	127
2.3. Results	130
2.4. Discussion	139
3. Effects of BPD features on Learning: The Role of Attachment	
3.1. Introduction	144
3.2. Methods	147
3.3. Results	151
3.4. Discussion	161
4. Effects of Ambiguous Social Interactions on Effortful Control and Mentalization: The Role of BPD	
4.1. Introduction	170
4.2. Methods	174
4.3. Results	185
4.4. Discussion	193
5. Effects of Unexpected Social Interactions on Effortful Control and Mentalizing: The Role of BPD features	
5.1. Introduction	198
5.2. Methods	202

5.3. Results	210
5.4. Discussion	221
6. Effects of Social Interactions on Hypermentalizing in BPD patients	
6.1. Introduction	227
6.2. Methods	232
6.3. Results	236
6.4. Discussion	246
Chapter III. Discussion and Conclusion	
A. Overview	254
B. Empirical Findings	255
C. Limitations	259
D. Research Implications	264
E. Clinical Implications	269
F. Future Directions	270
G. Final Conclusion	271
IV. Appendix	275
V: References	290

LIST OF TABLES

Table 1: Means, standard deviations, and bivariate correlations	109
Table 2. Results of regression analysis predicting borderline personality disorder features.	111
Table 3. Descriptive Statistic	131
Table 4. Bivariate correlations among the main study variables	132
Table 5. Descriptive statistics: means, standard deviations, and Cronbach's alpha coefficients of subscales and total scores of Personality Assessment Inventory –Borderline Features Scale.	152
Table 6. Descriptive statistics of the fraction of correct response	152
Table 7. Bivariate correlations between age and the PAI-BOR subscales, and the fraction of correct response.	154
Table 8. Descriptive statistics for outcome measurements	186
Table 9. Linear regression analyses between BPD features and baseline outcome measurements	190
Table 10. Descriptive Statistic.	212
Table 11. Results of regression analyses between Borderline Personality Disorder features and outcome variables.	215
Table 12. Means and standard deviations of the RMET in each condition	237

LIST OF FIGURES

Figure 1 . Need to belong mediates the indirect path between rejection sensitivity and BPD features	112
Figure 2 . Attachment anxiety, need to belong, and self-criticism mediate the indirect path between rejection sensitivity and BPD features	114
Figure 3 . Moderated Mediation Analysis: Attachment Anxiety, Need to belong, Self-criticism between rejection sensitivity and BPD features	116
Figure 4 . Indirect effect of rejection sensitivity and BPD features through effortful control	133
Figure 5 . Indirect effect of rejection sensitivity on BPD features through effortful control and intolerance of ambiguity.	135
Figure 6 . Indirect effect of borderline personality features on rejection sensitivity through intolerance of ambiguity and effortful control	136
Figure 7 . Moderated Mediation Analysis: Intolerance of ambiguity and effortful control between rejection sensitivity and BPD features.	138
Figure 8 . An interaction between attachment and BPD features on the fraction of correct response.	155
Figure 9 . Time by condition interaction on the fraction of correct response.	156
Figure 10 . Interactions between condition, attachment, and BPD features on the fraction of correct response.	157
Figure 11 . Learning difference in each condition.	158
Figure 12 . An interaction between attachment and BPD features on learning rate.	159
Figure 13 . Interaction plot for attachment and affective instability	161

on learning rates.	
Figure 14 . Procedure of the current study	178
Figure 15 . First reaction time between the low and high BPD groups.	188
Figure 16 . Interaction between time and self-harm tendencies.	193
Figure 17. Procedure of the current study.	205
Figure 18 . Interaction between conditions and the level of BPD features on the emotional Stroop task accuracy.	216
Figure 19. Interaction between conditions and the level of BPD features on the emotional Stroop task reaction time.	217
Figure 20. Interaction between time and the level of BPD features on the RMET accuracy.	219
Figure 21. Interaction between conditions and the level of BPD features on the RMET total score.	220
Figure 22. Interaction between time, valence and diagnosis on the RMET accuracy.	241
Figure 23. Interaction between condition and diagnosis on the RMET accuracy.	242
Figure 24 Interaction between time, valence and diagnosis on the RMET total number of words selected.	243
Figure 25. Interaction between time and condition on the RMET total.	244
Figure 26. Interaction between condition and diagnosis on the RMET total number of words selected	245
Figure 27. Theoretical Model of the Development of BPD	274

CHAPTER I

LITERATURE REVIEW

Borderline Personality Disorder (BPD) is a complex and serious mental disorder which is estimated to affect between 1-2% of the population (Coid, Yang, Tyrer, Roberts, & Ullrich, 2006; Gunderson et al., 2018; Lieb et al., 2004; Skodol et al., 2002; Widiger & Weissman, 1991). BPD causes significant challenges for patients, healthcare professionals (Langley & Klopper, 2005), and their significant others, such as families (Lazarus, Cheavens, Festa, & Rosenthal, 2014). BPD has been found to be associated with severe impairments in the social functioning, comorbid psychiatric disorders, intensive use of treatment, and high healthcare costs to society (Stepp & Lazarus, 2017) due to frequent use of healthcare services (i.e., multiple referrals and admissions to Accident and Emergency Departments and in-patients units) (Barnicot, Katsakou, Marougka, & Priebe, 2011; Fossati, Feeney, Maffei, & Borroni, 2014; Gunderson et al., 2018; Langley & Klopper, 2005; Lieb et al., 2004). It is not uncommon for healthcare professionals to become seriously distressed due to the time and attention BPD patients demand from them (Gunderson et al., 2018). BPD is more common among female patients (Lieb et al., 2004). Indeed, among BPD patients in the community, 66 to 75% of patients have been found to be female (Swartz et al., 1990; Torgersen et al., 2001). BPD is characterised by disturbed interpersonal relationships, intense negative affect, hypervigilance, impulsiveness, emotion dysregulation, identity problems, and self-harm/suicidal behaviours (Baer, Peters, Eisenlohr-Moul, Geiger & Sauer, 2012; Lieb, Zanarini, Schmahl, Linehan, & Bohus, 2004; Sanislow & McGlashan, 1998; Skodol et al., 2002).

BPD patients present dysfunctions in a wide range of neuro-behavioural systems including emotional expression, emotional and behavioural self-regulation, cognition, and interpersonal functioning (Lazarus, Cheavens, Festa, & Rosenthal, 2014). In order to cope with their emotional difficulties, BPD patients often engage in maladaptive coping strategies such as self-harm and suicidal behaviours (Brown, Comtois, & Linehan, 2002). Previous research showed that patients with BPD accounted for 9-33% of all suicides (Kullgren, Renberg & Jacobsson, 1986). A more recent study has shown that suicide risk is 50 times higher among BPD patients compared to healthy individuals, and up to 10% of BPD patients actually commit suicide (Skodol, Gunderson, Pfohl, Widiger, Liversley, & Siever, 2002). Given the severity of the outcomes associated with the disorder, further understandings of the disorder's causes are warranted as this may lead to more effective treatment and prevention strategies. Although intensive research has been conducted, the internal mechanisms that are accountable for the external behavioural features exhibited by BPD patients are still not fully understood.

Among many dysfunctions, the current thesis focuses on hypersensitivity to interpersonal threats in BPD patients and aims to investigate possible maladaptive coping strategies BPD patients may develop in response to childhood adversity. Furthermore, current research aims to examine the maladaptive cognitive response to perceived interpersonal threats among individuals with BPD features. Chapter I reviews the literature regarding the etiology of BPD. Possible interpersonal stimuli perceived as threats and maladaptive coping strategies in

response to threats in BPD patients are then explored. Finally, cognitive dysfunctions in BPD patients found in the literature are described.

A. Clinical Description of Borderline Personality Disorder

Diagnostic Criteria

The official DSM-5 (American Psychiatric Association, 2013) general criteria for a personality disorder include impairments in self (i.e., identity) and interpersonal difficulties (empathy or intimacy). Typically, disturbances in interpersonal functioning are the central features of personality disorders. Within personality clusters, there are currently three types of personality disorders included in the DSM. Cluster A includes paranoid, schizoid, and schizotypal personality disorders, which are described as odd and eccentric disorders. Cluster B encompasses antisocial, borderline, histrionic, and narcissistic personality disorders, which are characterised as dramatic, emotional or erratic disorders. In Cluster C, there are avoidant, dependent, and obsessive-compulsive personality disorders, all anxious or fearful disorders.

One of the core diagnostic criteria for a personality disorder is the interpersonal difficulties with abilities such as empathy or intimacy (DSM 5, American Psychiatric Association, 2013). Empathy is the capacity to detect the emotions or needs of others, and intimacy refers to the styles and perceptions of close relationships. BPD patients' interpersonal styles tend to be conflicted, intense, and unstable, affected by mistrust, intense desire for closeness, and anxious preoccupation with real or imagined rejection. Impairments in intimacy imply intense, unstable, and controlling means of relationships characterised by mistrust and anxious expectation and preoccupation with real or imagined

rejection where dominance, intimidation, or coercion can be used to control others. Intimate relationships among BPD patients can be viewed on an extreme spectrum shifting between idealisation and disappointment (Gunderson et al., 2018).

In order to be diagnosed with BPD, the diagnostic criteria require the patients to have four or more of the following symptoms and features: emotional lability (i.e., mood swings), anxiousness (i.e., threatened by uncertainty), separation insecurity (i.e., fears of rejection), depressivity (i.e., feelings of inferior self-worth), impulsivity (i.e., acting in response to immediate stimuli), risk-taking (i.e., self-damaging activities), and hostility (i.e., frequent anger).

As the diagnostic criteria (DSM 5, American Psychiatric Association, 2013) for personality disorders state that impairments in personality traits and social functioning are relatively stable across time and different situations, personality disorders such as BPD have been, until recently, considered to be pervasive and persistent mental disorders. However, contrary to this previous understanding of BPD, many recent studies have found that the BPD-related symptoms tend to decline with age (De Moor, Distel, Trull, & Boomsma, 2009; Paris, 2002; Zanarini, Frankenburg, Hennen, Reich, & Silk, 2006) and that some psychological treatments such as psychotherapies can be effective in reducing the core BPD symptoms (McMain, Links, Gnam, Guimond, Cardish, Korman, & Streiner, 2009). In the community, BPD has been found to be more common in the adolescent population than in the adult population. However, BPD symptoms seem to be less stable for adolescents than for their adult counterparts (Bernstein et al., 1993). A number of studies have found that the remission rate of BPD was

approximately 13% after 2 years (Links, Mitton, & Steiner, 1990), 68% after 6 years (Zanarini et al., 2003), 88% after 10 years (Zanarini et al., 2006), and 92% after 27 years (Paris, 2002).

Although BPD patients need long-term care, some treatments have been found to be effective (McMain, Links, Gnam, Guimond, Cardish, Korman, & Streiner, 2009). BPD patients are generally extremely difficult to engage in treatment (Gunderson et al., 2018), and their dropout rates tend to be high (15 - 77%) in a variety of treatment settings (De Panfilis, Marchesi, Cabrino, Monici, Politi, Rossi, & Maggini, 2012; Rüsçh, Schiel, Corrigan, Leihener, Jacob, Olschewski, & Bohus, 2008). However, it is not well understood why BPD patients tend to have such a high drop-out rate. A number of studies have investigated potential predictive factors of this early dropout from treatment. They found that socio-economic status, personality traits, treatment history, symptom severity, and comorbidity predicted dropout in BPD (De Panfilis et al., 2012; Rüsçh et al., 2008). A meta-analysis gathering all these previous findings (Barnicot et al., 2011) highlighted a high degree of variation in treatment completion rates between studies. Barnicot and colleagues (2011) have suggested that this variation in findings may be due to a disparity in the methodology used, including research setting (i.e., lab/hospital), population (i.e., gender, social-economic status), and type of treatment (i.e., numbers of sessions) (Rüsçh et al., 2008). Therefore, the potential factors predicting BPD patients' early dropout are still not well understood.

Traditionally, BPD has been considered to be a stable disorder and conceptualized as categorical. Therefore, research on BPD was focused on the

clinical population. However, recent research conducted within the non-clinical population has indicated that people with higher levels of BP traits also show substantial impairment (Bagge et al., 2004; Clifton & Pilkonis, 2007; Daley et al., 2000; Vega et al., 2017). Further, as described earlier, BPD symptoms have been found to decline with age (De Moor et al., 2009; Paris, 2002; Zanarini et al., 2006) and treatment (McMain et al., 2009). Gunderson and colleagues (2011) conducted a longitudinal study, finding that 85% of BPD patients remitted over 10 years of follow-up. This finding was similar to another longitudinal study (Zanarini, Frankenburg, Reich, & Fitzmaurice, 2010) in which 50% of patients recovered from BPD and 93% of patients achieved a remission of BPD symptoms over 10 years. A recent systematic review (Winsper et al., 2015) has revealed that the stability of BPD diagnosis (< 19 years old) may be low. Somewhere between 14 and 40% of children or adolescents were found to retain a BPD diagnosis after 2 - 20 years. These studies have therefore supported the view that BPD is on a spectrum rather than categorical and that the dimensional approach is more appropriate (Stepp & Lazarus, 2017) as it helps to capture developmental variability and heterogeneity.

However, recent theories have proposed a *hybrid model* that conceptualizes BPD as both categorical and dimensional (McGlashan et al., 2005; Zanarini et al., 2007). This hybrid model suggests that personality disorders in general and BPD in particular consist of both stable and dynamic elements. Stable elements are consistent across time and situation. On the other hand, dynamic elements are episodic. Herpertz and colleagues (2017) reviewed the literature regarding the current conceptualization of personality disorders, finding that

authors have concluded that the current discussion about categorical versus dimensional classification remains controversial, and strongly recommended retaining this hybrid model of personality disorder classification (Hypertz et al., 2017). This hybrid model has been tested in a longitudinal context (Conway, Hopwood, Morey, & Skodol, 2018). Conway and colleagues (2018) examined the longitudinal data to investigate whether BPD has both trait-like (i.e., consistent and stable across time and different events) and state-like (i.e., situational and episodic) elements. In contrast to the traditional view of BPD, less than half of BPD variability was stable over time. Conway and colleagues (2018) have concluded that BPD contains both stable and episodic components. Therefore, both categorical and dimensional approaches can be considered as appropriate for investigating BPD in the non-clinical and clinical populations.

Comorbidity

It is very uncommon for individuals with BPD features, particularly in the clinical population, to present with no other psychiatric conditions or diagnoses. A recent review by Kulacaoglu and Kose (2018) suggested that one of the important features of many psychiatric disorders is impulsivity. In this review, Kulacaoglu and Kose (2018) have found that impulsivity is the common diagnostic feature in attention-deficit/hyperactivity disorder (ADHD) and BPD. Many studies have therefore investigated the relationship between BPD and ADHD (Asherson et al., 2014; Ferrer et al., 2010; Philipsen, 2006; Philipsen et al., 2008), and similar clinical features between ADHD and BPD have been described (Asherson et al., 2014; Philipsen, 2006). Furthermore, childhood and adult ADHD were found to be more prevalent in patients with severe BPD (Ferrer

et al., 2010; Philipsen et al., 2008). It was found that those BPD patients with comorbid adult ADHD were more likely to also have a substance use disorder, antisocial personality disorder, and obsessive-compulsive personality disorder (Ferrer et al., 2010; Philipsen et al., 2008). In addition, BPD patients with comorbid adult ADHD showed more impulsive features, whereas BPD patients who did not have comorbid adult ADHD showed more anxiety and depressive symptoms (Philipsen et al., 2008). These findings suggest that cognitive disturbance, especially in attentional control, may explain high levels of impulsivity in BPD patients. In their systematic review, Davids and Gastpar (2005) found a strong link between ADHD and BPD in which a number of symptoms seem to overlap, such as deficits in control of affect and impulse, and interpersonal dysfunctions. The disturbance in cognitive capacities in BPD patients may, therefore, play an important role in their impulsive behaviours, which in turn may lead to interpersonal difficulties. The current thesis will address the role of cognitive factors in BPD and in hypersensitivity associated with BPD in particular.

B. Etiological Aspects of BPD

There are a number of theoretical models explaining the etiology of BPD. The first model, proposed by Linehan (1993), is a biosocial model that focuses on the affective instability of BPD. Based on her model, the disturbance in the temperament aspect of self-control that regulates emotional reactions is the main etiological pathway towards the development of BPD. In Linehan's view, BPD patients are more likely to show hypersensitivity to emotions, experience intense affect, and take a longer time to suppress emotional arousal compared to healthy

controls. Most of the BPD symptoms can be explained as an attempt to regulate the elevated emotions or as a result of the dysregulated emotional arousal. For example, emotional outbursts (i.e., anger) are seen as the consequence of dysregulated emotional arousal, and self-harm and suicidal behaviours are seen as a coping strategy to escape from the elevated negative affect (Fruzzetti et al., 2005). Similar to impulsivity, affective instability has been found more frequently in relatives of BPD patients compared to families of healthy individuals (Siever & Davis, 1991). In 1998, a twin study (Livesley, Jang, & Vernon, 1998) found that genetic factors accounted for a large proportion of the variance in affective instability. In addition, a past neuroimaging study indicated enhanced activity in the left amygdala (responsible for emotional reactions) in response to facial expressions, which suggests emotional dysregulation in BPD patients (Donegan et al., 2003). This evidence supports Linehan's biosocial model highlighting the role of affective components in the development of BPD.

Another theoretical model proposed by Gunderson and colleagues (2008) is a gene-environment-developmental model focusing on BPD patients' interpersonal hypersensitivity. This gene-environment interaction has been considered to be important in the development of the sense of self and others, which is essential in developing healthy interpersonal relationships. Rejection sensitivity, intolerance of being alone, and fear of abandonment have shown heritability (Jang et al., 1996). Given this, Gunderson and Lyons-Ruth (2008) proposed that the *interpersonal hypersensitivity* phenotype underpins BPD and particularly the interpersonal style of BPD patients. They argue that the clinical significance of an interpersonal phenotype can be seen in the study showing that

the intense negative arousal and self-harm behaviours, which characterise BPD patients, tend to be prompted by imagined or actual aversive interpersonal events, particularly in the context of their important attachment relationships (Gunderson & Lyons-Ruth, 2008). Furthermore, they proposed that genetic components such as the serotonergic system and dopaminergic system might be related to the interpersonal hypersensitivity in BPD patients. Disturbance in the serotonergic system increases the release of cortisol (stress hormone) in response to negative interpersonal situations such as separation. Disturbance in the dopaminergic system may decrease the reward value of their significant others' cues, in turn leading to impairments in pair bonding. Children's genetic code is associated with their readiness to perceive distress as well as separation anxiety. Therefore, Gunderson's gene-environmental-developmental model emphasizes that this genetic vulnerability will interact with the early attachment relationship with their caregivers and adverse childhood experience (Gunderson & Lyons-Ruth, 2008; Gunderson et al., 2018). Yet, clearly, further research regarding the etiology of BPD is needed. The current thesis particularly focuses on the developmental, affective and cognitive aspects of BPD patients.

Family Environment of BPD Patients

From the developmental point of view, early childhood experience appears to be a crucial factor in predicting future personality development. Much research in this area has therefore focused on the role of family factors in understanding the developmental of BPD (Afifi et al., 2011). A recent review (Teicher, Samson, Anderson, & Ohashi, 2016) has suggested that childhood maltreatment (i.e., abuse) is the leading risk factor for adult psychopathology. Childhood adversity

can alter trajectories of brain development including affect regulation, threat detection, and reward anticipation (Teicher et al., 2016). A large population-based study (Afifi et al., 2011) has found that childhood adversity was consistently associated with borderline, schizotypal, narcissistic, and antisocial personality disorders. Although childhood adversity is not specific for BPD, recent research has suggested a link between sexual and physical abuse and the development of BPD (Conway et al., 2015; Gunderson et al., 2018). However, Zanarini and colleagues (1998) gathered evidence from nine previous studies, which showed inconsistent findings in this regard. In this study, the experience of physical abuse ranged from as low as 10% to as much as 73%, whereas sexual abuse ranged from 16% to 71%. They also analysed their own sample of BPD patients, finding that 59% had experienced physical abuse and 62% had experienced sexual abuse. In total, 91% of patients reported experiencing some form of abuse during their childhood. In addition, 92% of patients reported neglect during childhood.

Further studies, both among BPD patients (Silk, Lee, Hill, & Lohr, 1995; Zanarini et al., 2002) and a non-clinical sample (Trull, 2001), showed that those with more severe childhood abuse also had more severe psychosocial problems and BPD symptoms. Thereby suggesting a link between the severity of the abuse and the BPD symptoms (Conway et al., 2015). Hengartner and colleagues (2013) suggested that aversive childhood experience (i.e. trauma) is the most significant environmental risk factor for BPD. It should be noted that childhood trauma is not a necessary precondition for developing BPD. Supporting this, a more recent study found that female adolescents with BPD had experienced more childhood maltreatment, including sexual abuse, low maternal care, and parental antipathy,

when compared to inpatients without BPD (Infurna et al., 2016). It follows that dysfunctional family relationships may play an important role in the development of BPD.

The first interpersonal interactions people experience are with their family, mainly the primary caregivers (i.e., mother). Hence, many scholars have argued the importance of bonding between the primary caregivers and their children in order to understand the development of BPD (Infurna et al., 2016). Many psychoanalysts have further argued that the development of BPD could be affected by the nature of parental involvement. For example, Masterson and colleagues (1975) were among the first to propose that BPD patients' mothers showed a dependency on their children for emotional support, leading to a state of over-involvement. On the other hand, Adler and Buie (1979) argued that the absence of maternal care could lead to a sense of loneliness and thus result in developing BPD features. Empirical evidence seems to support Adler and Buie's theory that individuals with low parental involvement are more likely to display BPD symptoms (Frank & Hoffman, 1986). It was further evidenced that parental over-involvement was not necessarily associated with BPD symptoms.

Frank and Hoffman (1986) found that low parental involvement was associated with BPD features in the non-clinical subjects; however, Paris and Frank (1989) reported that both low parental care and over-involvement were associated with BPD in the clinical subjects. These findings were further replicated in more recent studies comparing BPD patients with patients with schizotypal personality disorder (Torgersen & Alnaes, 1993). These latter authors found that both patients with schizotypal personality disorder and BPD reported

low parental care, suggesting that their parents were less warm, friendly, affectionate, and understanding. Whereas patients with schizotypal personality disorder reported under-involvement, BPD patients reported parental over-involvement. Thus, this study has highlighted the role of parental neglect during childhood in schizotypal personality disorder patients and negative parental over-involvement in BPD patients. Further, Nickell and colleagues found that healthy undergraduate participants with BPD features were more likely to perceive their mothers as less caring but over-protective (Nickell, Waudby, Trull, 2002). These findings suggest that the level of parental involvement, as well as parental care (e.g. affection), may be important in the development of BPD features.

Johnson and colleagues (2006) conducted a longitudinal study and found that lower parental affection and higher aversive parenting (i.e., harsh punishment) were associated with BPD in adulthood. This study investigated the current relationship that adults with BPD features had with their parents and found that individuals with higher BPD features were more likely to perceive parental criticism. They also found that perceived parental criticism was related to interpersonal difficulties, but not impulsivity (Cheavens et al., 2005). Another study in a clinical population found that BPD patients had more conflicting and less appropriate responses from their parents compared to control groups. Other studies have also explored the type of mother-child interactions. BPD patients had significantly more hostile mother-child relationships compared to patients with depression and bipolar disorder. However, the father-child relationships did not differ between BPD patients and comparison groups (Benjamin & Wonderlich, 1994). These findings suggest that BPD patients have dysfunctional parent-child

relationships, particularly mother-child relationships, during their childhood and then continue to have issues with their parents into adulthood.

Other research has explored the relationship between parents with BPD and their children. Feldman and colleagues (1995) investigated the difference between children of mothers with BPD and children of mothers with other types of personality disorders. They found that the children of mothers with BPD experienced more negative situations (i.e., parents' suicide attempts, substance abuse) than the comparison group. Further, children who had mothers with BPD had a higher prevalence of mental disorders and problems with impulsivity compared to children whose mothers had other personality disorders (Weiss et al., 1996). Although these studies' samples were limited (21 children from 9 families), other research has also found consistent results. Children of mothers with BPD were found to have more emotional and behavioural problems and perceive their mothers as over-protective compared to children of mothers with depression (Barnow et al., 2006). Further, observational studies have found that mothers with BPD showed less sensitivity to their children during face-to-face interactions (Crandell, Patrick, & Hobson, 2003). A recent review conducted by Wendland and colleagues (2014) stated that mothers with BPD appear to have severe difficulties in the transition to parenthood and in establishing healthy early mother-infant interactions. As a result, their offspring show a high risk of developing social and emotional dysfunction.

Taken together, the early parent-child relationship forms the basis of interpersonal relationship style in adulthood. As the early-life maltreatment and dysfunctional parent-child relationships in families with BPD have a major impact

on children and parents, problematic early family relationships are important in understanding the current interpersonal problems in BPD patients (Gunderson et al., 2018; Stepp et al., 2017).

Attachment in BPD

How well caregivers reliably, consistently, and sensitively satisfy their children's needs might affect the children's development of secure working attachment models. According to Bowlby's attachment theory (1969), children develop mental models about themselves and others based on their early interactions with primary caregivers. Based on these interactions, infants develop expectations and beliefs about social relationships, especially when they face distress. Hence, these internal models are thought to influence interpersonal relationship styles later in adulthood (Bowlby, 1969, 1973). If primary caregivers (i.e., mothers) can provide stability and safety, infants can begin to perceive their caregivers as reliable and protective figures when they experience distress, leading to feelings of security, support and thus a downregulation of distress. Subsequently, infants can resume their exploration of the world with confidence, knowing that they have a secure basis if they face distress. However, if there is a continual disruption of the attachment bond between infants and their primary caregivers, the infants are unable to develop a secure base from which to explore. As a result, infants develop insecure attachment styles and do not explore their environment even in the presence of their primary caregivers (i.e., mothers) as they cannot rely on their caregivers when in distress. Hence, the quality of attachment plays an important role in determining individuals' capacities to cope with distress.

Secure attachment can be a protective factor (Fonagy et al., 2017), but insecure attachment can be a risk factor in developing any form of psychopathology, including BPD (Barone, 2003; Fonagy et al., 2017). Further, insecure attachment can lead to dysfunction in self-control and emotional regulation (Fonagy & Bateman, 2008). Within insecure attachment models, there are a number of different types of attachment styles. Individuals with anxious-ambivalent or resistant attachment styles tend to make excessive demands of others (i.e., need to belong) and show anxious and clinging behaviours, along with an intense anger when their needs are not satisfied (i.e., neglect). Avoidant individuals, in turn, tend to be unable to develop deep interpersonal relationships as they avoid intimacy with others to protect themselves from potentially negative interpersonal experiences (i.e., rejection).

Insecurely attached individuals tend to be hypersensitive to threats in response to perceived insecurity and uncertainty/unpredictability of their attachment figures' (i.e., primary caregiver) behaviours and availability (Luyten & Fonagy, 2015). Although insecure attachment styles are related to interpersonal difficulties in general (Choi-Kai, Fitzmaurice, Zannarini, Laverdière, & Gunderson, 2009), the negative impact of insecure attachment styles is particularly prominent in BPD patients (Fonagy, Gergely, Jurist, & Target, 2002; Lorenzini & Fonagy, 2013).

A recent review has concluded that BPD was strongly associated with insecurity of BPD patients' attachment style, as expressed in disorganized, fearful, or preoccupied orientations (Agrawal, Gunderson, Holmes, & Lyons-Ruth, 2004). Specifically, BPD patients often have a combination of the

preoccupied and the unresolved/fearful attachment styles (Agrawal, Gunderson, Holmes, & Lyons-Ruth, 2004; Bakermans-Kranenburg & IJzendoorn, 2009; Fonagy et al., 1996; Levy et al., 2005; Nakash-Eisikovits, Dutra, & Westen, 2002).

As previously described, individuals with these insecure attachment styles tend to seek a high level of intimacy and connectedness to their significant others. Adults with the preoccupied attachment style tend to display attachment-related concerns that have an angry or passive quality. Those adults with the unresolved/fearful attachment style often display fearful or contradictory behaviours (i.e. desire emotional closeness, but feel uncomfortable with emotional closeness). Unresolved attachment in BPD patients has been associated with trauma (Stalker & Davies, 1995) and high levels of self-harm and suicide tendencies (Adam, Sheldon-Keller, & West, 1996). Therefore, insecure attachment styles are the predictive factor of interpersonal dysfunctions of BPD patients.

Although childhood adversity and disorganized attachment are risk factors for developing BPD symptoms, Fonagy and colleagues (2017) argued that personality disorders in general, and BPD in particular, can be characterized not only by the presence of insecure attachment but also by a lack of resilience. Given that BPD patients often do not have a stable and supportive interpersonal relationships (i.e., family), they are less likely to develop secure attachment. This absence of resilience may lead to the inflexibility in social communication because BPD patients often do not have any other adaptive strategy.

Taken together, the presence of developmental risk factors (i.e., childhood

maltreatment, insecure attachment) and the absence of resilience (i.e., secure attachment) may underlie the interpersonal difficulties in BPD patients.

C. Interpersonal Hypersensitivity in BPD

Interpersonal Difficulties as Core Dysfunctions of BPD

Interpersonal dysfunction has been proposed and delineated as a core dysfunction in personality disorders in a number of studies and diagnostic manuals (DSM-5, American Psychiatric Association, 2013). As described in the previous section on BPD diagnostic criteria, of the numerous difficulties BPD patients experience, disturbed interpersonal relationships are one of the core features and important factors underlying a variety of symptoms in BPD (Sanislow et al., 2002; Gunderson et al., 2018). BPD patients' interpersonal relationship style is typically considered to be intense but unstable, shifting from an extreme idealisation to an extreme devaluation (Gunderson et al., 2018). Although BPD patients have a strong desire to belong to others (Ayduk et al., 2008) and to maintain a stable interpersonal relationship, they are at the same time more likely to be withdrawn, aggressive or impulsive, and dismissive in interpersonal interactions (Rosenbach & Renneberg, 2011). BPD patients can become deeply involved and dependent on others due to this strong desire for intimacy, but they tend to become extremely demanding and manipulative when they feel that their needs are not met (Gunderson et al., 2018). As a result, self-injury behaviours and suicide attempts are more likely to occur in the context of interpersonal relations (Brodsky et al., 2006; Brown et al., 2002; Gunderson & Lyons-Ruth, 2008; Herpertz, 1995).

As described earlier, one of the risk factors for developing interpersonal

difficulties in BPD patients is a malfunctioning parent-child interactions, such as physical or psychological abuse (Afifi et al., 2011; Conway et al., 2015; Teicher et al., 2016). However, recent research has highlighted that the experience of bullying during childhood is also an important risk factor for developing BPD (Sansone, Lam, & Wiederman, 2010; Winsper, Hall, Strauss, & Wolke, 2017; Wolke, Schreier, Zanarini, & Winsper, 2012). Research has found that the experience of bullying during childhood was a significant risk factor for developing BPD in adolescence (Wolke et al., 2012) and adulthood (Sansone et al., 2010). Therefore, childhood adversity that increases the risk of developing BPD features includes child-peer interactions as well as parent-child interactions.

BPD patients' interpersonal problems have been frequently captured within the romantic relationship context among adult patients as well as adolescent patients. Bernstein and colleagues (1993), for instance, reported that adolescents with BPD were three times more likely to have no romantic relationships compared to adolescents without BPD in a large community sample. Further, Swartz and colleagues (1990) have shown that BPD patients are significantly more likely to have never been married compared to patients with other mental disorders. Labonte and Paris (1993) conducted a small retrospective study, which revealed that BPD patients experienced more breakups with significant others (i.e., spouse) in their lives compared to non-BPD or healthy controls. Another similar study conducted by Jovev and Jackson (2006) examined recent life events in BPD patients compared to patients with other personality disorders. BPD patients reported significantly more frequent separations from their significant others (i.e., breakups or divorce) than control groups in the past

six months. Hence, research findings are consistent in suggesting that individuals with BPD features are more likely to experience difficulties in forming and maintaining healthy romantic relationships.

Conrad and Morrow (2000) investigated the impact of emotional stress by using news clips of relationship violence. They found that men with more BPD features were more likely to show a willingness to use verbal aggression in romantic relationships in response to the news clips with violent or rejection themes compared to neutral news clips. A previous longitudinal study found that individuals with more BPD features were found to have a higher number of relationships (but not longer time spent in relationships), more chronic stress in intimate relationships, more conflicts with romantic partners, a higher frequency of unwanted pregnancy, decreased relationship satisfaction, and a more frequent experience of abuse by their partners (Daley, Burge, & Hammen, 2000).

Thus, these studies indicate that the parent-child, peer-child, and romantic partner interactions are important factors in understanding interpersonal difficulties in individuals with BPD features.

Hypersensitivity to Interpersonal Threats

As described earlier, interpersonal hypersensitivities (Gunderson & Lyons-Ruth, 2008; Gunderson et al., 2018) have been suggested as an explanation of BPD patients' interpersonal difficulties. Given that BPD patients are more likely to have experienced negative interpersonal interactions from childhood (i.e., parental neglect) to adulthood (i.e., divorce), their ability to detect social threats often become hypersensitive. As a result, BPD patients frequently perceive interpersonal threats and experience high levels of negative emotional arousal.

Although interpersonal hypersensitivity in BPD patients is well recognised, the social stimuli experienced as threats by BPD patients are not clearly understood. Within interpersonal situations, BPD patients present with an intense fear of rejection, as described in the diagnostic criteria (*DSM-5*; American Psychiatric Association [APA], 2013). Hence, any social stimuli that BPD patients have learnt to associate with rejection may be perceived as a threat. Therefore, the current research will investigate the interpersonal stimuli BPD patients may perceive as threats.

Rejection Sensitivity and Need to Belong

Based on the evolutionary perspective, one of the fundamental and universal needs and characteristics of human beings as a social species is the desire to be accepted or belong to others to have a positive and lasting interpersonal relationship, and to feel secure about attachments to others (Baumeister & Leary, 1995; DeWall, Deckman, Pond, & Bonser, 2011; Leary & Baumeister, 2000; Staebler et al., 2011). As social ties are essential for human survival, the fundamental and central motive is to increase social bonds and avoid social rejection in order to increase the chances of survival (Baumeister & Leary, 1995; Bowlby, 1969, 1973; Downey & Feldman, 1996; Staebler et al., 2011). Social exclusion is critical for survival, and detecting rejection-relevant cues is essential in order to prevent ostracism. Hence, rejection sensitivity can be considered to be evolutionarily adaptive (Leary & Baumeister, 2000). For instance, human infants cannot survive without caregivers for nutrition and protection.

As noted, research and literature suggests that early attachment with caregivers is critical for infants' survival and development. Even later on, human beings continue to form social groups to support one another in order to better survive by sharing responsibilities, food, and protection of offspring (Eisenberger 2015). In order to efficiently adapt to the surrounding social environment, human beings have developed a monitoring system to detect social rejection-relevant cues. When the fundamental need to belong to others is not met, individuals experience negative emotional, cognitive and behavioural responses (Staebler et al., 2011). For instance, when children detect threats to attachment bonds (i.e., neglect) from their caregivers, they undergo emotional distress (i.e., anxiety or fear) associated with future abandonment (Downey, Freitas, Michaelis, & Khouri, 1998; Downey & Feldman, 1996). In order to prevent the same situation from reoccurring, children will learn to associate social cues (i.e., facial expressions of their caregivers) with a negative consequence (i.e., neglect) and change behaviours when they detect the threatening cues. Although the ability to detect rejection cues is a central and universal human capacity, sensitivity and readiness to detect the cues and the response to rejection differ depending on past experience (Downey & Feldman, 1996).

Rejection sensitivity is defined as a cognitive and affective operating system of anxious expectations of rejection and exaggerated reactions to perceived rejection-relevant cues and intense response to perceived rejection (Downey & Feldman, 1996; Downey, Freitas, Michaelis, & Khouri, 1998). Extant theories concerning rejection sensitivity are based on attachment theory, cognitive social learning theory, and developmental accounts of early experiences of

rejection or neglect in developing anxiety or fear associated with future rejection (Downey et al., 1997; Downey & Feldman, 1996).

As discussed above, Bowlby's attachment theory proposes that children develop mental models about themselves and others that impact their interpersonal relationship styles later in adulthood (Bowlby, 1969, 1973). The fundamental factor underlying this model is the expectation of whether their significant others will satisfy or reject their needs. Their expectations derive from their early experience with their primary caregivers. Whether the caregivers reliably, consistently, and sensitively satisfy the child's needs (i.e., affection, safety etc) will influence the child's development of secure working models.

These models incorporate expectations about others as to whether they will be either rejected or accepted. If the primary caregiver (i.e., mother) does not reliably and sensitively respond to the child's needs (i.e., abuse), the child may form an expectation that he/she is more likely to be rejected when he/she seeks support or acceptance from his/her significant others. Hence, individuals with unreliable caregivers as children tend to become more anxious about expressing their needs to significant others and hypervigilant to rejection-relevant cues (Downey & Feldman, 1996). In response to repeated negative experience (i.e., rejection) from significant others (i.e., caregivers), individuals are more likely to develop heightened rejection sensitivity and experience cognitive impairments and emotional instability in interpersonal relationships (Staebler et al., 2011). It has been shown that early childhood traumatic experiences increase the risk of developing heightened rejection sensitivity (Feldman & Downey, 1994). When people detect potential threats such as neglect from caregivers and rejection by

significant others, emotional distress caused by rejection may lead to behavioural consequences (i.e., self-harm) (Berenson et al., 2016).

In this vein, Dixon-Gordon and colleagues (2011) suggested that expectations influence perceptions, attributions, and interpretations of others' behaviours. The cognitive process is linked to affective processes, so negative interpretation or perception of others' behaviours increases negative affect such as anxiety and pain. Also, an increase in negative affect impairs cognitive functions. This cognitive-affective process leads to behavioural outcomes such as over-reaction with intense hostility and interpersonal problems. Thus, rejection sensitivity refers to three processes: expectation, perception of rejection-related cues, and response to these cues (Rosenbech & Renneberg, 2011).

Dutton (1994,1995) has investigated rejection sensitivity and states that there are negative consequences of heightened rejection sensitivity. Those with higher rejection sensitivity were more likely to have interpersonal problems due to their tendency to exaggerate minor disagreement and interpret ambiguous behaviour as personal attacks. When people with heightened rejection sensitivity perceived potential rejection-relevant cues, they were more likely to respond with hostility (Downey, Freitas, Michaelis, & Khouri, 1998), and aggressive behaviours (Ayduk et al., 2008; Gupta, 2008) as perceptions of rejection could elicit anger (Leary, Twenge, & Quinlivan, 2006; Renneberg et al., 2012). This may lead to actual social rejection in a self-fulfilling prophecy (Downey, Freitas, Michaelis, & Khouri, 1998; London, Downey, Bonica, & Paltin, 2007; Staebler et al., 2011).

Research of romantic relationship styles in individuals with heightened

rejection sensitivity has shown that females with heightened rejection sensitivity are more likely to have fights with their romantic partners and express verbal and non-verbal hostility in response to perceived rejection (Ayduk, Downey, Testa, Yen, & Shoda, 1999). Also, males with heightened rejection sensitivity were more likely to engage in intimacy-seeking behaviours towards their romantic partners and physical violence than men with low rejection sensitivity (Downey, Feldman, & Ayduk, 2000). Hence, individuals who are hypersensitive to potential rejection threats are more likely to have interpersonal problems due to impairments in cognitive-affective responses. In response to features of even innocent social interactions, people with high rejection sensitivity may misinterpret and experience intense negative emotional arousal, which may then lead to maladaptive social behaviours such as aggression or withdrawal (Downey, Freitas, Michaelis, & Khouri, 1998; Euler et al., 2018; Staebler et al., 2011). Those maladaptive consequences ultimately undermine their interpersonal relationships even further and create reasons for others to reject them (Berenson et al., 2009), eliciting more negative affect related to rejection.

Rejection Hypersensitivity in BPD

As described earlier, one of the diagnostic criteria, and a core symptom, of BPD is the fear of rejection by significant others (*DSM-5*; American Psychiatric Association [APA], 2013). Given that BPD patients frequently endorse a history of maladaptive childhood experiences, such as parental criticism (Crowell, Beauchaine, & Linehan, 2009), psychological or physical neglect (Widom, Czaja, & Paris, 2009), psychological, physical and sexual abuse (Ball & Links, 2009; Conwat et al., 2015; Hengartner et al., 2013) and bullying (Sansone et al., 2010;

Winsper et al., 2017; Wolke et al., 2012), they are expected to show high levels of rejection hypersensitivity. Although rejection sensitivity has been associated with many aspects of personality, such as low self-esteem, anxiety, insecure attachment, and neuroticism (Berenson et al., 2009), and is considered to be a core feature of mental disorders characterized by interpersonal problems (Feldman & Downey, 1994), rejection sensitivity has been investigated mostly in social psychology in community samples, and there are very few studies in clinical populations (Staebler et al., 2011). Feldman and Downey (1994) have suggested that rejection sensitivity is an important feature in individuals with social phobia and avoidant personality disorder who show abnormal social avoidance, as well as those with dependent personality disorder who show an intense social preoccupation. However, a recent review proposes that rejection sensitivity is an important feature not only in those two specific clinical populations but also in a wider range of clinical and subclinical groups.

Rosenbech and Renneberg (2011) have conducted a systematic review and indicated a positive relationship between rejection sensitivity and a number of clinical and subclinical symptoms such as BPD traits, depressive symptoms, social anxiety symptoms, and aggressive behaviours. An increasing number of studies have supported this link between rejection sensitivity and BPD features (Gunderson, 2007; Renneberg et al., 2012), and have empirically examined this relationship (Ayduk et al., 2008; Butler et al., 2002; Boldero et al., 2009; Fertuck et al., 2013; Meyer, Ajchenbrenner, & Bowles, 2005; Ruocco et al., 2010; Staebler et al., 2011). Clinical and non-clinical individuals with higher BPD features have been shown to have heightened levels of rejection sensitivity (Arntz,

Dreessen, Schouten, & Weertman, 2004; Arntz, Dietzel, & Dreessen, 1999; Ayduk et al., 2008; Butler et al., 2002; Boldero et al., 2009; Fertuck et al., 2013; Gunderson, 2007; Meyer et al., 2005; Miano et al., 2013; Renneberg et al., 2012; Ruocco et al., 2010; Staebelr et al., 2011; Stanley & Siever, 2010) and believe that they would be rejected in the future (Arntz, Dreessen, Schouten, & Weertman, 2004; Arntz, Roos, & Dreessen, 1999; Ayduk et al., 2008; Renneberg et al., 2012).

Intense and maladaptive reactions in response to perceived rejection in BPD patients are widely acknowledged in interpersonal situations. Individuals with more BPD features experience an intense negative emotional reactivity in response to social rejection (Chapman et al., 2014; Lobbestael & McNelly, 2015). Although not all BPD patients experience rage, both individuals with higher rejection sensitivity and BPD experience intense hostility and rage towards others in response to perceived rejection (Berenson, Downey, Rafaeli, Coifman & Paquin, 2011).

To this end, Berenson and colleagues (2011) investigated the rejection-rage contingency in BPD patients compared with healthy controls in a laboratory setting and in their daily lives using electronic diaries. In order to examine the extent to which thoughts of abandonment automatically induce thoughts of rage among BPD patients compared to healthy individuals, researchers asked participants to read the words presented in the centre of a computer screen aloud while ignoring the distractive words appearing at the top or bottom of the screen. The distractive words included rejection-related words to induce thoughts of abandonment. BPD patients were significantly faster to respond to rage-related

words when the distractive word was rejection-related words than when it was neutral. Hence, the authors concluded that BPD patients had a tendency to automatically associate rejection-related stimuli with rage. Authors further asked participants to take an electronic diary home and complete the diary for 21 days. Participants were instructed to answer questions regarding their current thoughts (i.e., *I am rejected by others*) and feelings (i.e., *irritated*). BPD patients were found to experience significantly more rejection and rage compared to healthy individuals during the 21 days.

Veen and Arntz (2000) also investigated the effect of themes of rejection or abandonment on BPD patients. In this study, participants watched a series of video clips on different themes. BPD-related themes in these video clips involved relationship crises, threatening desertion (e.g., a dying child), sexual abuse of a child, and threatening rejection of a child. BPD patients were found to show strong emotional reactions and extreme evaluations of others (i.e. all good/ all bad) in situations that were emotionally provoking for them, such as rejection. BPD patients also showed more dichotomous thinking, but only following the BPD-related negative social situations (e.g., relationship crises). Further, the association between BPD features and trust appraisal was mediated by rejection sensitivity (Miano et al., 2013).

To assess the effect of social exclusion on BPD patients, Staebler and colleagues (2011) conducted an experiment using the Cyberball paradigm, an online ball-tossing game, to induce the experience of social inclusion and exclusion. In the inclusive interactions, participants received a fair number of ball-tosses. In the exclusion condition, participants received almost no ball-tosses

during the game; hence, they felt rejected by the other players. The participants' emotional states were assessed before and after the Cyberball paradigm. Also, participants' facial expressions during Cyberball were video-recorded and analysed. Results indicated that BPD patients experienced more negative emotions following social exclusions and showed fewer positive facial expressions during exclusive interactions.

Further, self-injury behaviours and suicide attempts are more likely to occur in the context of interpersonal relations (Brodsky et al., 2006; Brown et al., 2002; Herpertz, 1995). Twenge and colleagues (2002) have postulated that the experience of social exclusion increases self-defeating behaviours (Twenge, Catanese, & Baumeister, 2002). These features are related to the BPD symptoms of recurrent suicidal behaviour, sense of emptiness and dissociative symptoms.

Intense and abnormal reactions to perceived rejection among BPD patients are seen not only in their behaviours, but also in their neural responses. Recent neuroimaging research has indicated that BPD patients have abnormal brain activity following social rejection (Renneberg et al., 2012; Staebler et al., 2011). Domsalla and colleagues (2014) assessed BPD patients' brain activities using the functional magnetic resonance imaging (fMRI) during the Cyberball paradigm. The results revealed a stronger activation in the insula and the dorsal anterior cingulate cortex (dACC). However, it is not entirely clear why those brain regions have abnormal activity as these areas play a role in a variety of functions, including error detection, processing uncertainty, and negative affective components of social pain (Botvinick et al., 2004; Eisenberger et al., 2015).

An Alarm System To Detect Threats

Recent reviews have suggested that the dACC is responsible not only for the cognitive processing to detect salience, but also for pain and negative affect. For instance, Shackman and colleagues (2011) conducted a meta-analysis investigating the function of each part of the ACC. They found that the dACC was activated during the tasks associated with negative affect, physical pain, and conflict monitoring. Lamm and Singer (2010) have also proposed that the anterior insula is responsible for learning about uncertainty in social situations.

Eisenberger and her colleagues have suggested that the dACC and insula function as a neural “alarm system” involving both cognitive and affective components (Eisenberger et al., 2004; 2015). According to this model, the cognitive aspect of this alarm system is monitoring for any potential hazards, such as uncertain or unexpected situations, where there is a discrepancy between their predictions and reality. In the face of anxiety or fear when BPD patients detect a potential threat, the alarm system is activated in order to shift attention to the problem. The affective component of this alarm system gives a warning by increasing negative affective arousal, such as social pain. Hence, the anterior insula and the ACC are considered to be an emotional salience network to meant to detect a hazard (Seeley et al., 2007).

Given that patients with BPD have increased vulnerabilities due to their genetics and developmental environment, they may have developed a highly sensitive alarm system to monitor for potential threats. It can be speculated that the alarm system among BPD patients is hypersensitive; hence, it is quickly and frequently activated by stimuli that they have learned to associate with danger. As

a result, BPD patients may be constantly under distress due to elevated negative arousal. However, it is not well understood exactly when this alarm system is activated. In other words, the triggers for the activation of the dACC and the insula in BPD patients are still not well understood.

An increasing number of cognitive, neuroimaging and neuroscience studies have proposed three important triggers that are relevant to BPD patients' hypersensitivity to detecting threats: rejection (Eisenberger, 2015; Kawamoto et al., 2012), uncertainty (Mortensen et al., 2016), and expectation violation (Botvinick et al., 2004; De Panfilis et al., 2015; Somerville et al., 2006). It may be argued that when BPD patients encounter uncertain/ambiguous situations or when their expectations are violated and they perceive rejection, their alarm system is quickly activated by detecting those social threats.

Negative Affect of Social Pain

The first factor, which explains the increased activity in the dACC and insula following social exclusion among BPD patients, is the negative affect induced by social pain (Kawamoto et al., 2012). In the past decade, a number of researchers have investigated the individual's experiences of social pain. A growing number of empirical research studies using different research methodologies suggest an overlap between social and physical pain perception mechanisms. In response to those negative social experiences, people across many different cultures with different languages frequently describe rejection as painful (MacDonald & Lear, 2005), which suggests that it may be a universal phenomenon (Eisenberger, 2015). Although physical pain sensations are unpleasant for anyone, pain has essential benefits in increasing the chances of

human survival by capturing attention and motivating individuals to remove themselves from potential or actual harmful situations.

Given that humans are a social species that heavily depends on others, separation from the social group represents a devastating threat to physical safety and survival. Hence, both social pain due to the exclusion from the social group and physical pain might have the same or similar function, purpose, and mechanisms (Eisenberger 2015). Bush and colleagues (2000) have argued that the ACC is primarily responsible for processing affective components of social pain. This argument has been supported by recent meta-analyses showing that more general negative affect activates the dACC and AI (Kober et al., 2008; Shackman et al., 2011). In addition, more recent meta-analyses of only those studies that used emotion-inducing tasks and excluded emotion perception tasks (i.e. emotional face recognition) found that the dACC was responsive to emotion-inducing tasks and most consistently responsive to negative affect, such as fear and anxiety (Etkin et al., 2011; Shackman et al., 2011; Vytal & Hamann, 2010).

Although many studies suggest that the dACC is responsive to negative emotions, such as fear and anxiety, it is still not clear whether the activation in the dACC is part of a social-affective process or non-social affective process. Lesion studies with animals have found that monkeys who had damage to the ACC displayed reduced social interaction behaviours, but did not consistently alter their non-social behaviours (Hadland et al., 2003). Further, lesion studies have indicated that the activities in the dACC and the AI were specific to social affective processes and pain, but not specific to the affective processes that do not include social components (Eisenberger, 2015).

In summary, the above findings suggest that the dACC is responsive to a variety of emotions, in particular, fear and anxiety, which enhances social behaviours.

Intolerance of Uncertainty

Another possible explanation for the activation of the dACC and insula following social exclusion among BPD patients is that they may be uncertain as to whether the interaction is positive or negative. Social interactions always contain some ambiguity as the true intentions of others' behaviours cannot be seen. Therefore, people can only speculate about others' intentions based on observable behaviours or previous experience. However, uncertainty in social situations is threatening (Mortensen, Evensmoen, Klensmeden, & Haberg, 2016), particularly among insecurely attached individuals who are more likely to perceive uncertainty and unpredictability from their parents (Carleton, 2016). Adult attachment insecurity is associated with an increase in cognitive closure tendencies, intolerance of uncertainty, and dogmatic thinking tendencies (black/white thinking) (Mikulincer, 1997). Given that rejection-hypersensitive individuals hold anxious expectations, they automatically assume that interpersonal situations will have negative consequences (i.e., abandonment). However, not knowing when or whether these negative events may happen in the current situation elevates anxiety.

Past research has used physical pain stimuli to investigate whether uncertainty about the timing of negative events affects perceptions. The results suggest that uncertainty about the timing of receiving the painful stimulus increases the negative affect of a painful experience (Oka et al., 2010; Prince et

al., 1987) and pain perception of a non-painful or mild pain stimulus (Atlas et al., 2010; Sawamoto et al., 2000). Therefore, not knowing when to expect a negative experience has an aversive effect by intensifying negative emotional arousal (i.e., fear, pain). In this regard, intolerance of ambiguity is defined as an individual's tendency to react in an intolerable manner in response to uncertain situations (Buhr & Dugas 2002; Dugas, Buhr, & Ladouceur, 2004). Further neuroimaging studies have shown that individuals with higher intolerance of uncertainty displayed increased activity in the insula when they viewed ambiguous facial expressions (Simmons et al., 2008). In another study conducted by Schienle and colleagues (2010), researchers showed aversive (i.e., accident) and neutral (i.e., geometric figures) pictures to the participants while scanning brain activities. The results showed that processing uncertainty increased activity in the ACC and the insula, and intolerance of uncertainty was positively correlated with amygdala (responsible for emotions) activation, which might indicate that uncertainty increased negative affect.

Intolerance of uncertainty has been investigated most extensively and systematically with generalized anxiety disorder (GAD) and obsessive-compulsive disorder (OCD) (Leyro et al., 2010; Schienle et al., 2010). However, intolerance of uncertainty has been recently linked to a variety of mental disorders, including neuroticism (Norton & Mehta, 2007), mood disorders (i.e., depression), psychotic experiences (i.e., persecutory delusions) (Freeman et al., 2006), and personality disorders (i.e., obsessive-compulsive personality disorder). Intolerance of uncertainty has been associated with cognitive rigidity, maladaptive level of openness to experience (Fergus & Rowatt, 2014), impulsivity, need for

cognitive closure (Berenbaum et al., 2008), and jumping to conclusions (Freeman et al., 2006).

As described earlier, Downey and Feldman (1996) proposed a model suggesting that individuals with higher rejection sensitivity hold anxious expectations of rejection and perceive intentional rejection, whether it is intentional or not, in their significant others' ambiguous or insensitive behaviours, experience intense negative affect, and react with hostility. This model is supported by a number of empirical studies (Downey & Feldman, 1996; Pietrzak, Downey, & Ayduk, 2005), finding that individuals with higher rejection sensitivity experienced more rejected mood specifically when they received ambiguous rejections. Rejection-sensitive individuals had a tendency to try to identify the reasons for their rejection, whereas individuals with lower rejection sensitivity were less likely to perceive the other's ambiguous behaviours as a rejection and less likely to attribute it to personal causes. As many future events and outcomes in everyday social life often involve uncertain situations, individuals' capacity to tolerate uncertainty or ambiguity is important in understanding maladaptive cognition and behaviours during the social interactions.

Given that one of the BPD diagnostic criteria includes being “threatened by uncertainty” (*DSM-5*; American Psychiatric Association [APA], 2013), BPD patients tend to be intolerant of uncertainty. Consistent empirical evidence has suggested that BPD patients are more likely to have negative cognitive and affective bias towards neutral or ambiguous social stimuli (Baer et al., 2012; Fertuck et al., 2013; Mitchell et al., 2014). For instance, robust empirical evidence

has shown that BPD patients tend to perceive ambiguous facial expressions more negatively (Arntz et al., 2001), ascribe anger to ambiguous faces (Domes et al., 2008), rate ambiguous faces as more untrustworthy (Miano et al., 2013), attribute negative emotions to ambiguous faces (Dyck et al., 2009; Wagner & Linehan, 1999), and have more aversive reactions in response to neutral faces (i.e. hyperactivation in the amygdala) on the Reading the Mind in the Eyes Test (RMET) (Donegan et al., 2003; Minzenberg et al., 2008). The RMET consists of a series of pictures of the areas of faces around the eyes, and participants are asked to judge the mental state of the person in the pictures. These findings suggest that BPD patients present with negative biases toward ambiguous social cues.

Lobbestael and McNelly (2016) investigated whether BPD can be characterized by interpretation and attributional bias for ambiguous stimuli in favour of threatening attributions, such as rejection, using vignettes describing ambiguous social interactions. Participants' interpretation was assessed in both open and closed answer formats. BPD patients exhibited rejection and anger-related attributions and interpretation bias in ambiguous social situations (Lobbestael & McNelly, 2016). Further, LeGris and colleagues (2012) conducted a study to investigate the impact of uncertainty of reward-punishment probabilities on emotionally related decision-making processes using the Iowa Gambling Task. Participants were instructed to select cards from four decks, and some of the decks had greater advantages for maximizing profit than others. However, participants were not aware of when the task would end or which decks had more advantages. It was found that BPD patients performed significantly worse compared to healthy individuals, which suggested that experiencing

uncertainty led to poor decision-making among BPD patients (LeGris, Links, van Reekum, Tannock, & Toplak, 2012). This suggests that intolerance to ambiguity may lead to impairments in higher cognitive functions.

Meyer and colleagues (2005) assessed rejection sensitivity in those with BP features and avoidant personality features using a vignette task (i.e., imagine you are invited to a party, but a host expresses hesitation, which possibly suggests that the invitation is not sincere) to investigate the pessimistic cognitive-affective response in the rejection-related situations. They found that those with higher BP features were more likely to experience intense negative moods, more problematic attachment with their caregivers, catastrophic interpretations of ambiguous situations, and hypersensitivity to subtle emotional stimuli. Further, another study (Miano et al., 2013) investigated the association between BPD features and attribution bias of untrustworthiness to neutral faces using non-clinical samples. Participants were exposed to a number of faces on a screen and rated how trustworthy the faces were. They found that individuals with higher levels of BP features perceived the ambiguous faces as less trustworthy.

As described earlier, BPD patients often have dichotomous thinking (Kernberg, 1975; Linehan, 1993; Veen & Arntz, 2000). Kernberg (1975) argued that extreme evaluations of others (dichotomous thinking) helps minimize uncertainty-related distress. At the same time, it can also lead to a firm belief and cognitive inflexibility (i.e., narrowed attention focus on relevant information for the belief). A recent neuroimaging research (Mortensen et al., 2016) has investigated whether uncertainty-related distress can elicit impulsivity in BPD. The results indicated that the uncertainty increased activity in the dACC and

insula and led female BPD patients to become more impulsive (more incorrect and faster reactions on cognitive task) compared to healthy individuals.

These findings suggest that the abnormal reactivity in the ACC following the social rejection may be due to the experience of ambiguous social cues perceived by BPD patients (Mortensen et al., 2016). These findings are considered to be consistent with the anxious expectations of rejection in BPD patients (Domes, Schulze, & Herpertz, 2009).

Expectation Violation

The final possible explanation for the activation of the dACC and insula following rejection is that exclusive interactions during the Cyberball paradigm contradict what BPD patients expect to experience. As previously described, human brains are constantly making predictions about what will happen in the environment, and the alarm system monitors for any prediction error. If the expectations differ from the reality, the alarm system is activated, inducing negative affect to send a warning, leading individuals to modify their predictions for given situations. If they can adjust their expectations to better match reality, people can behave in a more appropriate manner. Some researchers have therefore argued that the dACC is responsible for detection of expectancy violations (Botvinick et al., 2004). They proposed an expectancy violation hypothesis stating that the dACC was activated after the exclusion condition in the Cyberball game not because they experienced affective components of pain, but because they did not expect to be excluded. Hence, the expectation was violated, leading to an increase in the dACC activation.

One of the first studies to test the expectancy violation hypothesis was

conducted by Somerville and colleagues (2006). This study investigated whether the ventral or subgenual ACC would be activated in response to social rejection and whether dACC activity would increase in response to the expectation violation. They tested this hypothesis using the social feedback task in which participants viewed multiple pictures of others and rated whether they liked them. Participants were also informed whether or not the people pictured liked them. The authors defined social rejection as occurring when others did not like the participants, and expectancy violation as when the responses of the participants and others did not match. The researchers found that the increase in activity in the dACC during the expectancy violation was comparable to that in the congruent condition. An increase in activity in the subgenual ACC was found during the social acceptance compared to the rejection condition. This result suggests that the dACC is activated in response to social exclusion due to the expectancy violation instead of the experience of social pain.

Those findings suggest that BPD patients may have abnormal expectations that are constantly violated. As a result, the alarm system keeps being activated, and BPD patients frequently experience negative emotional arousal. A recent study has indeed found that BPD patients had an unrealistic expectation of social participation. In this study, BPD patients and healthy controls played the Cyberball paradigm manipulating social interactions. BPD patients perceived more rejection than controls and reacted as if they were socially excluded even in the situation where they were objectively included (Renneberg et al., 2012; Staebler et al., 2011). This finding was further supported by neuroimaging evidence in which the same enhanced neural reactions in response to social

exclusion were detected following social inclusion among BPD patients. Gutz and colleagues (2015) investigated the neural responses to social interactions in BPD patients compared to patients with social anxiety disorder and healthy individuals. In this experiment, all participants had inclusive and exclusive social interactions manipulated by the Cyberball paradigm. They found that all participants showed a similar response to exclusive interactions. However, only BPD patients also showed neural reactions and felt they were more excluded following inclusive interactions. Hence, BPD patients perceived even inclusive interactions as rejecting and displayed negative reactions.

Such findings indicate that BPD patients may perceive rejection even in positive interactions due to their heightened rejection sensitivity. It may also be the case that BPD patients have abnormal expectations of social inclusion. Their threshold for social inclusion may be so high that the normal level of social inclusion may be perceived as exclusion. To investigate whether BPD patients indeed have an abnormal social expectation, De Panfilis and colleagues (2015) conducted an experiment employing a modified Cyberball paradigm by adding an extra condition: social inclusion, over-inclusion, and ostracism. They found that BPD patients exhibited similar levels of negative emotions, particularly anxiety, as that of healthy controls only when they were over-included. This finding suggests that BPD patients' elevated negative emotional reactions were reduced to the healthy level in response to the over-inclusion condition. However, BPD patients experienced negative emotions and more disconnection when they were in the inclusion condition. The authors concluded that BPD patients' idealized expectations of social inclusion due to their heightened need for belonging to

others may not be sufficiently fulfilled by “normal” levels of interpersonal inclusion. They may feel rejected because their implicit expectations for an extreme inclusion are violated. Nevertheless, this study did not assess the pre-existing expectations of social interactions among BPD patients. Hence, it is not clear whether BPD patients reacted negatively to social inclusion because they felt social pain (as they perceived social inclusion as rejection) or because they were surprised that they did not receive as many balls as they expected. Thus, BPD patients are not only hypersensitive to rejection-relevant cues, but may also hold an unrealistically idealized expectation for social inclusion. This extreme expectation could possibly reflect their fundamental need and desire to belong in interpersonal relationships.

To summarize, it may be argued that the alarm system in BPD patients is hypersensitive to potential hazards in unexpected and uncertain interpersonal situations due to their rejection hypersensitivity.

D. Coping Strategies in BPD

In response to social cues they perceive as threats, BPD patients develop coping strategies to reduce elevated negative affect (i.e., distress). Yet since these coping strategies tend to be rather maladaptive, they may cause more interpersonal problems.

Attachment Strategies

There are a number of theories explaining the interpersonal maladaptive behaviours in BPD patients. One such theory is the attachment theory, which emphasizes the developmental aspects of childhood interactions between the primary caregivers and infants. As described earlier, a robust literature confirms

that developmental factors play an important role in BPD patients' interpersonal hypersensitivity (Ayduk et al., 2008; Gunderson & Lyons-Ruth, 2008), a factor that is often the trigger for the emotional interchanges that can characterize the social experience of these individuals.

A more recent attachment theory proposed by Mikulincer and colleagues (Mikulincer & Shaver, 2012; Mikulincer, Shaver, Sapir-Lavid, & Avihou-Kanza, 2009) argued that the two-dimensional concepts of attachment anxiety and avoidance could reflect individuals' attachment security and their response to interpersonal threats and distress. According to this model, an avoidant attachment style was associated with schizoid and avoidant personality disorders. Anxious attachment was associated with borderline, dependent, and histrionic personality disorders. Recent studies have supported this model and suggested that the effect of adult attachment needs to be differentiated depending on the attachment style. Past research findings have suggested that attachment anxiety and attachment avoidance would have different effects on perceptions of conflict and support from romantic partners (Campbell, Simpson, Boldry, & Kashy, 2005) and reaction to perceived rejection (Besser & Priel, 2009). Campbell and colleagues (2005) conducted a two-part study in which dating couples completed diary questions regarding the amount of daily conflict, support, and perceived quality related to their romantic relationship for 14 days. After the first part of the study, participants discussed possible solutions to their conflicts with their partners. Individuals who were anxiously attached to their romantic partners were more likely to perceive conflict on a daily basis than what their partners reported. Also, anxiously attached individuals felt that the conflict was more hurtful to

them and that it would have a more negative and long-lasting impact on their relationships. When they discussed a serious conflict, anxiously attached individuals reported an elevated level of emotional distress. Individuals with avoidant attachment perceived supportive events less positively.

Besser and Priel (2009) investigated responses to imagined rejection by romantic partners using a vignette. Participants who were in romantic relationships read a vignette of hypothetical situations with themes of romantic rejection. Results suggested that those with an anxious attachment style, but not attachment avoidance, had more intense emotional reactions. Anxiously attached individuals reported more intense distress, anger, and vulnerability, along with lower self-esteem after reading the hypothetical romantic rejection scenarios. Individuals with the resistant/preoccupation attachment style (with attachment anxiety) exhibited an intense need to belong to others, sought a higher level of intimacy, and experienced substantial anxiety in response to separation. On the other hand, people with a dismissive attachment style (with attachment avoidance) were found to make extreme efforts to suppress their desire for attachment and maintain detachment when they dealt with a loss (Agrawal et al., 2004).

Further, neuroimaging studies have also supported rejection-related distress in anxiously attached individuals by showing heightened activity in the related brain regions. However, individuals with an avoidant attachment style exhibited less activation in these brain regions. Thus, these findings suggest that a heightened desire to belong to others, or attachment need, may only exist in anxiously attached individuals. The strategies used in individuals with different

attachment styles may vary in order to promote social bonds (DeWall et al., 2011).

A recent study (Cohen et al., 2016) has found attachment anxiety to be the mediator of the impact of childhood maltreatment on self-control capacities. Those who have experienced childhood adversity have more personality dysfunctions and self-control capacity due to an anxious attachment style. Therefore, attachment anxiety can be seen as a maladaptive strategy to cope with interpersonal adversities, which leads to cognitive dysfunction.

These attachment strategies have been investigated among individuals with BPD features. Attachment anxiety has been associated with BPD symptoms, whereas avoidant attachment is less consistently associated with personality disorders (Mikulincer & Shaver, 2007). Hence, avoidant attachment is not considered to be the primary risk factor for BPD symptoms (Beeney et al., 2015). A recent literature review (Cameranesi, 2016) has also suggested that an anxious attachment style predicts the development of borderline personality traits, while an avoidant attachment style predicts the development of antisocial personality disorder (ASPD). Another recent study (Ehrenthal, et al., 2018) has investigated the effect of childhood adversity on stress reactions in BPD patients compared to individuals with subclinical BPD symptoms and individuals without BPD symptoms. The authors concluded that the effect of childhood adversity on cortisol reactivity was moderated by attachment strategies. Therefore, it is important to investigate how BPD patients cope with their childhood adversity (i.e., abuse, bullying) as maladaptive coping strategies (i.e., attachment anxiety) may lead to further impairments (i.e., impaired self-control).

Self-Critical Perfectionism

As BPD patients have an elevated desire to belong to others due to attachment anxiety, they may try to achieve acceptance by others through perfectionism. A growing body of clinical and empirical evidence indicates that perfectionism may be a risk and maintaining factor for a variety of psychological problems, including depression, anxiety disorders, and suicidal behaviours (Campos, Besser, & Blatt 2013; Flett & Hewitt, 2002; Hewitt & Flett, 2002). People with BPD features and perfectionistic traits have been shown to have impaired interpersonal relationships (Ducasse, Courtet, & Olie, 2014; Flett & Hewitt, 2002), which are, in turn, associated with an elevated risk to experience psychological distress (i.e., suicide ideation and self-harm). In this context, self-critical perfectionism is described as an extremely critical evaluation of one's own performance, inability to be satisfied with one's successes, and chronic concerns about criticism by others (Dunkley, Blankstein, Masheb, & Grilo, 2006).

Although there are a number of different theoretical frameworks for the etiology of self-critical perfectionism and personality disorders, Blatt (1990) and colleagues have described personality development as the result of the integration of two polarities: self-definition (e.g., self-criticism) and interpersonal relatedness (e.g., dependency). Blatt (2008) suggested that aversive experience during early childhood (i.e., parental rejection and/or criticism), most probably in interaction with other environmental and biological factors, typically result in two maladaptive personality orientations. Adolescents may seek an achievement-oriented psychological control, in turn leading to a preoccupation with perfectionism. Blatt and Auerbach (1988) distinguished anaclitic BPD patients

(dependency) from introjective BPD patients (self-criticism). On the one hand, disturbance in issues of relatedness with their caregivers (i.e., the need to belong and to be acknowledged by caregivers), may lead to a tendency to become overly dependent on others, as is typical for so-called ‘anaclitic’ BPD patients. Anaclitic BPD patients tend to be preoccupied with the fear of rejection, whereas more introjective BPD patients tend to be worried about criticism and self-worth and thus primarily experience difficulties concerning identity and autonomy.

Another similar theoretical framework that relies upon the cognitive approach is Beck’s distinction between sociotropy and autonomy (1983). Beck’s constructs of autonomy and sociotropy are similar to Blatt’s constructs of self-criticism and dependency (Morse, Robins, & Gittes-Fox, 2002; Ouimette, Klein, Anderson, Riso, & Lizardi, 1994). Beck and colleagues (1990) construed BPD as a broader set of cognitive biases and behavioural patterns including both autonomy and sociotropy. Consistent with this assumption, Ouimette and colleagues (1994) found both autonomy and self-criticism to be associated with borderline, paranoid, and self-defeating personality features. On the other hand, sociotropy was associated with dependent, avoidant and histrionic personality disorder after controlling for severity of depressive symptoms.

A recent study reported that the association between past experience of parental rejection and risk of suicide ideation was mediated by self-critical perfectionism (Campos et al., 2013). In addition, self-criticism mediated the association between child maltreatment and non-suicidal self-injury behaviours (Glassman, Weierich, Hooley, Deliberto, & Nock, 2007). Another study (Falgares et al., 2017) has noted that self-criticism, but not dependency, mediated the link

between the insecure attachment styles (anxiety and avoidance) and suicide-related behaviours. Further, self-criticism has been shown to have a negative effect on both intrapersonal and interpersonal functioning in clinical and nonclinical populations. On the other hand, dependency had a negative effect only on intrapersonal functioning (Besser, Flett, & Davis, 2003), while being unrelated to interpersonal functioning (Dimitrovsky, Levy-Shiff, & Schattner-Zanany, 2002). Moreover, other studies have found the same effects even after controlling for the severity of depressive symptoms (Besser et al., 2003).

Another widely accepted conceptualization of perfectionism distinguishes between self-oriented perfectionism (SOP), other-oriented perfectionism (OOP), and socially-prescribed perfectionism (SPP). According to Hewitt and Flett, (1991), SOP refers to the tendency to set high standards for oneself in combination with high self-criticism. On the other hand, OOP refers to the tendency to expect others to be perfect. SPP is the perceptions that others expect perfection of oneself. Recent research has shown a robust association between SPP and suicidality (O'Connor, 2007), and BPD patients have been shown to have higher levels of SPP (Hewitt et al., 1994). Further, people with perfectionistic traits tend to have greater interpersonal problems, and SPP has also been found to be positively correlated with hypersensitivity to social rejection (Flett, Besser, & Hewitt, 2014). Previous research has also shown that people with borderline personality traits and perfectionistic traits have impaired interpersonal relationships (Ducasse et al., 2014; Hewitt & Flett, 2002), which has been linked to the risk of psychological distress (i.e. suicide ideation and self-harm).

Therefore, growing evidence has demonstrated the importance of perfectionistic

traits, particularly SPP, in predicting maintained suicidal behaviour (O'Connor, 2007) and shared characteristics with people with BPD, such as hypersensitivity to social rejection and interpersonal problems (Flett, Besser, & Hewitt, 2014). However, perfectionistic traits in people with BP traits are rarely investigated.

Although the link between self-critical perfectionism and BPD features is suggested in the previous study (Gunderson et al., 2018), the function of self-critical perfectionism in BPD patients has still not been well investigated. Thus, further research is needed to examine the function of self-critical perfectionism in relation to rejection sensitivity and BPD features.

Self-Harm Behaviours

As described earlier, self-harm behaviours and suicide attempts in BPD patients are more likely to occur within interpersonal contexts, particularly in response to negative social experience (Brodsky et al., 2006; Brown et al., 2002; Herpertz, 1995). There are a number of theories explaining the function of non-suicidal self-injurious behaviours and suicide attempts in BPD patients. One of these theories suggests that self-harm behaviours, and non-suicidal self-injuries in particular, may function as a coping strategy in BPD patients (Chapman et al., 2014; Grats, 2003; Gunderson et al., 2018; Linehan, 1993). As the experience of rejection increases self-harm behaviours (Twenge, Catanese, & Baumeister, 2002), it has been proposed that inducing physical pain sensations through self-harm and destructive behaviours (i.e., cutting) may function as a coping mechanism to distract attention from emotional distress (Chapman et al., 2014) and to regulate emotional distress in BPD patients (Grats, 2003; Gunderson et al., 2018; Linehan, 1993).

In support of the argument that self-harm behaviours are a coping strategy to divert attention away from psychological pain, BPD patients frequently describe the use of self-harm behaviours as a way to express anger, punish oneself, avoid or escape undesired emotions and situations, and control elevated emotional arousal (Brown et al., 2002). Twenge and colleagues (2003) endorse the effect of self-harm behaviours in reducing negative arousal. In this study (Twenge et al., 2003), self-harm behaviours were found to increase numbness, apathy, an absence of meaningful thoughts, and avoidance of self-awareness. It was suggested that other strategies to shift attention from negative stimuli may be insufficient; hence, the extreme stimuli by self-harm behaviours may be needed for BPD patients (Niedtfeld et al., 2010). Recent research has suggested that the overlapping mechanism of physical and social pain may explain the role of physical pain in reducing psychological pain among BPD patients.

Physical Pain and Psychological Pain

Brain lesion studies describe two types of components in the experience of physical pain: a sensory component and an affective component. A sensory component of physical pain focuses on the pain localization in the body, while the affective component encompasses the unpleasant feelings or distress from the experience of physical pain (Price et al. 1987). Lesion studies with animals have supported the link between the ACC and distress during mother-infant separation. Infant mammals with a damaged ACC had decreased distress vocalizations when they were separated from their mothers (Hadland et al., 2003). On the other hand, stimulating the ACC increased distress vocalizations (Robinson, 1967).

From observations of patients with brain lesions, these two components

have been found to be processed by different brain regions. It has been suggested that the affective aspect is processed by the dACC and the anterior insula (AI), whereas the sensory aspect is processed by somatosensory cortices and the posterior insula (PI) (Treede et al., 1999). Patients with damage to the dACC and AI can localize the source of physical pain, but the pain no longer bothers them. Further, patients with a pain disorder who have damaged sensory regions other than the affective regions reported the experience of pain following the experience of the death of a younger sibling (Danziger & Willer 2005). This indicates that people still can experience pain even if their sensory regions are impaired as long as the affective regions remain intact.

Neuroimaging studies have also supported that these two components of physical pain. Individuals' self-reported unpleasant feeling of physical pain positively correlated with the activity in the dACC and AI (Tölle et al., 1999). Thus, the overlapped component of physical and psychological pain is the affective aspect of painful experience (Eisenberger 2012, Eisenberger & Lieberman 2004; Eisenberger 2015). The affective component of pain alerts individuals via unpleasant feelings so that the individuals are motivated to reduce or escape from the source of the physical or psychological pain.

As described previously, past empirical research indicates that the dACC and anterior insula respond to both social rejection (Domsalla et al., 2014) and physical pain (Cacioppo et al., 2013; Eisenberger et al., 2003). Other studies have also shown that different forms of socially painful experiences, such as recalling romantic rejection (Fisher et al., 2010; Kross et al., 2011), encountering the threat of negative evaluation (Takahashi et al., 2009; Wager et al., 2009), and

remembering lost significant others (Gündel et al., 2003; O'Connor et al., 2008), and looking at rejection-related pictures (Kross et al., 2007), could also increase the activation of the dACC and AI. Therefore, these brain regions, the dACC in particular, have been suggested to be a common neural alarm signal of physical and psychological pain (Eisenberger, 2015; Eisenberger & Lieberman 2004; Gunderson et al., 2018).

In the study by Kross and colleagues (2011), both the sensory and affective regions of the participants showed overlapping activity following the social and physical pain task. Further, the dACC activity following social rejection was positively correlated with self-reported social pain (Eisenberger et al., 2007). Moreover, DeWall and colleagues (2010) reported that acetaminophen, a mild pain reliever that inhibits the ACC activity, could inhibit physical pain as well as the subsequent social pain of ostracism. Social supports that are known to reduce social pain also reduce physical pain, so those who have more social supports are more likely to feel less pain (Zaza & Baine, 2002). Also, looking at the photo or holding the hand of their romantic partner decreased self-reported pain and dACC and AI activity following the painful stimuli (Eisenberger et al., 2011; Master et al., 2009; Younger et al., 2010).

If the neural mechanisms for social pain and physical pain do indeed overlap, one should expect that individuals who are sensitive to one kind of pain are also sensitive to the other kind of pain. In fact, clinical reports have found that chronic pain patients do have a higher sensitivity to social pain (Asmundson et al., 1996), and those who are more likely to be hypersensitive to social pain reported more somatic symptoms, such as pain (Ciechanowski et al., 2002; Ehnvall et al.,

2009; Waldinger et al., 2006). In addition, subjects who carry a gene (μ -opioid receptor gene; OPRM1) associated with physical pain sensitivity reported greater sensitivity to social rejection and revealed higher activity levels in the dACC and the AI following social exclusion (Way et al., 2009).

Although past neuroimaging studies have suggested that social and physical pain share overlapping neurological pathways, factors in the interplay between social and physical pain are not well understood. Eisenberger and colleagues (2006) have argued that an increase in exclusion experiences also increases pain sensitivity. They found that individuals who were hypersensitive to experimentally increased physical pain reported more psychological pain following social exclusion (Eisenberger et al., 2006), which was consistent with other studies (Levine et al., 1993; van den Hout et al., 2000). However, DeWall and Baumeister (2006) found that social exclusion reduced pain sensitivity (numbing).

According to the analogy of physical pain, mild pain increases pain perception, but severe pain leads to analgesia. Thus, Bernstein and Claypool (2012) investigated the moderating factors in the pain process. They proposed a severity hypothesis in which the intensity of social rejection modulated the painful experiences. The pain sensitivity of participants was assessed before and after playing the Cyberball paradigm. Their results suggested that the severity of social exclusion modulated the pain perception. Severe pain stimuli led to a physical pain-numbing, whereas the mild pain led to heightened pain sensitivity. Thus, severe social exclusion increased physical pain tolerance and reduced pain sensitivity, but less severe social exclusion increased pain sensitivity and reduced

pain tolerance. The authors concluded that the perceived severity of social exclusion was an important factor in the association between social and physical pain sensitivity (Bernstein & Claypool, 2012). Although BPD patients have a higher tolerance for acute physical pain, they show higher sensitivity to social pain caused by perceived interpersonal rejection (Beeney et al., 2014).

Based on these studies, it has been suggested that physical pain induced by self-harm behaviours may function as a coping strategy to reduce psychological pain because both physical and psychological pain activate the same brain areas, including the insula, amygdala, and the dACC, and the brain tries to compensate for the hyperactivity of this area by suppressing the reaction toward the physical pain (Ducasse et al., 2014).

E. Cognitive Disturbance in BPD

Social Cognition

As described earlier, the alarm system of BPD patients is so hypersensitive that BPD patients may perceive many social cues (i.e., rejection, uncertainty, expectation violation) as threats, leading to elevated negative emotional arousal. This affective instability, a core BPD characteristic, has been shown to have a negative impact on cognition in BPD patients (Schulze et al., 2011). Within interpersonal contexts, social cognitive capacities to accurately interpret social cues and understand others' intentions, known as mentalizing, are critical to avoid miscommunication and to develop healthy interpersonal relationships. Mentalizing is defined as the implicit and explicit social cognitive ability to understand oneself and others based on intentional mental states (Bateman & Fonagy, 2004; Luyten & Fonagy, 2015). It is a fundamental and central capacity

in a social environment and normative human development. Unsurprisingly, individuals with personality disorders have been associated with impaired mentalization. However, further research has shown that mentalizing impairments are seen not only in personality disorders, but also in many other forms of psychopathology, such as psychosis (Chung, Barch, & Strube, 2014), eating disorders (Kuipers & Bekker, 2012), and major depression (Cusi, Nazarov, Holshause, Macqueen, & McKinnon, 2012).

Accurate mentalizing enables people to predict what others would do next based on their intentions; hence, they can adjust their actions to achieve an aimed goal (Franzen et al., 2011). Further, an awareness and understanding of one's own and others' intentions based on their behaviours is important in order to regulate one's own subsequent emotional reactions. In order to interpret others' mental states, people need to analyse external (i.e., behaviours or facial expressions) as well as internal cues (i.e., emotions). Bateman and Fonagy (2004) have proposed that impairments in mentalizing capacity are a significant contributor to the interpersonal problems in BPD patients. In contrast to theory of mind (ToM), the ability to recognize that others have a different mental state from oneself, mentalizing requires the ability to recognize one's mental intention and infer others' mental intentions based on both emotional and mental states.

Fonagy and Bateman (2004) have developed a psychological treatment that focuses on enhancing the mentalizing capacities in BPD patients, mentalization-based treatment (MBT). Impairments in mentalizing capacities have been suggested as a possible explanation for the difficulties in treatment among BPD patients. In the therapeutic setting, BPD patients have difficulty

understanding the intentions of their therapists due to their impaired mentalizing. As BPD patients cannot understand the intention of the therapists, they cannot trust their therapists as a reliable source of information in order to integrate their advice to modify their perceptions of the social world and their behaviours.

Developmental Aspects of Mentalizing

According to Fonagy and colleagues (2003), developing a secure attachment depends on the caregivers' abilities to understand their own and others' needs, minds and desires, and the caregivers' own mentalizing capacity helps their children develop this capacity. If they fail to develop this capacity to comprehend their own and others' behaviours based on the underlying mental states, they are more likely to experience challenges when interacting with others, as they struggle with interpreting social interpersonal experiences, particularly in situations where the attachment system is activated (i.e. perceived threat). Hence, mentalizing is a developmentally achieved cognitive capacity acquired through early interactions with primary caregivers. If individuals are insecurely attached due to dysfunctional interactions with caregivers (i.e., neglect), they will have deficits in mentalizing, leading to more interpersonal problems. Fonagy (1998) has argued that the primary caregivers' capacity to understand, react with contingent mirroring, and show affection in response to their children's subjective mental states and needs are critical for children to be able to comprehend their own and others' mental state and intention.

A considerable amount of evidence has shown the importance of individuals' early attachment relationships with their caregivers in developing healthy mentalizing abilities. Bateman and Fonagy (2006) argue that family

background may disrupt the development of mentalizing both with and without any episode of childhood trauma. Traumatic family context and biological factors may evoke to a maladaptive and hypersensitive stress-response mechanism, leading to hyper-arousal, affective instabilities, and hyperactivity in the orbitofrontal cortex, which is a brain region associated with mentalizing.

Epistemic Trust, Attachment, and Mentalizing

Fonagy and Allison (2014) go on to note that impairments in mentalizing capacities have negative influences on the ability to trust the source of information as reliable and trustworthy (epistemic trust). Epistemic trust is described as a belief that newly transmitted information from others is trustworthy, generalizable, and self-relevant.

If people cannot understand others' mental state and intentions, they cannot predict the future actions of others. Therefore, they cannot consider others as reliable and trustworthy. Impairments in mentalizing are critical in the therapeutic setting because BPD patients cannot trust their therapists as a reliable source of information without understanding their therapists' intentions (Langley & Klopper, 2005). One of the most important factors that contributes to the better treatment outcomes is patients' trust in clinicians (Langley & Klopper, 2005). Hence, Fonagy and colleagues have argued that BPD patients tend to have difficulties in therapy due to their impaired mentalization (Fonagy & Allison, 2014; Fonagy & Bateman, 2008).

Outside the therapy room, BPD patients are found to have difficulties in trusting others in general. In the previous study using a virtual trust-game, BPD patients showed the tendency to mistrust their partners, and an inability to

maintain cooperation. Also, BPD patients displayed impairments in repairing the damaged cooperation due to mistrust (King-Casas, Sharp, Lomax-Bream, Lohrenz, Fonagy, & Montague, 2008; Seres, Unoko, & Kèri, 2009). Trusting others and cooperating are essential in developing healthy interpersonal relationships in both social and therapy situations (Langley et al., 2005). The high rate of early drop-out from treatment among BPD patients may be due to the mistrust in their therapists. Even if BPD patients continue in therapy, the treatment cannot be effective without cooperation from patients.

From the developmental perspective, childhood experiences with the primary caregivers form the foundation of epistemic trust (Fonagy & Allison, 2014). Corriveau and colleagues (2009) conducted a longitudinal study exploring whether children trusted their mothers or strangers when they made either the same or conflicting claims. In this study, visual cues of unfamiliar objects and hybrid animals (equal hybrid: 50% bear, 50% pig; unequal hybrid: 75% bird, 25% fish) were presented, and children identified the objects in the visual cues based on the information provided by their mothers and strangers. Results revealed that children had a tendency to request and take the information provided by their mothers in response to visual cues of unfamiliar objects and hybrid animals (50% - 50%). However, if the majority of visual cues of hybrid animals (i.e., 75% bird, 25% fish) were inconsistent with their mothers' claim (i.e., fish), but consistent with the strangers' response (i.e., bird), children were less likely to trust their mothers. Further analyses revealed that individual differences in reliance on information by their mothers and strangers varied depending on their attachment styles. Children with secure attachments were flexible when their mothers and

strangers made conflicting claims. When the visual cues and their mothers' claim were consistent, they relied on their mother's information. However, when their mothers' claims were not plausible, they relied on the information from strangers. On the other hand, children with avoidant attachments showed the least reliance on their mothers and were less likely to rely on information provided by their mothers regardless of the consistency of the visual cues and their mothers' claim. Children with resistant attachments showed the greatest reliance on information provided by their mothers, even when their mothers' claims were improbable. Children with disorganized attachments had the most inconsistent responses, tending to regard both claims from their mothers and strangers with suspicion. Thus, insecure attachment styles based on maladaptive childhood experience might generate epistemic mistrust (Corriveau, Harris, Meins, Fernyhough, Arnott, Elliott, & Fosnary, 2009).

An increasing number of studies investigating the social cognitive capacity of BPD patients have suggested that due to the maladaptive cognitive-affective process (i.e., negative cognitive biases) and epistemic mistrust described earlier, BPD patients often have disturbances in social cognition, which hinders healthy social interactions and results in interpersonal difficulties (Herpertz & Bertsch, 2014; Roepke et al., 2015). However, the results for mentalizing capacities in BPD patients are rather mixed.

Impaired Mentalizing in BPD

A large number of studies have investigated this topic in BPD patients and suggested that impaired social cognition may be responsible for the development and maintenance of BPD (Hill et al., 2008; Levy, 2005; Preißler et al., 2010;

Roepke et al., 2013). In order to understand and speculate about other's intentions underlying their actions, people first need to understand the context of the situations and external cues from observation (i.e., facial expressions, body language etc). BPD patients are more likely to misinterpret social cues at the basic level, which impairs their understanding of social interactions (Lazarus et al., 2014).

Along these lines, Lazarus and colleagues (2014) have conducted a systematic review investigating the impairments in social cognition of BPD patients by using emotion recognition tasks. The results suggested that increasing inputs of emotional information of others (i.e. eye vs. full face stimuli) may lead to higher affective arousal, which may decrease the capacity of BPD patients' to accurately recognize other people's emotions. Early studies adopted the facial emotion recognition (FER) tasks, of which require participants to report their perceptions of emotion on human faces. Levine, Marziali & Hood (1997) showed that patients with BPD displayed a significantly lower awareness of emotion as well as poor accuracy in recognizing facial expression in social contexts compared to the healthy controls, resulting in impaired social relationships. In particular, they found that BPD patients in the study demonstrated greater difficulty in discriminating the negative facial expression of emotions yet had unimpaired performance for positive emotions. Also, other studies have observed this same lack of accuracy in BPD when discriminating negative facial expressions (Unoka et al., 2011) compared to healthy controls. Richman and Unoka (2015) conducted a meta-analysis on the RMET, concluding that BPD patients were significantly less accurate than healthy individuals in assessing the

emotional states of others. Findings in neuroimaging studies have suggested an interrelation between emotion and mentalizing. Applying fMRI and skin conductance techniques, Dziobek and colleagues (2011) showed that patients with BPD showed both cognitive and emotional deficits in decoding others' emotions and referring to their mental states.

Unimpaired/Enhanced Mentalizing in BPD

In contrast, some recent studies have suggested enhanced capacities to infer others' mental states in BPD patients. In the study using the RMET, BPD patients were found to be more accurate in assessing the mental state of others compared to healthy individuals (Fertuck et al., 2009; Frick et al., 2012; Scott et al., 2011). Further, biased identification of anger was not found by Lynch and colleagues (2006), who presented both BPD patients and healthy controls with face stimuli that morphed from neutral to maximum emotional intensity. Accurate emotion-recognition has been further supported by recent studies (Preißler *et al.*, 2010; Unoka *et al.*, 2011). Preißler and colleagues (2010) used a more ecologically valid social cognitive test, the "Movie for the Assessment of Social Cognition" (MASC; Dziobek *et al.*, 2006). The MASC is a newly developed method to assess mentalizing in which participants watch a 15-minute film and indicate what each character is feeling or thinking. Results have shown an enhanced ability in identifying mental states of others. Better performance was observed in patients with BPD when required to identify the mental states of movie characters in an everyday life context in which each character elicited different intentions, emotions and thoughts.

In past neuroimaging studies, hyper-activation found in the amygdala, the

brain region associated with emotions, was thought to lead to increased attention to emotionally related stimuli and thus enhance the recognition of emotional stimuli (Herpertz *et al.*, 2001; Mier *et al.*, 2014). Although these studies have provided notable evidence of affective vulnerability in BPD, the results have remained inconsistent regarding the direction of emotion regulation effects on patients with BPD. Additionally, adopting both neuroimaging and mentalizing tasks, researchers have found significant evidence showing that patients with BPD generated more accurate and rapid responses to social discrimination tasks when differentiating emotional stimuli from others (Fertuck *et al.*, 2009; Frick *et al.*, 2012; Scott *et al.*, 2011).

Unbalanced Mentalizing in BPD

To explain the inconsistent findings regarding mentalizing capacities among BPD patients, recent studies have suggested that BPD patients do not simply lose mentalizing capacity per se, but more that mentalizing capacity lies on a continuum. From the neuroscience evidence, Fonagy and colleagues have proposed that mentalizing consists of four dimensions/polarities: automatic or controlled, self or others, internal or external, and cognitive or affective (Fonagy & Luyten, 2009). *Automatic* mentalizing is considered to be unconscious, implicit, non-reflective, and non-verbal, whereas, *controlled* mentalizing is explicit, conscious, verbal, and reflective. *Self* refers to one's own feelings and thoughts, and *others* refers to others' mental states. *Internal* means invisible features, but *external* means visible and observable features or actions of oneself or others. *Cognitive* refers to thoughts, beliefs, or intentions, whereas, *affect* refers to emotions or feelings. Mentalizing is thus concerned with the balance between

those four polarities. If individuals are extremely sensitive to others' emotional states, they may impair the awareness of their own emotional states. Hence, good mentalizing ability is considered to maintain a good balance in these four dimensions.

Cognitive and affective neuroscience studies have suggested that two important factors contribute to the balance of mentalizing; stress/arousal and the use of attachment strategies (Luyten & Fonagy, 2015). Fonagy and Bateman (2006) proposed that the activation of the attachment system in response to stress is associated with dysfunctions in mentalizing capacities. Fonagy and Luyten (2009) have suggested that the elevated level of stress and arousal triggers a switch from a cortical (controlled) system to a subcortical (automatic) system, which leads to *pre-mentalizing* (automatic) modes. Automatic mentalizing tends to be more rigid and consists of cognitive biases (i.e., anxious expectations) about self and others. There may be variation and individual differences in when the stress triggers the switch from the controlled mentalizing (cortical) to the automatic mentalizing (subcortical).

It has been suggested that when BPD patients perceive social threats (i.e., rejection), the alarm system (as described previously) is activated. Their automatic mentalizing system then comes online, which may subsequently lead to non-mentalizing or pre-mentalizing modes (Fonagy & Luyten, 2009). Inconsistent findings regarding social cognitive capacities may be due to the impairments in different aspects of mentalizing captured in each study. For instance, some research has shown that people with BP traits have a normal cognitive ability to understand others (Preißler et al., 2010), but impaired affective aspects of social

cognition (Gorska & Marszal, 2014). Thus, BPD patients may experience emotional distress due to an affect-dominated, rather than a cognitive-dominated, mentalizing about others (Gunderson et al., 2018).

Recent studies have suggested that the unbalanced mentalizing among BPD patients is seen as a tendency to over-interpret the mental state (i.e., intentions) of others, which leads to hypermentalizing, excessive and inaccurate mentalizing. Studies conducted with adults (Schilling *et al.*, 2012) and adolescents (Sharp *et al.*, 2011) indicate that impaired social cognition (i.e., emotion dysfunction) was more apparent in the hypermentalizing than the loss of the mentalizing capacity. Sharp and colleagues (2011) have provided evidence that BPD traits may be associated with hypermentalizing and that it is mediated by the affect regulation difficulties. Hence, there may be mediating factors that trigger the imbalance in mentalizing capacity. This tendency to over-analyze social cues of BPD patients may be critical, as they tend to over-interpret any social cues in the surrounding social environment through a negative lens, which further elevates negative emotional arousal and leads to their impulsive behaviours. In addition, increased rates of rumination, a repetitive thinking style that involves catastrophizing, have been found in BPD patients (Baer & Sauer, 2011). According to the emotional cascade model, negative affect can trigger rumination, which fuels the affect, feeding further rumination and creating a vicious cycle. A recent meta-analysis has found that rumination and brooding were significant risk factors for suicidal ideation and attempts (Rogers & Joiner, 2017). These findings highlight the importance of hypermentalizing in BPD patients.

Learning and Epistemic Trust

Affective instability also may impair learning among BPD patients (Dixon-Gordon, Tull, Hackel, & Gratz, 2018; Lieb et al., 2004; Pesic et al., 2014), which has been suggested to be critical for therapeutic efficacy. In order to benefit from the psychotherapy, patients need to learn new knowledge and skills to evaluate contingencies from their therapists. Compared to patients with secure attachment, patients with insecure attachment tend to be less likely to trust clinicians, be dissatisfied with the treatment (Holwerda et al., 2012), and have an early dropout from the treatments (Levy, Meehan, Kelly, Reynoso, Weber, Clarkin, & Kernberg, 2006). This is a critical issue for patients, as the distrust in clinicians prevents them from learning about their maladaptive perception and interpretation of others' behaviours, and from relearning more socially appropriate and accurate understanding of their own and others' behaviours. Thus, mistrusting clinicians as a reliable source of information hinders their learning, which may explain their high dropout rate and reduced treatment effects.

Based on the natural pedagogy theory (Csibra & Gergely, 2009), when people, particularly insecurely attached individuals, develop epistemic vigilance in which they consider new knowledge or information to be unsafe to internalize, they will lose the capacity to learn new knowledge or skills. From the developmental perspective, when young children encounter new information, they will determine whether the source of information is trustworthy based on their previous experiences with accuracy and reliability. If the information previously given was inaccurate or unreliable, children are likely to distrust the source of information and learn from other informants (Corriveau & Harris, 2009);

Corriveau et al., 2009). Therefore, epistemic trust highly influences young children's learning. A recent study has investigated how toddlers learn novel words from interactions with their primary caregivers (Brooker & Poulin-Dubois, 2013). After observing 24-month-old toddlers during 10-minute interactions with their primary caregivers, the authors found that toddlers learnt better from emotionally reliable primary caregivers. The authors concluded that the emotional reliability of primary caregivers, including their availability, consistent responsiveness, and sensitivity, influenced young children's learning.

In addition, insecure attachment has been associated with cognitive inflexibilities, such as intolerance of uncertainty, dichotomous thinking, and stereotypical judgments, as they are more likely to be unable to incorporate new information (Mikulincer, 1997). Given that BPD patients are more likely to have the preoccupied attachment style, they tend to fail to learn from their therapists due to epistemic mistrust and to have difficulties internalizing new perspectives to modify their maladaptive perceptions during the therapy.

Furthermore, BPD patients often need to talk about their personal experience including childhood trauma and interpersonal problems during the psychotherapies. Therefore, treatments may activate their attachment system and elevate emotional arousal. Learning capacities may be impaired due to this elevated emotional arousal in BPD patients. Dixon-Gordon and colleagues (2018) have investigated the impact of negative emotional arousal on learning in BPD patients. They found that BPD patients had more impairments in learning capacities in response to the negative emotional induction compared to patients with mood disorders and healthy controls. Based on these findings, it may be

argued that the activating attachment system may impair learning capacities in BPD patients due to the negative emotional arousal.

When BPD patients learn new information, knowledge, and skills such as the evaluation of contingencies from their therapists, mentalizing may enable them to relax their inflexible perceptions and increase epistemic trust (Fonagy & Allison, 2014). Cognitive flexibility is critically important in the therapeutic setting as BPD patients need to incorporate new perspectives from their therapists to modify their rigid and maladaptive perceptions of interpersonal relationships. This will allow them to take on different perspectives when they encounter emotionally and cognitively challenging situations, particularly in interpersonal social interactions. Learning about their inflexibilities and negative attributional biases in their perceptions of social interactions will promote their capacity to modify their interpretations of others' behaviours and social cues (i.e., facial expressions).

To summarize, an insecure attachment style based on early interpersonal experiences has been shown to be linked with impaired mentalizing and epistemic mistrust, which are critical in social learning. However, there is no research investigating the role of activation of the attachment system in the basic mechanisms of learning among individuals with BPD features. Given that the emotional arousal can impair learning in BPD patients (Dixon-Gordon et al., 2018), it may be argued that the activation of attachment systems may have a negative impact on learning capacities among BPD patients due to the negative emotional arousal.

Effortful Control

When BPD patients have cognitive disturbances due to the elevated emotional arousal, there needs to be a regulatory system to control the abnormality in cognition or affect. Hence, self-regulation capacities are important to suppress the hyper-activated emotional reactions and inhibit impulsive behaviours so as to enable healthy interpersonal interactions (Tangney, Baumeister, & Booner, 2004)

Self-regulation is a developmental capacity that enables individuals to behave in a more socially appropriate way and to have effective social interactions (Posner & Rothbart, 2009; Nigg, 2017). Within self-regulation capacities, the temperament aspect, effortful control, helps individuals to regulate contingent affect, attention, impulse, thoughts, and behaviours in order to achieve long-term goals and to respond in a more appropriate manner (De Panfilis et al., 2015). Effortful control and executive functions are closely related concepts, but arise from different conceptual models (Nigg, 2017). Executive functions emerged from cognitive and clinical neuropsychology (Luria, 1966). Executive functions include a wide range of top-down aspects of self-regulation (Nigg, 2017). Effortful control is also described as top-down aspects of self-regulation which includes cognitive control aspects of executive functions, executive attention in particular. Although questions remain regarding the precise functions, effortful control is narrower than executive functions (Nigg, 2017).

Effortful control reflects the capacity to inhibit dominant behavioural reactions in response to immediate emotions and act in favour of a long-term and goal-directed subordinate response (Casey, Tottenham, & Fossella, 2002; Posner

& Rothbart, 2009). Executive control has been conceptualized as the cognitive capacity to override and inhibit automatic or habitual reactions for more appropriate responses in an effortful and controlled manner (Botvinick et al., 2001; Casey et al., 2002). Posner and Rothbart (2009) proposed that a voluntary anterior attentional system controls an automatic process by overriding habitual mental processes, inhibiting behavioural inclinations, and monitoring for conflicts or errors in information processing (Casey et al. 2002).

Such a system may developmentally link to processes underpinning cognitive controls (Snyder, Miyake, & Hankin, 2015) and has been shown to be relatively poor in individuals with both internalizing and externalizing problems (Beauchaine & Thayer, 2015). Effortful control is therefore an adaptive mechanism that enables individuals to exert control over their emotions, thereby reducing possible negative consequences of impulsive overreactions (Bijttebier, Beck, Claes & Vandereycken, 2009), whilst contributing to attentional control processes, which allows the voluntary focus and shift of attention (Evans & Rothbart, 2007). Hence, it is generally understood that impaired self-regulation is related to greater psychological and interpersonal instabilities (Cain, De Panfilis, Meehan, & Clarkin, 2013; DePanfilis, Meehan, Cain, & Clarkin, 2013).

Effortful control has been suggested to include three components: the capacity to suppress inappropriate response or behaviours (inhibitory control), the capacity to initiate actions despite a strong tendency to avoid the action (activation control), and the capacity to focus and shift attention where it is desired to do so (attentional control) (Evans & Rothbart, 2007; Hoermann et al., 2005). If individuals need to work on an unpleasant task, an activation control is

required to activate behaviours to counteract their avoidance urges. When there is an urge to express maladaptive emotional reactions (i.e., hostility), an inhibitory control needs to be activated to suppress the hostility. In order to disengage from the maladaptive emotional reactions, an attentional control is needed to refocus their attention on other aspects. Extensive research on effortful control capacities has been conducted among children, adolescents and adults. Consistent evidence suggests that a reduced level of effortful control capacity predicts greater psychological and interpersonal difficulties (Cain et al., 2013; De Panfilis, Meehan, Cain, & Clarkin, 2013).

Effortful control has been suggested to be important (Domes et al., 2006) and lacking in BPD patients (Ayduk, Zaya, Downey, Cole, Shoda & Mischel, 2007; Claes, Vertommen, Smits, & Bijttebier, 2009; Clarkin & Posner, 2005; De Panfilis, Meehan, Cain, & Clarkin, 2015; De Panfilis et al., 2016; Gardner, Qualter, Stylianou, & Robinson, 2010; LeGris et al., 2012). A recent meta-analysis (Baer et al., 2012) found effortful control to be an important characteristic feature of BPD, and deficits in effortful control predicted greater problems with conflict resolution and interpersonal disturbance. Effortful control has been suggested to be a mediator between genetic predispositions, early developmental experience, and adult social functioning (Fonagy & Target, 2006) as well as between interpersonal difficulties or distress and BPD features (De Panfilis et al., 2015). Effortful control impairments have been seen in the form of dysregulated affective, cognitive and behavioural reactions in BPD patients.

Affect Dysregulation in BPD

Emotional dysfunction suggests a loss of inhibitory control, resulting in impulsive behaviour, and has been linked to the root of maladaptive cognitive functioning in BPD patients (Mathews & MacLeod, 2005; Wilson, MacLeod & Campbell, 2007). When negative emotional arousal occurs, subsequent maladaptive cognitive or behavioural reactions need to be regulated, either by being suppressed or modified to be more socially appropriate.

Emotional instability and affective dysregulation has captured attention and been suggested to be the fundamental characteristics of BPD (Ayduk, Zaya, Downey, Cole, Shoda & Mischel, 2007; Gunderson et al., 2018; Gross, 2002; Kröger, Vonau, Kliem, & Kosfelder, 2011; Linehan, 1993; Paris 2002). As described earlier, Linehan (1993) argued in the biosocial model that dysregulations of emotions (i.e., higher sensitivity to emotional stimulus, delay in regulating emotional arousal), particularly temperamental aspects, were the primary contributing factors to interpersonal problems in BPD. BPD patients tend to be hypersensitive to emotions, experience intense emotions, and take a longer time to return to their baseline after experience strong an emotional arousal relative to those without BPD (Gunderson et al., 2018).

The tendency to experience intense and reactive emotions has been found, in both clinical and non-clinical population, to be correlated with the severity of BPD-related symptoms (Rosenthal, Cheavens, Lejuez, & Lynch, 2005). BPD patients have shown intense emotional outburst (i.e., rage) in response to unpleasant social situations (i.e., rejection) (Berenson, Downey, Rafaeli, Coifman & Paquin, 2011). Moreover, a recent longitudinal study found emotional

instability to be the strongest and most consistent predictor of BPD symptoms across time (Tragesser, Solhan, Schwartz-Mette, & Trull, 2007). From this perspective, most other BPD symptoms are considered to be a maladaptive coping strategy to regulate intense emotional arousal or a result of disrupted emotions.

A recent review (Carpenter & Trull, 2013) has conceptualized affect dysregulation in BPD patients as consisting of four elements: hypersensitivity to emotion, intense negative affect, a lack of regulation capacities, and maladaptive coping strategies. Based on the previous literature, the authors concluded that a negative bias in identifying others' emotions and evaluating others may intensify emotional arousal in BPD patients. As BPD patients are less tolerant to emotional distress in everyday life, they are more likely to cope with the distress through maladaptive strategies (e.g., impulsivity, rumination, self-destructive behaviours). Therefore, the authors have suggested that negative cognitive bias in processing social stimuli is a key component of affective instability in BPD patients (Carpenter & Trull, 2013).

Cognitive Dysregulation in BPD

As described in the previous section, BPD patients are more likely to show impairments in emotion regulation and decreased ability to suppress intense and negative emotional arousal or express emotions in a more socially appropriate manner. Previous research has suggested that affect dysregulation is strongly associated with negative attentional biases such as selective attention to threatening cues and negative attributional biases (Carpenter & Trull, 2013; Mathews & MacLeod, 2005; Gunderson et al., 2018). Subsistent impulsive and maladaptive behaviours due to unregulated emotional reactions have been

associated with cognitive dysfunctions in BPD patients (Gunderson et al., 2018; Mathews & MacLeod, 2005; Wagner & Linehan, 1999; Wilson, MacLeod & Campbell 2007).

Of the types of effortful control, inhibitory and attentional shift are suggested to be particularly important in BPD patients. Given that BPD patients are highly sensitive and tend to have intense emotional arousal, specifically in regard to negative emotions such as anger (Koenigsberg et al., 2002; Skodol et al., 2002), shifting attention away from the source of emotional distress as well as voluntarily suppressing emotional reactions are the essential capacities for them. Linehan (1993) suggests that attentional control is weaker in those with BPD, as past, future or current emotional distress distracts them from the immediate task at hand. The inability to inhibit disturbing emotions consequently affects their overall everyday functionality and is where the disorder presents a significant challenge to the livelihood of patients. Attentional biases are accompanied by an increased memory span for negative experiences, (Harvey, Watkins, Mansell & Shafran, 2004).

Impairments in attentional control were indeed associated with an increase in BPD features among student samples (Gardner, Qualter, Stylianou, & Robinson, 2010) and patients with personality disorders (Claes, Vertommen, Smits, & Bijttebier, 2009), as well as BPD patients (LeGris et al., 2012). Attentional controls were found to moderate the association between rejection sensitivity and BPD features (Ayduk et al., 2008). The study conducted by Ayduk and colleagues (2008) found that among individuals with low attention control, an increase in rejection sensitivity was associated with an increase in BPD features.

However, among those with greater attention control, rejection sensitivity was not associated with BPD features. Further, among those with higher rejection sensitivity, a decrease in attention control was associated with an increase in BPD features. However, among those with lower rejection sensitivity, attention controls was not associated with BPD features. Therefore, the authors concluded that BPD features were predicted by the interaction between rejection sensitivity and attention control (Ayduk et al., 2008). This finding suggests that the capacity to control attention may be impaired in those with higher BPD features due to the elevated rejection sensitivity. Individuals with higher rejection sensitivity who fail to control attention may also fail to disengage their attention from the perceived rejection cues, and the excessive focus on rejection cues will make it easier for them to interpret their significant others' behaviours as intentional rejection (Dodge, 1980). In addition, this excessive focus on the rejection-relevant cues may elevate negative affect which may elicit impulsive and destructive reactions (Downey & Feldman, 1996).

A recent study (Bertsch et al., 2013) using eye tracking has found that female patients with BPD exhibited more and faster fixation on the angry facial stimuli compared to the healthy control group. Also, BPD patients showed increased amygdala activation in response to angry faces compared with healthy controls. This suggests that BPD patients have emotional hypersensitivity and an excessive focus on negative stimuli.

A large body of evidence supports the theory of an attentional bias in BPD patients, as significant differences between the response time for emotional words compared to neutral words in the emotional Stroop task have been reported in the

literature. Arntz and colleagues (2000) tested the response time in the emotional Stroop task using five different categories of words: malevolent (e.g., rejection), abuse-related (e.g., prick), negative self-view (e.g., vulnerable), negative events (e.g., cancer), and neutral (e.g., chat). In the emotional Stroop task, participants need to respond to the task as quickly as possible while ignoring emotional distracting stimuli. In this task, participants view the emotional and neutral words in different colours and are asked to name either the colour of the ink or the words. The emotional words presented are believed to act as distractors to the primary colour naming task. Hence, a slower response time is generally assumed to be caused by attentional resources being initially captured by these distractors, which therefore hinders response times. It is thought that lower effortful control levels will cause individuals to impulsively choose the answer reflecting the emotional distraction first, before they arrive at the correct answer.

Participants were instructed to read the words (written in three colours) aloud on the emotional Stroop task. Results revealed that BPD patients were slower on the colour naming task with all negative words compared to the control group.

Another study investigated the response inhibition in BPD patients using the emotional Stroop task with negative life events-related words (Wingenfeld et al., 2009). In this study, researchers used negative and neutral word stimuli (same as the Emotional Stroop task described above) but extended the task by adding negative words selected by participants. Participants were instructed to list a series of words describing their life events that were currently causing distress to them and no longer causing distress to them. Compared to the healthy control group, BPD patients were slower only in response to words associated with their

currently distressing life events, not in response to other word stimuli including the words associated with the life events that were no longer causing distress to them (Wingenfeld et al., 2009). This suggests that BPD patients' negative attentional bias may not be general, but rather specific to personally significant emotional stimuli. Hence, BPD patients' effortful control capacities may not be simply either good or bad, but change depending on the given social situation.

On the other hand, some inconsistent results have been found in other studies. A past study has found that BPD patients did not differ in their response time on the emotional Stroop task (Domes et al., 2006). Jacob and colleagues (2009; 2013) have also found that BPD patients did not significantly differ from the control group in their responses on the Stroop task and the "Go/No-go" task, which is another paradigm by which to assess inhibitory capacities. In addition, Sprock and colleagues (2000) found no difference in the emotional Stroop task performance between patients with BPD and depression and healthy controls. However, this result may be due to the emotional words used not being sufficiently distractive or emotionally provocative or because BPD patients were slower in response to the word stimuli regardless of stimulus valence.

In addition, Sieswerda, Arntz, and Kindt (2007) investigated attentional bias in BPD patients compared to healthy controls in a treatment outcome study. Prior to receiving treatment, BPD patients were slower and less accurate in response to both BPD-related and BPD non-related negative words than the control group on the emotional Stroop task. After completing a 3-year intensive treatment program, BPD patients whose symptoms were reduced showed a significant improvement on the Stroop task, no longer differing from the control

group. However, BPD patients whose symptoms were not reduced after the treatment did not change in their Stroop task performance. Thus, exemplifying how individuals with emotional concerns and difficulties regulating their emotions, will demonstrate enhanced interference in such a task due to their impaired inhibition of attention. Although this result must be interpreted with caution because of the small sample of recovered patients ($N = 6$), other studies have also found a similar result supporting the impaired effortful control in response to negative emotional stimuli in BPD patients (Arntz, Appels, & Sieswerda, 2000; Wingenfeld et al., 2009).

It is plausible that negative emotional arousal intensifies the attentional focus on the negative aspects of events and hinders cognitive capacity to take a wider perspective on given social situations, which may lead to rather biased and an extreme judgment (i.e., jump to conclusion) in BPD patients (Mortensen et al., 2016; Veen & Arntz, 2000). BPD patients indeed often obtain an extreme evaluation of others' facial expressions and emotions in the social environment. Past research found that individuals with BPD were more likely to have an extreme categorization of others when they watched a film associated with rejection and abandonment than those with Cluster C personality disorders or healthy controls (Veen & Arntz, 2000). Past clinical studies have revealed that BPD patients tend to exaggerate and consider minor misunderstandings or disagreements to be personal attacks, which leads them to become more defensive and react with more intense negative affect (Ayduk et al., 2008). This may be due to the dysregulated cognitive biases. Focusing on negative aspects of the given situations may elevate unpleasant feelings, which enhances cognitive closures and

extreme judgements (Mikulincer, 1997).

In addition, the impairment in effortful control, particularly inhibitory control, impacts on other higher-level cognitive functions, such as planning and the decision-making process. BPD patients have been found to make impulsive and disinhibited choices in decision-making tasks and poor choices in planning tasks (Bazanis et al., 2002). Similarly, Lenzenweger and colleagues (2004) who tested patients using the Wisconsin Card Sorting Test, found impairments in the executive control, sustained attention, and spatial working memory of participants diagnosed with BPD compared to healthy participants (Lenzenweger, Clarkin, Fertuck, & Kernberg, 2004). Therefore, although the effortful control is only one aspect of cognitive function, the impairments in effortful control can be considered to be the major contributing factor to BPD symptoms (De Panfilis et al., 2016). Nonetheless, few studies have investigated how the effortful control is affected by the social threats (i.e., rejection) in individuals with BPD features.

Behaviour Dysregulation in BPD

Another consequence of the disruption of effortful control is impulsive behaviours (Baetens et al., 2011). Numerous studies have shown that BPD patients tend to exhibit impulsive behaviours (Lieb et al., 2004; Gunderson et al., 2018) that indicate a lack of inhibitory control. Impulsive behaviours in BPD patients include unprotected sexual activities, impulsive spending, substance misuse, reckless driving, eating disorders and self-destructive behaviours (Soloff et al., 2000; Dougherty et al., 2004; Gunderson et al., 2018). A longitudinal study has found impulsive behaviours to be the strongest predictor of BPD pathology after 7 years (Links et al., 1999). One of the impulsive actions captured in

numerous studies is response inhibition using a computer task. Those studies have found that the response inhibition and inability to withhold a response to be one of the main disturbances in a number of mental disorders (Wright, Lipszyc, Dupuis, Thayapararajah, & Schachar, 2014), including BPD (Gunderson et al., 2018; Nigg, Silk, Stavro, & Miller, 2005).

One of the behavioural paradigms frequently used to assess response inhibition is the Go/No-go (GNG) task. In the GNG paradigm, participants are asked to respond to given stimuli in the Go condition, while they are instructed not to respond to given stimuli in the No-go condition. In other words, participants are required to take actions in the Go-condition, but inhibit their response in the No-go condition. Nigg and colleagues (2005) found that the performance of individuals with BPD or BPD features on the GNG task were significantly worse compared to healthy controls, which suggested that impulsivity was associated with BPD features. In general, people with BPD features are more likely to make errors on the GNG task. However, the difference between BPD patients and healthy individuals was only seen in the No-go condition, not the Go condition (Rentrop et al., 2008). This finding supports the idea that BPD patients have impairments in response inhibition, not activation control.

These behavioural dysregulations are not only seen in the impulsive behaviours, but also in self-harm behaviours among BPD patients. As described earlier, inappropriate emotional reactions (i.e., anger outbreak) are seen as a consequence of deficits in affective regulation (Fruzzetti et al., 2005), and often result in self-destructive behaviours (i.e., self-harm) due to BPD patients'

maladaptive coping strategies. Past research has found that individuals with a recent history of self-harm behaviours exhibited impairments in effortful control (Baetens et al., 2011), particularly attentional functioning (Dixon-Gordon, Gratz, McDermott, & Tull, 2014), compared to those without a history of self-harm. Poor attentional control was associated with self-harm tendencies among individuals with BPD features (Drabble, Bowles, & Barker, 2014). Among those with higher BPD traits, high focusing ability was associated with a high probability of self-harm incidence. On the other hand, the ability to focus attention was found to reduce the risk of self-harm among those with low levels of BPD features. Drabble and colleagues (2014) have found that those with a capacity to shift attention tend to have a lower likelihood of self-harm, which may indicate that the ability to shift attention reduces the self-harm tendency (Drabble, Bowles, & Barker, 2014). Further, those with a history of self-injury behaviours tend to respond impulsively and exhibit impaired inhibitory control capacities, especially in response to negative emotional stimuli (Allen & Hooley, 2015).

Taken together, it may be argued that BPD patients experience intensified emotional arousal due to a failure of the effortful control capacity. Emotional regulation is a common motive for non-suicidal self-harm behaviours. Therefore, self-harm behaviours can be seen as maladaptive coping strategies in BPD patients used to suppress emotional arousal (Allen & Hooley, 2015). At the same time, self-harm behaviours are the consequence of the emotional arousal due to their impaired effortful control (Baetens et al., 2011).

Summary

Section A described the clinical features of BPD and highlights the current

controversy over the conceptualization of BPD. Among a number of common psychiatric conditions that BPD patients often present, the common diagnostic features between ADHD and BPD highlight the importance of attentional problems and impulsivities in BPD patients. Section B introduced the theoretical models describing the etiology of BPD, particularly the developmental aspects, childhood adversity and attachment. Section C introduced interpersonal hypersensitivity in BPD patients and described the risk factors for developing interpersonal difficulties. This section then proposed the possible interpersonal cues that can be perceived as threats by BPD patients, including rejection, uncertainty, and expectation violation. Section D highlighted the possible maladaptive coping strategies utilized by BPD patients in response to perceived interpersonal threats including attachment strategies, self-critical perfectionism, and self-harm behaviours. Finally, Section E described the negative consequences of maladaptive responses to interpersonal threats in BPD patients. Although BPD patients have difficulties in a various social functions, this section mainly focused on cognitive impairment, namely effortful control, learning, and mentalizing.

F. Present Study

Rational

As presented in the literature review, interpersonal hypersensitivity and difficulties are frequently observed in BPD patients and individuals with BPD features. However, there are still many gaps in our understanding of BPD. As BPD is a multifaceted disorder, there are several distinct core factors including the developmental, cognitive, affective, social and behavioural components to understand the etiology of BPD. Given that BPD patients often have more developmental risk factors (i.e., childhood maltreatment, bullying), but less protective factors (i.e., secure attachment), they often have a disturbed affective-cognitive mechanism driven by the hypersensitive alarm system. However, the maladaptive coping strategies BPD patients use to satisfy their unmet needs are still not well investigated. Maladaptive coping strategies may further impair affective-cognitive functions, which may lead to the development of BPD features. Therefore, in order to understand the etiology of BPD, the role of developmental factors and the possible coping mechanism that are activated in response to distress need to be further investigated. Although BPD patients may use many maladaptive coping strategies, the current research focuses on the anxious attachment and self-criticism to satisfy their need to belong to others (see Section D).

Although some of the treatments have been found to be effective, BPD patients tend to have a high rate of early dropout from the treatment. However, the predictive factors of BPD patients' early dropout are not well understood. It is plausible that the activation of attachment systems during the treatment may

impair learning capacities of BPD patients, which may lead to their early dropout from the treatments (see Section E). However, there is little research investigating the role of attachment system on learning capacities among individuals with BPD features. Therefore, the current research examines the impact of the activation of the attachment system on contingency learning capacity in individuals with BPD features.

As described earlier, the interpersonal hypersensitivity and difficulties are the core characteristics of BPD. One of the most important cognitive capacities to develop and maintain healthy interpersonal relationships is social cognition, mentalizing in particular. Recent research has suggested that BPD patients may have difficulties in maintaining a good balance of mentalizing due to interpersonal stress/arousal that they often experience. However, it is not well understood what stimuli can be perceived as a threat and elevate negative emotional arousal in individuals with BPD. Therefore, the cognitive response to stimuli that BPD patients may perceive as threats needs to be investigated. Among many possible interpersonal threats, the current research focuses on rejection, uncertainty, and expectation violation (see Section C).

When individuals with BPD features experience a disturbance in the affective-cognitive mechanism in response to perceived threats, self-regulation capacities need to suppress the maladaptive response and activate more appropriate actions. Impairments in the capacity to self-regulate interpersonal distress, and effortful control in particular, may help to further explain interpersonal difficulties in BPD patients. Therefore, in this thesis, the role of

effortful control in explaining interpersonal hypersensitivity in individuals with BPD will investigate (see Section E).

Aims and Objectives of the Thesis

The aim of this thesis is to address the gaps in prior research regarding the interpersonal functioning in the BPD population by examining the fundamental mechanism of interpersonal hypersensitivity in BPD patients. This thesis particularly focuses on the developmental and cognitive factors in explaining interpersonal hypersensitivity in relation to BPD features using a multi-method approach in both clinical and non-clinical samples. Chapter II presents six empirical studies investigating the developmental and cognitive factors in explaining hypersensitivity in BPD (discussed in Chapter I).

The key questions addressed in these studies include:

1. What is the role of attachment strategies and self-criticism in explaining the link between rejection sensitivity and BPD features?
2. What is the role of intolerance of ambiguity and effortful control in explaining the link between rejection sensitivity and BPD features?
3. How does the activation of the attachment system impact on learning among people with BPD features?
4. How do ambiguous social interactions impact on effortful control and mentalizing capacities in individuals with BPD features?
5. How do unexpected and exclusive interactions impact on effortful control and mentalizing capacities in individuals with BPD features?
6. How do inclusive and exclusive social interactions impact on mentalizing capacities in BPD patients?

Study 1 and Study 2

Study 1 and Study 2 will address the first two aims of this thesis in non-clinical participants using self-report measurements. As described in the section D, attachment strategies and self-criticism may be maladaptive coping strategies to satisfy the need to belong to others among rejection-sensitive individuals, which may be related to increased risk of developing BPD features. Therefore, Study 1 will investigate the mediating and moderating role of adult attachment, need to belong, and self-criticism in the association between rejection sensitivity and BPD features.

As described in the section C, rejection-sensitive individuals may be threatened by uncertainty, which may increase the development of BPD features. One of the negative consequences of interpersonal hypersensitivity is the impairment in effortful control, which may elevate the development of BPD features as described in the Section E. Therefore, the role of intolerance of ambiguity and effortful control in the association between rejection sensitivity and BPD features will be investigated in Study 2.

Study 3

As described in the section E, the activation of attachment systems may impair learning capacities in individuals with BPD features. Therefore, Study 3 will address the question of this thesis, “How does the activation of the attachment system impact on learning among people with BPD features?”, in the non-clinical participants using the Go/No-go paradigm. To activate the attachment system, each participant’s mother’s pictures will be used. It is hypothesized that individuals with BPD features will learn less on the Go/No-go task if the visual

cues are presented with their mothers' pictures compared to strangers' pictures, particularly when they have to inhibit actions (No-go).

Study 4

As described in the section C, BPD patients may perceive uncertainty as a threat. In response to the perceived threat, effortful control and mentalizing may be impaired. Therefore, Study 4 will address the question of the thesis, "How do ambiguous social interactions impact on effortful control and mentalizing capacities in individuals with BPD features?", in the non-clinical participants using the behaviour interaction task. Effortful control will be assessed by using the emotional Stroop task, and mentalizing will be assessed by using the modified Reading the Mind in the Eyes Test (RMET). Ambiguous social interactions will be manipulated by using confederates. It is hypothesized that individuals with higher BPD features will be less accurate and faster on the emotional Stroop task, and less accurate and over-analysing facial cues on the modified RMET particularly following the ambiguous social interactions compared to individuals with low BPD features.

Study 5

As described in the section C, BPD patients may perceive rejection and expectation violation as a threat. As a result, their effortful control and mentalizing may be impaired. Therefore, Study 5 will address the question of the thesis, "How do unexpected and exclusive interactions impact on effortful control and mentalizing capacities in individuals with BPD features?", in the non-clinical participants using computer paradigms. The social interactions will be manipulated by using the Cyberball paradigm. It is hypothesized that participants

with high BPD features will be less accurate and faster on the emotional Stroop, and less accurate and over-analysing facial stimuli on the RMET following the unexpected exclusive interactions compared to those with low BPD features.

Study 6

As described in the section C, BPD patients may have distorted expectations of social inclusion. Therefore, BPD patients may perceive objectively inclusive interactions as well as exclusive interactions as threats. In response to the perceived threats, they may exhibit hypermentalizing. Therefore, Study 6 will address the question “How do inclusive and exclusive social interactions impact on mentalizing capacities in BPD patients?” using the computer paradigms. The social interactions will be manipulated by using the Cyberball paradigm. It is hypothesized that BPD patients will show hypermentalizing (less accurate and over-associating emotional states of others) in response to both inclusive and exclusive social interactions compared to healthy individuals.

CHAPTER II

CURRENT STUDIES

1. Rejection Sensitivity and BPD: A Mediation Model of Attachment Anxiety, Need to Belong, and Self-Criticism

1.1. Introduction

As described earlier, interpersonal hypersensitivity has been considered to be the core feature of BPD patients. Their interpersonal relationship style was found to be intense and unstable (Gunderson & Lyons-Ruth, 2008; Gunderson et al., 2018; Rosenbach & Renneberg, 2011). Within their interpersonal difficulties, hypersensitivity to rejection or abandonment has been considered to be important factors underlying a number of BPD features (Lazarus et al., 2014; Sanislow et al., 2002). Although their behavioural difficulties and maladaptive reactions to negative social interactions (i.e., social rejection) have been captured in numerous studies (Ayduk et al., 2008; Boldero et al., 2009; Ruocco et al., 2010), it is still not well understood how their developmental aspects may contribute to the link between rejection hypersensitivity and BPD features.

Rejection Sensitivity and Need to Belong to Others

As the need to belong to others is a fundamental and universal need for human beings, people have an aversive reaction when this need is not satisfied. In response to the repeated negative experience that threatens their survival (i.e., neglect), children's sensitivity to detect social threats become hypersensitive. As described in the previous section, rejection sensitivity is based on the attachment theory which accounts for the importance of developmental aspects. Given that individuals who have grown up in a malfunctioning environment (i.e., abuse,

neglect) are more likely to have attachment issues, rejection hypersensitive individuals are more likely to have insecure attachment. However, not every insecurely attached individual behave in the same way as they use a different strategy to cope with their dissatisfied need to belong to others.

Need to Belong and Attachment Strategies

Some individuals with attachment avoidance try to suppress their desire to be close to others and avoid intimacy so that they will not get hurt by others. However, this is a maladaptive coping strategy as an avoiding intimacy will lead to social isolation. On the other hand, other individuals with attachment anxiety are more likely to have a stronger desire for belongingness, which also elevates the fear of abandonment at the same time. The intense fear often results in hindering further affective and cognitive functions of individuals, which leads to interpersonal difficulties. Hence the fundamental motivations and expectations for interpersonal interactions differ depending on the attachment strategy. Anxiously attached individuals seek more interpersonal connections, but avoidant individuals do not want others' acceptance.

Self-criticism

Similar to attachment anxiety, but dislike to attachment avoidance, self-critical individuals are ambivalent in their interpersonal relationships. They tend to have a strong desire to belong to and to be approved by others, but also hold an intense fear of disapproval or rejection by others (Blatt & Shichman, 1983). To achieve acceptance from others, anxiously attached individuals may try to improve themselves by being over-critical about themselves. Hence, self-critical perfectionism may function as a self-improvement strategy driven by the desire

for acknowledgement by others (Hewitt & Flett, 1995) among anxiously attached individuals. On the other hand, self-criticism may be used as a self-punishment strategy (Whelton & Greenberg, 2005) driven by the negative self-image (i.e., disgust in self) among avoidant individuals.

Although an increasing number of studies have suggested that rejection sensitivity was an important factor in understanding BPD features (Ayduck et al., 2008; Butler et al., 2002; Boldero et al., 2009; Fertuck et al., 2013; Gunderson, 2007; Gunderson et al., 2018; Meyer et al., 2005; Renneberg et al., 2012; Rosenbech & Renneberg, 2011; Ruocco et al., 2010; Staebler et al., 2011), the role of developmental factors in this association between rejection sensitivity and BPD features have not been well understood. Research suggests that those individuals with heightened rejection sensitivity are more likely to develop BPD features due to maladaptive coping strategies to satisfy their basic need.

Present Study and Hypotheses

When individuals experience emotional distress due to rejecting experiences (i.e., neglect), one can suppress the needs and avoid intimacy to protect themselves from being hurt. Others can try to satisfy the basic needs by being overcritical about themselves and pursuing perfectionism. However, self-critical perfectionistic traits in people with BPD features (O'Connor, 2007) and shared characteristics with people with BPD such as rejection hypersensitivity and interpersonal difficulties (Flett, Besser, & Hewitt, 2014) were rarely investigated. Therefore, the research investigating the mediating and/or moderating roles of self-critical perfectionism in explaining the association between rejection sensitivity and BPD traits is needed.

As self-criticism has been shown to be more associated with BPD features (Quimette et al., 1994; Flett et al., 2014), particularly interpersonal problems and self-harm behaviours (Ducasse et al., 2014; Hewitt & Flett, 2002), only self-criticism, not dependency, was not included in the current proposed model.

It was predicted that attachment anxiety, the need to belong, and self-criticism mediated the association between rejection sensitivity and BPD features. Further, it was predicted that the mediated association through the need to belong was moderated by attachment anxiety and self-criticism. The adult attachment styles were predicted to be associated differently with the need to belong. It was hypothesized that attachment avoidance was negatively associated, but attachment anxiety was positively associated with the need to belong. Further, only attachment anxiety was expected to be associated with BPD features.

1.2. Materials and Methods

1.2.1. Participants and procedure

An online advert was posted on the University College London (UCL) psychology subject pool (SONA) system to recruit participants. A total of 256 healthy participants (172 females and 84 males; age range 18–52; mean 23.77, SD 6.67) partook in the study. Once participants signed up on the SONA system, a researcher sent a Qualtrics link to complete the questionnaires. When the completed data was collected on the Qualtrics, participants were incentivized by gaining a course credit or £10. All participants completed the informed consent form, which was approved by the ethics board (University College London, UK). All questionnaires were collected using Qualtrics, an online survey system.

1.2.2. Materials

Demographic questionnaires

Participants completed self-reported demographic questions including age, sex, ethnicity (white/Black/Hispanic/Mixed-white and black/mixed- white and Asian/mixed other/Asian/ middle east/ any other), household income (Less than 10,000/10,000-20,000/20,000-35,000/35,000-50,000/50,000-75,000/75,000-100,000/100,000 +), their highest education qualification (no qualification/less than high school/some high school/no diploma/high school graduate/some college credits/trade technical vocational training/associate degree/bachelor degree/master/PhD), job title, and mental health status. Overall, participants were: White/Caucasian (37.1%), Asians (51.6 %), mixed (5.5%), Hispanic (1.6%), African/Caribbean (3.9), and others (0.4%). There were no participants who had a diagnosis of any mental illness at the time of the assessment.

Need to Belong Scale

Need to belong Scale (Leary, Kelly, Cottrell, & Schreindorfer, 2013) is a 10-item self-reported questionnaire assessing the level of belonging needs (e.g., “I want other people to accept me”). Participants answered the degree to which each statement characterises them on a 5-point scale (1 = *Strongly disagree*, 5 = *Strongly agree*). The appropriate items were reverse scored so that higher numbers indicated a greater need to belong. A high test-retest reliability ($r = .87$) was found in the previous study (Leary et al., 2013). The internal reliability was high in the current participants (Cronbach’s $\alpha = .82$).

Personality Assessment Inventory-Borderline Features Scale

The level of BPD features was assessed using the Personality Assessment Inventory – Borderline features scale (PAI-BOR; Morey, 1991). This is a 24-item self-report measurement that assesses four core factors of the construct of BPD using six items per subscale: affective instability (PAI-BOA; e.g., “My mood can shift quite suddenly”), identity problems (PAI-BOI; e.g., “Sometimes I feel terribly empty inside”), interpersonal problems (PAI-BON; e.g., “My relationships have been stormy”), and self-harm (PAI-BOS; e.g., “I sometimes do things so impulsively that I get into trouble”). Participants were asked to answer using a four-point scale (0 = *false*, 1 = *slightly true*, 2 = *mainly true*, and 3 = *very true*). The past study has shown a high reliability (Cronbach’s $\alpha = .93$), and convergent validity with the Personality Diagnostic Questionnaire Fourth Edition-BPD Scale (PDQ4-BPD) ($r = .86$) in a large non-clinical population (Gardner & Qualter, 2009). In the current subjects, the internal reliability was relatively high (Cronbach’s $\alpha = .77$).

Experiences in Close Relationships-Revised

Participants' adult attachment style was assessed using the Experiences in Close Relationships-Revised (ECR-R; Fraley, Waller, & Brennan, 2000). This is a 36-item questionnaire assessing attachment anxiety (e.g., “When my partner is out of sight, I worry that he or she might become interested in someone else”) and attachment avoidance (e.g., “I prefer not to show a partner how I feel deep down”) in intimate relationships. The first 18 items comprise the attachment-related anxiety scale. Items 19-36 comprise the attachment-related avoidance scale. Each item is rated on a 7-point scale (1 = *Strongly disagree*, 7 = *Strongly agree*). The internal reliability was high in this study (Cronbach’s $\alpha = .87$).

Brief Symptom Inventory

Subjects' psychological and physical symptoms were assessed by the brief symptom inventory (BSI; Derogatis & Melisaratos, 2012). Participants were asked to indicate how much they were distressed by each symptom in the last 7 days (including the assessment day) using a four-point scale (Not at all/A little bit/Moderately/Quite a bit/Extremely). The questionnaire contained 53 questions assessing 9 categories of psychopathology including; depression, anxiety, somatization, obsession-compulsion, interpersonal sensitivity, phobic anxiety, hostility, paranoid ideation, and psychoticism. A high internal consistency was found (Cronbach's $\alpha = .97$) in the current subjects. Depressive and anxiety symptoms were treated as covariates in the main analyses.

Rejection sensitivity Questionnaire

Individuals' level of rejection sensitivity was measured by using the Rejection Sensitivity Questionnaire (RSQ; Downey & Feldman, 1996). It contains 18 hypothetical scenarios in which an individual makes requests to friends or significant others (i.e., romantic partner/family member). In each hypothetical situation, there is a possibility that the individual will receive a rejection (e.g., "You call your boyfriend/girlfriend after a bitter argument and tell him/her you want to see him/her"). Participants were asked to imagine they were in each situation, and to indicate how concerned or anxious they would be about how the other person(s) would respond to the request (i.e., "How concerned or anxious would you be over whether or not your boyfriend/girlfriend would want to see you?") on a 6-point scale (1 = *very unconcerned*, 6 = *very concerned*), and how they expected the other person would be likely to respond to the request (e.g., "I

would expect that he/she would want to see me”) on a 6-point scale (1 = *very unlikely*, 6 = *very likely*). Individuals’ level of rejection sensitivity was calculated by multiplying the score for degree of anxiety or concern by the score of expectancy of acceptance (after reverse scoring). The total score for rejection sensitivity was divided by the number of situations (18). A previous study (Downey & Feldman, 1996) showed high internal consistency (Cronbach’s $\alpha = .81$) and high test–retest reliability ($r_{tt} = .83$ after 2 weeks, $r_{tt} = .78$ after 4 months). The high internal consistency was found in the current subjects (Cronbach’s $\alpha = .86$).

Depressive Experiences Questionnaire

Self-criticism was assessed using the Depressive Experiences Questionnaire (DEQ; Blatt, D’Afflitti, & Quinlan, 1976) which included 66 items (e.g., “*I set my personal goals and standard as high as possible*”). Participants were asked to indicate how much they agreed or disagreed with each statement using a 7-point scale (1 = *Strongly Disagree*, 7 = *Strongly Agree*). Past study has shown that DEQ had high test-retest reliability (Zuroff, et al., 1983), and high internal consistency and construct validity (Blatt et al., 1976). The current study found a high internal reliability (Cronbach’s $\alpha = .85$).

1.2.3. Statistical Analytic Plan

In order to establish the association between rejection sensitivity, attachment anxiety, need to belong, self-criticism and BPD features, Pearson correlation coefficients were first calculated (see Table 1). A series of t-tests were conducted to assess the gender effect on variables. In addition, bivariate correlational analyses were tested to examine whether age was associated with

variables. In the main analyses, a simple mediation model between rejection sensitivity and BPD features through the need to belong was first conducted (see Figure 1). Then a mediation model treating adult attachment, need to belong, and self-criticism as mediators, rejection sensitivity as an independent variable, and BPD features as the dependent variable (see Figure 2) was tested using the Hayes's bootstrapping procedure with the PROCESS macro model 6 (Hayes, 2013).

In order to further examine whether this mediated association between rejection sensitivity and BPD features through the need to belong was moderated by adult attachment and self-criticism (see Figure 3), the PROCESS macro model 28 was conducted to test a moderated mediation model (Hayes, 2013). In this moderated mediation model, need to belong was treated as a mediator of the association between rejection sensitivity and BPD features, adult attachment as a moderator of the association between rejection sensitivity and need to belong. Further, self-criticism was treated as a moderator of the association between need to belong and BPD features, and between rejection sensitivity and BPD features. Rejection sensitivity was treated as an independent variable and BPD features were treated as a dependent variable. Five thousand bootstrap samples were used to create 95% confidence intervals to test the indirect effect of rejection sensitivity on BPD features on PROCESS macro. Anxiety and depressive symptoms were treated as covariates.

1.3. Results

1.3.1. Descriptive and Preliminary Analyses

The means and standard deviation of all variables are presented (see Table 1). A series of t-tests were conducted to assess the gender effect on attachment anxiety, attachment avoidance, the need to belong, self-criticism, rejection sensitivity and BPD features. The results indicated that the need to belong was significantly higher among females ($M = 34.78$, $SD = 6.45$) comparing to males ($M = 31.74$, $SD = 8.17$); $t(254) = -3.34$, $p = .001$. There was no gender effect on rejection sensitivity; $t(254) = 1.29$, $p > .05$, BPD features; $t(254) = -.56$, $p > .05$, attachment anxiety; $t(254) = -.01$, $p > .05$, attachment avoidance; $t(254) = -.03$, $p > .05$, and self-criticism; $t(254) = -1.06$, $p > .05$.

Table 1. Means, standard deviations, and bivariate correlations between rejection sensitivity, self-criticism, need to belong, adult attachment, and BPD features.

Variable	Mean	SD	1	2	3	4	5
1. Rejection Sensitivity	9.50	3.38	-	-	-	-	-
2. Self-criticism	.05	.99	.38**	-	-	-	-
3. Need to belong	33.78	6.94	.18**	.20**	-	-	-
4. Attachment Anxiety	3.57	1.10	.51**	.51**	.35**	-	-
5. Attachment Avoidance	3.45	1.07	.19**	.25**	-.14*	.27**	-
6. BPD features	24.99	10.77	.39**	.63**	.35**	.54**	.05

Note. PAI-BOR = Personality Assessment Inventory-Borderline Feature scale.

* $p < .05$, two-tailed, ** $p < .01$, two-tailed

1.3.2. Pearson Correlations and Regression Analyses

Bivariate correlational analyses for all variables with age were conducted. Age was significantly associated with BPD features ($r = -.14, p = .02$), the need to belong ($r = -.27, p < .001$), and attachment anxiety ($r = -.17, p = .008$). Hence, age was treated as a covariate in the main analysis.

A series of simple linear regression analyses were then conducted to assess whether primary variables predicted the level of BPD features (see Table 2). The results indicate that rejection sensitivity significantly predicted identity problems ($R^2 = .14, \beta = .37, F(1, 254) = 40.02, p < .001$), affective problems ($R^2 = .10, \beta = .31, F(1, 254) = 27.51, p < .001$), interpersonal problems ($R^2 = .11, \beta = .33, F(1, 254) = 31.38, p < .001$), self-harm tendencies ($R^2 = .03, \beta = .16, F(1, 254) = 6.77, p < .01$), BPD features ($R^2 = .15, \beta = .39, F(1, 254) = 44.51, p < .001$), attachment anxiety ($R^2 = .26, \beta = .51, F(1, 254) = 87.91, p < .001$), attachment avoidance ($R^2 = .04, \beta = .19, F(1, 254) = 9.84, p = .002$), self-criticism ($R^2 = .14, \beta = .38, F(1, 254) = 41.61, p < .001$), and the need to belong ($R^2 = .03, \beta = .18, F(1, 254) = 8.02, p = .005$). Need to belong significantly predicted identity problems ($R^2 = .21, \beta = .46, F(1, 254) = 66.95, p < .001$), affective problems ($R^2 = .05, \beta = .23, F(1, 254) = 13.81, p < .001$), interpersonal problems ($R^2 = .09, \beta = .30, F(1, 254) = 24.40, p < .001$), BPD features ($R^2 = .12, \beta = .35, F(1, 254) = 34.38, p < .001$), attachment anxiety ($R^2 = .12, \beta = .35, F(1, 254) = 35.45, p < .001$), attachment avoidance ($R^2 = .02, \beta = -.14, F(1, 254) = 4.71, p = .03$), and self-criticism ($R^2 = .04, \beta = .20, F(1, 254) = 10.67, p = .001$). Attachment anxiety significantly predicted identity problems ($R^2 = .28, \beta = .53, F(1, 254) = 100.44, p < .001$), affective problems ($R^2 = .13, \beta = .36, F(1, 254) = 38.04, p < .001$),

interpersonal problems ($R^2 = .26, \beta = .51, F(1, 254) = 89.08, p < .001$), self-harm tendencies ($R^2 = .05, \beta = .23, F(1, 254) = 14.29, p < .001$), BPD total features ($R^2 = .29, \beta = .54, F(1, 254) = 102.36, p < .001$), and self-criticism ($R^2 = .26, \beta = .51, F(1, 254) = 87.18, p < .001$). Attachment avoidance significantly predicted self-criticism ($R^2 = .07, \beta = .25, F(1, 254) = 17.52, p < .001$), but was not associated with BPD features ($R^2 = .002, \beta = .05, F(1, 254) = .56, p = .46$). As attachment avoidance did not predict BPD features, it was not included in the main analyses. Attachment anxiety, the need to belong, and self-criticism were significantly associated with rejection sensitivity and BPD features; hence, the conditions for mediation analysis was satisfied and conducted.

Table 2. Results of regression analysis predicting borderline personality disorder features.

Independent variable	<i>B</i>	<i>R</i> ²	<i>SE</i>	<i>t</i>	<i>β</i>
Rejection sensitivity	1.22	.15	.18	6.67	.39***
Need to belong	.54	.12	.09	5.87	.35***
Attachment Anxiety	5.27	.29	.52	10.12	.54***
Attachment Avoidance	.47	.00	.63	.75	.45
Self-criticism	6.87	.40	.53	12.89	.63***

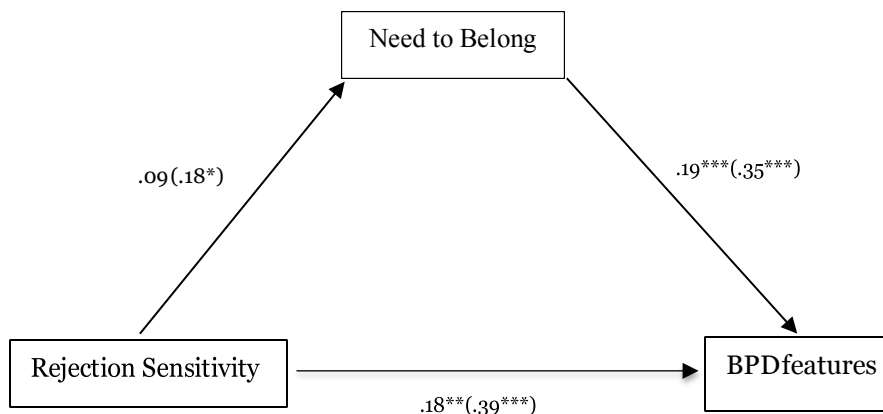
Note. PAI-BOR = Personality Assessment Inventory-Borderline Feature scale.

* $p < .05$, two-tailed, ** $p < .01$, two-tailed, *** $p < .001$

1.3.3. Mediation Analyses

First, a simple mediation model was tested to assess whether the need to belong mediated the positive association between rejection sensitivity and BPD features (Fig 1). It was found that there was an indirect effect of rejection sensitivity and BPD features through the need to belong ($R^2 = .23$, $F(2, 253) = 37.50$, $p < .001$). The direct effect of rejection sensitivity on BPD features was still significant ($b = .18$, $p < .001$) indicating that the need to belong partially mediated the association between rejection sensitivity and BPD features.

Figure 1. Need to belong mediates the indirect path between rejection sensitivity and BPD features.

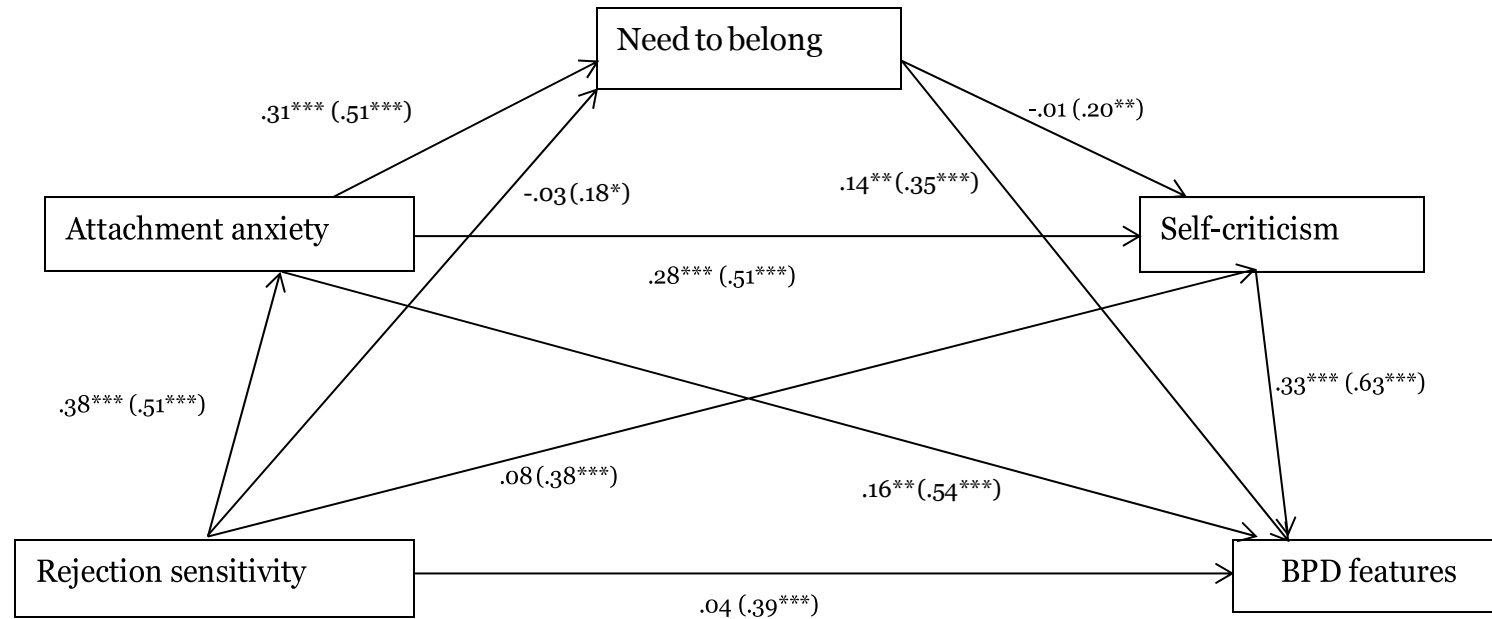


Note: * $p < .05$, ** $p < .01$, *** $p < .001$.

Another mediation model with attachment anxiety, the need to belong, and self-criticism as mediators, rejection sensitivity as an independent variable, and BPD features as a dependent variable was tested (Fig 2). It was found that there was an indirect effect of rejection sensitivity and BPD features through attachment anxiety, the need to belong, and self-criticism ($R^2 = .55$, $F(6,249) = 50.53$, $p < .001$). The direct effect of rejection sensitivity on BPD features was no

longer significant after controlling for those mediators ($b = .04, p = .42$) indicating that attachment anxiety, the need to belong, and self-criticism mediated the association between rejection sensitivity and BPD features. The mediating role of attachment anxiety ($b = .16, p < .01$), the need to belong ($b = .14, p < .01$), and self-criticism ($b = .33, p < .001$) were all significant.

Figure 2. Attachment anxiety, need to belong, and self-criticism mediate the indirect path between rejection sensitivity and BPD features.

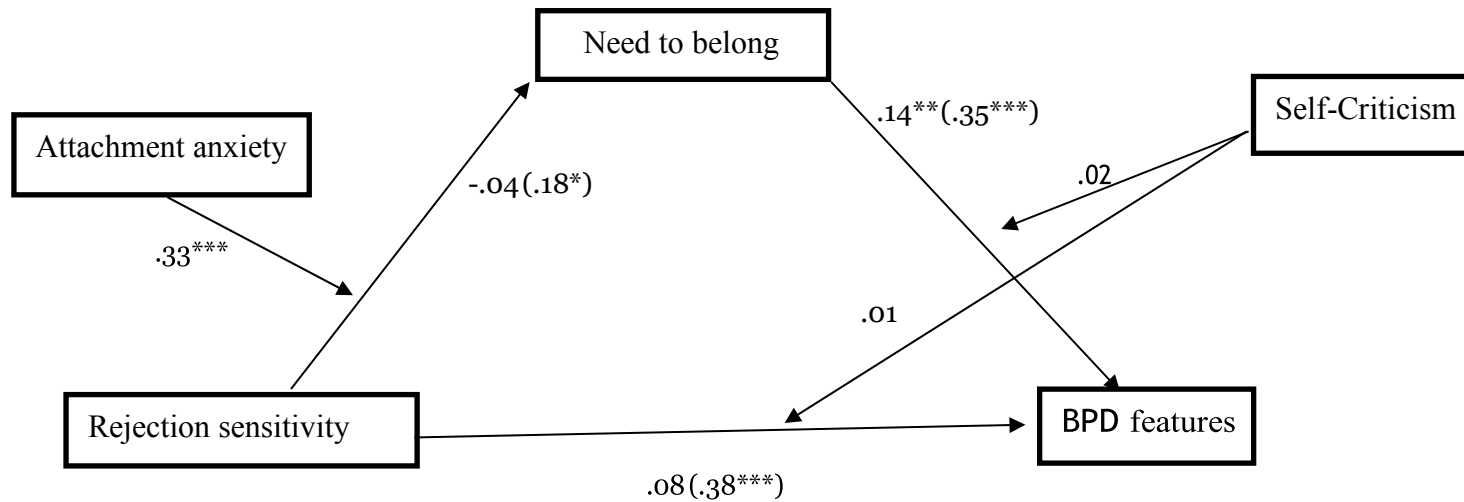


Note: $*p < .05$, $**p < .01$, $***p < .001$.

1.3.4. A Moderated Mediation Analysis

Then the moderated mediation model (Fig 3) was further tested to examine whether the mediated association between rejection sensitivity and BPD features through the need to belong was moderated by attachment anxiety and self-criticism. Also, it was tested whether self-criticism moderated the direct association between rejection sensitivity and BPD features. The results found that there was an indirect effect of rejection sensitivity on BPD features through attachment anxiety, the need to belong, and self-criticism ($R^2 = .54$, $F(7,248) = 41.00$, $p < .001$). The direct association between rejection sensitivity and BPD features after controlling mediators and moderators was not significant ($b = .08$, $p = .09$). It was found that mediating effect of the need to belong ($b = .17$, $p < .01$), and the moderating effect of attachment anxiety on the association between rejection sensitivity and the need to belong was significant ($b = .33$, $p < .001$). However, the moderating effect of self-criticism on the association between the need to belong and BPD features ($b = .02$, $p = .57$) and between rejection sensitivity and BPD features was not significant ($b = .01$, $p = .86$).

Figure 3. Moderated Mediation Analysis: Attachment Anxiety, Need to belong, Self-criticism between rejection sensitivity and BPD features.



Note: $*p < .05$, $**p < .01$, $***p < .001$.

1.4. Discussion

Extensive evidence supports the association between rejection sensitivity and BPD features (Ayduk et al., 2008; Boldero et al., 2009; Butler et al., 2002; Fertuck et al., 2013; Gunderson et al., 2018; Meyer et al., 2005; Miano et al., 2013; Ruocco et al., 2010; Staebler et al., 2011). The current study investigated the role of developmental aspects (self-criticism) and possible coping strategies (anxious attachment) in the indirect link between rejection sensitivity and BPD features through the need to belong. Results indicated that rejection sensitivity predicted the level of adult attachment, self-criticism, the need to belong and BPD features. Individuals with higher rejection sensitivity were more likely to seek closeness to others, have insecure attachment style, be self-critical, and have BPD features.

The need to attach and belong to significant others is an evolutionally fundamental need as infants cannot survive if primary caregivers do not provide the safe and stable environment (Baumeister & Leary, 1995; Bowlby, 1969, 1973; Staebler et al., 2011). When this basic need is not satisfied, the cognitive-affective mechanism is activated and increases anxiety and fear of future rejection. In response to repeated distressful interactions (i.e., neglect), rejection sensitivity to detect potential threatening cues becomes hypersensitive. Early detection of rejection-relevant cues will enable them to change their behaviours to prevent further social ostracism (Downey & Feldman, 1996). However, intense negative emotional reactions (i.e., anxiety) caused by repeated stressful experience (i.e., abuse) will lead to insecure attachment (Bowlby, 1969, 1973; Luyten & Fonagy, 2015). In response to distress caused by rejection, some individuals may

experience learned helplessness, suppress the desire to belong and avoid intimacy as a coping strategy (Guerra et al., 2016). Others may try to cope with distress by being self-critical to be perfect, so that they can achieve acceptance from others. Hence, self-critical perfectionism may function as a self-improvement strategy (Hewitt & Flett, 1995).

Need to Belong , Attachment and Self-Criticism

To support that, results found that attachment anxiety and avoidance were associated differently with the need to belong and BPD features. Attachment anxiety was positively associated with the need to belong, whereas attachment avoidant was negatively associated with the need to belong. In other words, individuals with a tendency to avoid intimacy to significant others were less likely to seek belongingness to others. On the other hand, those individuals who become anxious about being close to significant others were more likely to seek intimacy with others. Given that people with a higher need for belonging were more likely to be self-critical, people with attachment anxiety, not avoidant attachment, should have been associated with a higher self-critical tendency. However, the results found that both individuals with anxious attachment and avoidant attachment styles were more likely to be self-critical. This finding may suggest two things. First, although the need to belong to others is a basic human need, this basic need may be suppressed in individuals who avoid intimate relationships. Second, self-criticism may be developed as a coping strategy in response to stressful life events (i.e., social rejection) for some individuals. Those individuals who still want to be accepted by others may try to prevent future possible rejection by developing self-critical perfectionism. Therefore, self-criticism might

be used as a self-improving strategy to satisfy the need to belong to others (Hewitt & Flett, 1995). On the other hand, the desire to be close to others might not be a motivation to be self-critical for those who avoid intimate relationships. As attachment anxiety was more strongly associated with self-criticism compared to attachment avoidance, self-criticism might be strategically used more often among individuals who were anxiously attached to significant others such as individuals with BPD features.

Limitations

However, the current study findings need to be interpreted with caution due to several limitations. First, the study was a cross-sectional study using only self-report questionnaires. This study design has two issues: causality and common-method variance. As the current data was cross-sectional, not ideal for examining directionality, it could not draw any causal claim or justify the directionality of the association. Although the current study proposed only two models to explain the association between rejection sensitivity and BPD features, multiple other models could be theoretically plausible. Hence, future study should investigate the developmental accounts using a longitudinal study and behavioural measurements. In addition, as all constructs were assessed using only self-report measures at the same point in time, possible common-method variance among all constructs might confound interpretation of the results. However, as predicted, attachment avoidance was not associated with BPD features, which indicated that there was a discriminant validity in the current study.

Second, the current study might have limited generalizability as the subjects were recruited from the only nonclinical population who had low BPD

features compared to the clinical population. Thus, these findings might not be generalizable to a wider population with different demographic background and clinical features. However, past research has found substantial impairments in non-clinical individuals with high BPD features (Clifton & Pilkonis, 2007). Hence, the dimensional approach, not the categorical approach, was appropriate to capture BPD features on the spectrum in the nonclinical population. Also, half of the current participants were Asians. Although there was no systematic difference among participants from the different ethnic background, this limits the generalizability of the findings.

Third, the relationship between attachment styles and self-criticism was not clear from the current results. Attachment anxiety was positively correlated with the need to belong and self-criticism, whereas attachment avoidance was negatively correlated with the need to belong and positively correlated with self-criticism. Given that the direction of the association with the need to belong was opposite, but same with self-criticism between attachment anxiety and avoidance, the drive to be self-critical might not be the desire to belong to others. Thus, a further longitudinal study is required to understand the function and the motivation of self-criticism among individuals with different attachment styles and BPD features.

Fourth, although there were other approaches to test mediation and moderated mediation analyses (i.e., structural equation modelling), the current study used only PROCESS macro. This might limit the robustness of the current findings. However, PROCESS macro was selected as Hayes and colleagues

(2017) argued that there would be no difference in using these two modelling (PROCESS and structural equation modelling) in a large sample.

Overall Conclusions

Robust evidence has indicated that BPD patients had hypersensitivity to rejection (Ayduk et al., 2008; Butler et al., 2002; Boldero et al., 2009; Fertuck et al., 2013; Meyer, Ajchenbrenner, & Bowles, 2005; Ruocco et al., 2010; Staebler et al., 2011). As predicted, the association between rejection sensitivity and BPD features was mediated by the level of attachment anxiety, the need to belong, and self-critical traits. Attachment anxiety and avoidance were differently associated with the need to belong and BPD features. Although there are other possible interpretations of the current findings, among those people with high BPD features who were more likely to present attachment anxiety, the desire to belong to others might be the motivation to be self-critical. Those with avoidant attachment might develop self-criticism for different reasons. In order to satisfy the elevated need to belong to others, BPD patients with anxious attachment may manifest self-critical perfectionism as a coping strategy.

Although the current study has shown the role of attachment, the need to belong, and self-criticism in explaining the association between rejection sensitivity and BPD features, it has to be noted that there may be other factors contributing to this link. The future longitudinal experimental study should examine the potential coping strategies in response to rejection for those with different attachment styles in BPD patients.

2. Rejection Sensitivity and BPD: A Mediation Model of Effortful Control and Intolerance of Ambiguity

2.1. Introduction

As described in the previous chapter, the desire to belong to others is a fundamental need to increase the chance of survival, and the capacity to detect rejection cues is essential to prevent ostracism (Leary & Baumeister, 2000). Downey and Feldman (1996) proposed a rejection sensitivity which focuses on the developmental (insecure attachment), cognitive (anxious expectations of future rejection and misattribution of ambiguous cues), and behavioural (hostility) aspects (Rosenbach & Renneberg, 2011). To understand the hypersensitivity to rejection in people with BPD features, the developmental approach suggested the maladaptive coping strategy to satisfy the fundamental need to belong to others in the Study 1. However, the role of cognitive impairments in understanding the relationship between rejection sensitivity and BPD features is still not well understood. Study 2 examines another theoretical approach focusing on the cognitive aspects to understand the link between rejection hypersensitivity and BPD features.

Intolerance of Ambiguity and BPD

Recent research has suggested that BPD patients' threat detection sensors become so hypersensitive that even any ambiguous cues may be considered as threats (Mortensen et al., 2016). If BPD patients are constantly alerted even by non-threatening ambiguous cues that they learned to associate with threats, they are more likely to be habitually under distress. Elevated emotional distress may

lead to further cognitive impairments, which restrains the capacity to construct healthy relationships.

Consistent empirical evidence has suggested that BPD patients indeed have the negative cognitive biases and hypersensitivity to ambiguous social cues (Arntz & Veen, 2001; Baer, Peters, Eisenlohr-Moul, Geiger, & Sauer, 2012; Fertuck et al., 2013; Mitchell, Dickens, & Picchioni, 2014; Wagner & Linehan, 1999). Past empirical research has found that BPD patients had difficulties in judging the emotion of neutral faces accurately (Wagner & Linehan, 1999), perceived ambiguous facial expressions more negatively (Arntz & Veen, 2001), attributed negative affect (i.e., anger and rejection) to ambiguous faces (Domes et al., 2008; Dyck et al., 2009; Wagner & Linehan, 1999), rated ambiguous facial expressions as more untrustworthy (Fertuck et al., 2013), and had more aversive neurological reactions when they saw neutral faces (i.e., amygdala hyperactivation) using the RMET (Donegan et al., 2003; Minzenberg et al., 2008).

Together, these findings suggest that BPD patients are more likely to appraise uncertainty or ambiguous social stimuli as more threatening and react in a more intolerant manner (Domes et al., 2008). In order to react more appropriately to ambiguous social cues, BPD patients need to suppress/inhibit an initial maladaptive response and reappraise the ambiguous social cues by shifting attention to different aspects/possibilities of alternative interpretations. Thus, self-regulating capacities (i.e., effortful control) to suppress and override initial maladaptive emotional, cognitive, and behavioural reactions (Botvinick, Braver, Barch, Carter, & Cohen, 2001; Casey, Davidson, & Rosen, 2002) are particularly important to behave in a more socially appropriate manner for BPD patients.

However, the association between tolerance for ambiguity and effortful control is not well investigated in relation to rejection sensitivity and BPD features.

Effortful Control and BPD

Disturbance in self-regulation capacities in individuals with BPD features have been presented in a number of previous clinical and research reports (Claes, Vertommen, Smits, & Bijttebier, 2009; De Panfilis, Meehan, Cain, & Clarkin, 2015; Gardner, Qualter, Stylianou, & Robinson, 2010; LeGris et al., 2012). Some research has shown that effortful control, particularly attentional control, was negatively associated with BPD features in non-clinical student samples (Gardner et al., 2010) as well as clinical samples (Claes et al., 2009; LeGris et al., 2012). As described earlier, the emotional instability is considered to be the central feature of BPD patients (Linehan, 1993) and a large number of previous research has found that the affect dysregulation was strongly associated with maladaptive cognitive biases such as attentional biases (i.e., selective attention to threatening cues) and attributional biases (i.e., misattributing trivial cues as threats) (Mathews & MacLeod, 2005). Widening perspectives on social stimuli can distract attention from negative thoughts and ease the intense negative emotional arousal. Therefore, to suppress and correct this maladaptive response to social threats, attentional control is required to shift attention from the negative aspects to other positive aspects. However, BPD patients have a tendency to over-focus on negative aspects, which only intensifies negative emotional arousal (Mathews & MacLeod, 2005; Wagner & Linehan, 1999; Wilson et al., 2007).

Past research indeed confirmed that the moderating effect of effortful control on the association between rejection sensitivity and BPD features.

Rejection hypersensitive individuals were more likely to have BPD features only when they also have low attentional control (Ayduk et al., 2008). In addition, impairments in effortful control capacities were suggested to foster the association between rejection sensitivity and BPD features by intensifying interpersonal distress (De Panfilis et al., 2015). These findings suggest that rejection hypersensitive individuals are more likely to develop BPD features due to the impaired attentional controls. It is plausible that when rejection hypersensitive individuals encounter ambiguous social cues, they may fail to disengage attention from perceived rejection cues due to limited effortful control capacities, and excessive focus on rejection cues and negative cognitive biases would make intentional rejection highly accessible as an interpretation for their significant others' behaviours (Dodge, 1980). In addition, this preoccupation with rejection-relevant cues may elevate negative affect, which may, in turn, elicit impulsive and destructive behaviours (Downey & Feldman, 1996) due to hindered inhibitory controls in BPD patients. Past neuropsychological findings have found that the activity of the ACC (responsible for inhibitory control) was impaired in BPD patients (Ruocco, 2005). These impairments in effortful control may be an important factor contributing to the BPD features (Clarkin & Posner, 2005). Further, BPD is highly comorbid with attention-deficit/hyperactivity disorder (Davids & Gastpar, 2005), which may support the impairments in attentional functions among BPD patients (LeGris et al., 2012).

Present Study and Hypotheses

Although robust evidence has suggested that rejection sensitivity was an important contributing factor in impairments in cognitive-affective processes and

interpersonal functions among BPD patients (Berenson et al., 2011; Domsalla et al., 2014; Renneberg et al., 2012; Staebler et al., 2011; Veen & Arntz, 2000), little is known about the role of cognitive factors underlying these associations. It is plausible that rejection-hypersensitive individuals are more likely to develop BPD features due to elevated levels of intolerance of ambiguity and impairments in effortful control. Their anxious expectations of negative interpersonal consequences (i.e. future rejection) due to heightened rejection sensitivity might decrease their tolerance of uncertainty in social situations and increase disturbance in effortful control capacities. These cognitive tendencies to react negatively to uncertainty and impairments in self-regulating capacities to control initial negative responses might explain the positive association between rejection sensitivity and BPD features.

Therefore, the current study aimed to examine the potential mediating roles of intolerance of ambiguity and effortful control (see Figure 5) in the association between rejection sensitivity and BPD features. Intolerance of ambiguity and effortful control were predicted to mediate the association between rejection sensitivity and BPD features. Rejection sensitivity was predicted to be more strongly associated with higher intolerance of ambiguity, lower effortful control capacities, and higher BPD features.

Furthermore, the moderating role of intolerance of ambiguity between rejection sensitivity and effortful control, and between rejection sensitivity and BPD features was also examined (see Fig 7). Intolerance of ambiguity was predicted to moderate the association between rejection sensitivity and effortful control and between rejection sensitivity and BPD features.

2.2. Materials and Methods

2.2.1. Participants and procedure

The sample of this study is the same as Study 1. Therefore, the demographic of participants were described in the Study 1. Participants completed the online survey, which included a general demographic questionnaire and self-reported questionnaires on intolerance of ambiguity, effortful control, rejection sensitivity, and BPD features (see below). Students were compensated with course credits after completing the survey.

2.2.2. Materials

Brief Symptom Inventory

The depressive and anxiety symptoms were assessed using the BSI (see Study 1).

Personality Assessment Inventory-Borderline Features Scale.

BPD features were assessed using the PAI-BOR (see Study 1).

Rejection Sensitivity Questionnaire.

Rejection sensitivity was assessed using the RSQ (see Study 1).

Effortful Control Scale.

The Effortful Control Scale (ECS) involves 19 items and is a part of the Adult Temperament Questionnaire-short form (ATQ; Evans & Rothbart, 2007). The ATQ is a self-report instrument assessing temperament, including effortful control (EC), negative affect, extraversion/surgency, and orienting sensitivity. The subscales of the EC are: activation control (e.g., “When I am afraid of how a situation might turn out, I usually avoid dealing with it” [reverse scored]), attentional control (e.g., “It is very hard for me to focus my attention when I am

distressed” [reverse scored]), and inhibitory control (e.g., “It is easy for me to inhibit fun behavior that would be inappropriate”). Participants completed the questionnaire using a 7-point Likert-scale (1 = *extremely untrue of you*, 2 = *quite untrue*, 3 = *slightly true*, 4 = *neither true or false*, 5 = *slightly true*, 6 = *quite true*, 7 = *extremely true of you*).

Need for Cognitive Closure Scale.

Individual differences in the level of need for cognitive closure were measured using the Need For Cognitive Closure Scale (NFCS; Webster & Krulanski, 1994). The NFCS comprises 42 items assessing five factors: desire for predictability (e.g., “I dislike unpredictable situations”), preference for order and structure (e.g., “I like to have a plan for everything and a place for everything”), discomfort with ambiguity (e.g., “I don’t like situations that are uncertain”), decisiveness (e.g., “I usually make important decisions quickly and confidently”), and close-mindedness (e.g., “I always see many possible solutions to problems I face”). Subjects answered using a 6-point Likert scale (1 = *strongly disagree* to 6 = *strongly agree*). Past research has indicated that the NFCS has excellent convergent and discriminant validity, good test–retest reliability, and adequate internal consistency (Freeman et al., 2006).

2.2.3. Statistical Analytic Plan

First, Pearson correlation coefficients were calculated to determine the associations among rejection sensitivity, intolerance of ambiguity, effortful control, and BPD features. In order to examine whether effortful control and intolerance of ambiguity mediate the relationship between rejection sensitivity and BPD features, Hayes’s bootstrapping procedure was conducted using the

PROCESS macro (Hayes, 2013). To replicate the previous findings (De Panfilis et al., 2015), a simple mediation model (Fig 4) was tested to examine the indirect effect of rejection sensitivity on BPD features through effortful control. Then another mediational model (Fig 5) was tested with rejection sensitivity as an independent variable, BPD features as the dependent variable, and effortful control and intolerance of ambiguity as the mediators. In order to determine whether effortful control capacities and intolerance of ambiguity mediate the association between rejection sensitivity and BPD features, it must be established first that effortful control is associated with rejection sensitivity and BPD features, and second, that intolerance of ambiguity is associated with rejection sensitivity and BPD features. Five thousand bootstrap samples were used to create 95% confidence intervals to test the indirect effect of rejection sensitivity using the PROCESS model 6. Anxiety and depressive symptoms were used as covariates in the analyses.

In order to examine the directionality between rejection sensitivity and BPD features, an alternative mediation model was tested with BPD features as an independent variable, rejection sensitivity as a dependent variable, and intolerance of ambiguity and effortful control as mediators (Fig 6) using the PROCESS model 6. In addition, a moderated mediation analysis was also conducted to examine the possible moderating role of intolerance of ambiguity between rejection sensitivity and effortful control, and between rejection sensitivity and BPD features (Fig 7) using the PROCESS model 8.

2.3. Results

2.3.1. Descriptive and Preliminary Analyses

The means, standard deviation, and Cronbach's alpha coefficients of each measurement are presented (see Table 3). A series of t-tests were conducted to assess the effect of gender on effortful control, intolerance of ambiguity, BPD features, and rejection sensitivity. The results indicated that intolerance of ambiguity was significantly higher among females ($M = 38.42$, $SD = 6.22$) compared with males ($M = 36.23$, $SD = 5.97$); $t(254) = -2.68$, $p = .008$. Preference for order and structure was significantly higher among females ($M = 42.26$, $SD = 7.42$) compared with males ($M = 37.99$, $SD = 8.21$); $t(254) = -4.18$, $p < .001$. Desire for predictability was significantly higher among females ($M = 30.88$, $SD = 6.33$) than males ($M = 28.92$, $SD = 5.80$); $t(254) = -2.40$, $p = .02$. Decisiveness was significantly higher among males ($M = 25.65$, $SD = 5.79$) than females ($M = 23.22$, $SD = 6.54$); $t(254) = 2.91$, $p = .004$. NFCS total score was significantly higher among females ($M = 159.95$, $SD = 18.47$) compared with males ($M = 153.96$, $SD = 19.86$); $t(254) = -2.38$, $p = .02$. There was no gender difference on BPD features; $t(254) = -.56$, $p > .05$. Attentional control was significantly higher among males ($M = 4.28$, $SD = 1.23$) than females ($M = 3.93$, $SD = 1.12$); $t(254) = 2.24$, $p = .03$. There was no sex difference on activation control; $t(254) = .25$, $p > .05$, and on inhibitory control; $t(254) = -.66$, $p > .05$. There was no significant difference in rejection sensitivity between males and females; $t(254) = -.56$, $p > .05$.

Table 3 Descriptive statistics.

Variable (<i>n</i> = 209)	Mean	<i>SD</i>	α
Adult Temperament Questionnaire – Effortful control			
Activation control	4.42	1.03	.58
Attentional control	4.05	1.17	.75
Inhibitory control	4.33	.88	.48
Total	4.29	.80	.71
Need for Cognitive Closure			
Discomfort with ambiguity	37.70	6.22	.72
Personality Assessment Inventory – Borderline Features scale			
Identity	7.41	3.71	.72
Affective	6.65	3.66	.76
Interpersonal	6.91	3.42	.65
Self-harm	4.02	3.18	.63
Total	24.99	10.77	.77
Rejection Sensitivity			
Total	9.50	3.38	.86

2.3.2. Pearson Correlations and Regression Analyses

Bivariate correlational analyses for all variables with age were conducted. Age was significantly associated with identity problems ($r = -.23$), BPD total features ($r = -.17$), and discomfort with ambiguity ($r = -.20$). Hence, age was treated as a covariate in the main analysis.

A series of simple linear regression analyses (see Table 4) was conducted to assess whether primary variables predicted the level of BPD features (see Table 3). The results indicate that rejection sensitivity significantly predicted BPD features ($R^2 = .15$, $\beta = .39$, $F(1, 255) = 44.51$, $p < .001$), effortful control ($R^2 = .06$, $\beta = -.25$, $F(1, 255) = 17.28$, $p < .001$), and intolerance of ambiguity ($R^2 = .02$, $\beta = .14$, $F(1, 255) = 4.85$, $p < .05$). Effortful control significantly predicted BPD features ($R^2 = .34$, $\beta = -.58$, $F(1, 255) = 128.30$, $p < .001$) and intolerance of ambiguity ($R^2 = .03$, $\beta = -.17$, $F(1, 255) = 7.19$, $p = .008$). Intolerance of ambiguity significantly predicted BPD features ($R^2 = .13$, $\beta = .36$, $F(1, 255) = 37.48$, $p < .001$). As effortful control and intolerance of ambiguity were significantly associated with rejection sensitivity and BPD features, the mediation analysis was conducted.

Table 4 Bivariate correlations among the main study variables.

Variable	Mean	SD	1	2	3
1. PAI-BOR total	24.99	10.77	-	-	-
2. Effortful control	4.29	.80	-.58***	-	-
3. Rejection sensitivity	9.50	3.38	.39***	-.25***	-
4. Intolerance of ambiguity	37.70	6.22	.36***	-.17**	.14*

Note. PAI-BOR = Personality Assessment Inventory-Borderline Feature scale.

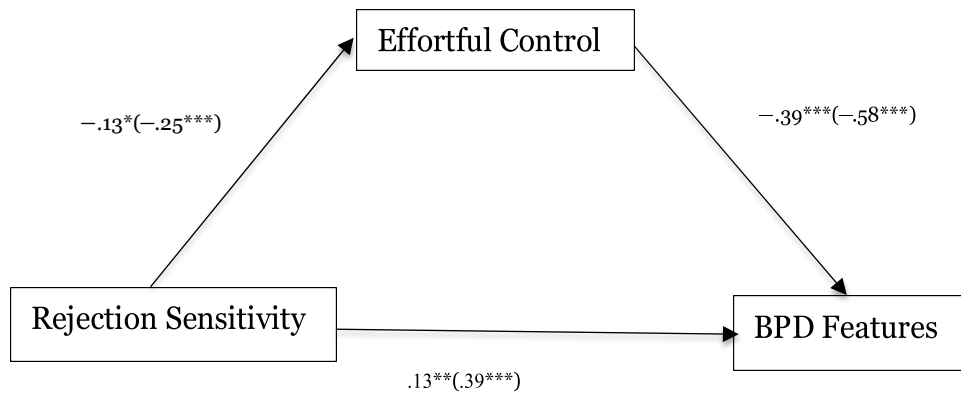
* $p < .05$, two-tailed. ** $p < .01$, two-tailed

2.3.3. Mediation Analyses

First, a simple mediation analysis was conducted to examine the mediating effect of effortful control on the association between rejection sensitivity and

BPD features (Fig 4). There was a significant indirect effect of rejection sensitivity on BPD features through effortful control ($R^2 = .54$, $F(4, 251) = 73.24$, $p < .001$). The mediating role of effortful control was significant ($b = -.39$, $p < .001$).

Figure 4. Indirect effect of rejection sensitivity and BPD features through effortful control.



Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

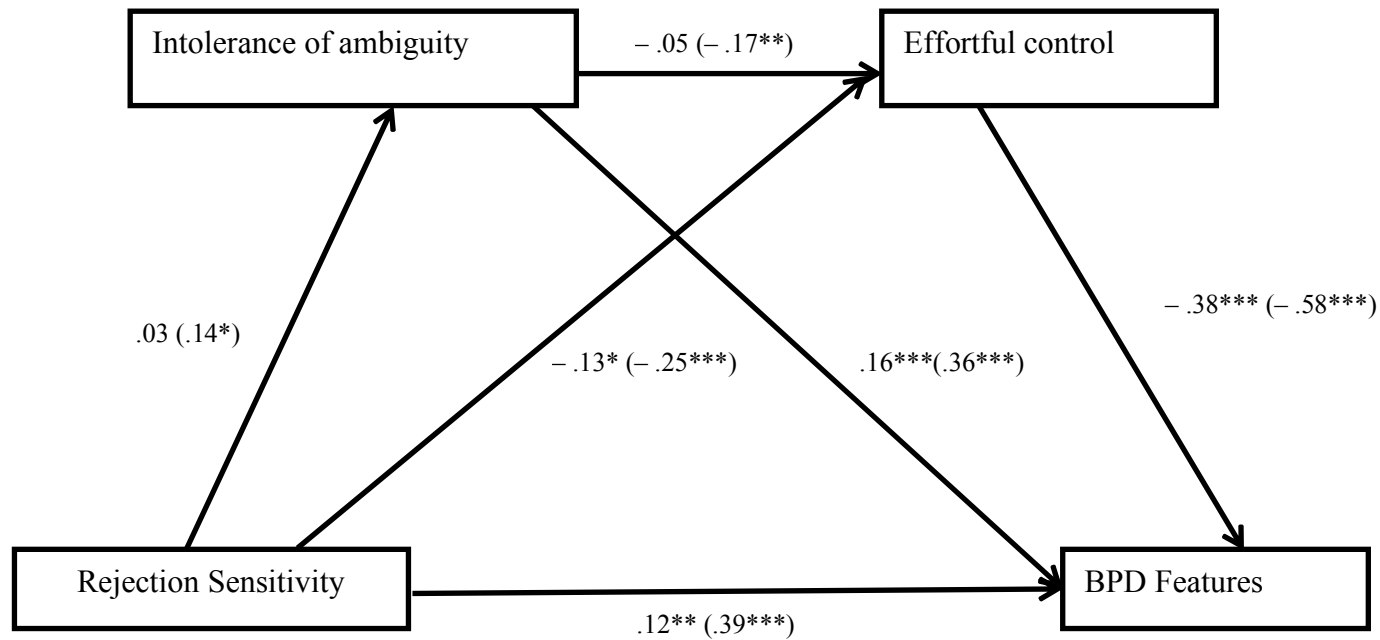
BPD = Borderline personality disorder.

Then the mediating role of intolerance of ambiguity was included in the model. Results of the mediation analysis (Fig 5) revealed an indirect effect of rejection sensitivity on BPD features through intolerance of ambiguity and effortful control ($R^2 = .56$, $F(5, 250) = 64.26$, $p < .001$). The direct effect of rejection sensitivity on BPD features was also significant after controlling for effortful control and intolerance of ambiguity ($b = .12$, $p = .007$), indicating that effortful control and intolerance of ambiguity mediated the relationship between rejection sensitivity and BPD features. The mediating roles of intolerance of

ambiguity ($b = .16, p < .001$) and effortful control ($b = -.38, p < .001$) were both significant.

To test the directionality of the effects, an alternative model (Fig 6) was tested ($R^2 = .20, F(6,249) = 10.07, p < .001$). The direct effect of BPD features on rejection sensitivity was also significant ($b = .22, p = .01, CI [.05, .38]$) after controlling for effortful control and intolerance of ambiguity.

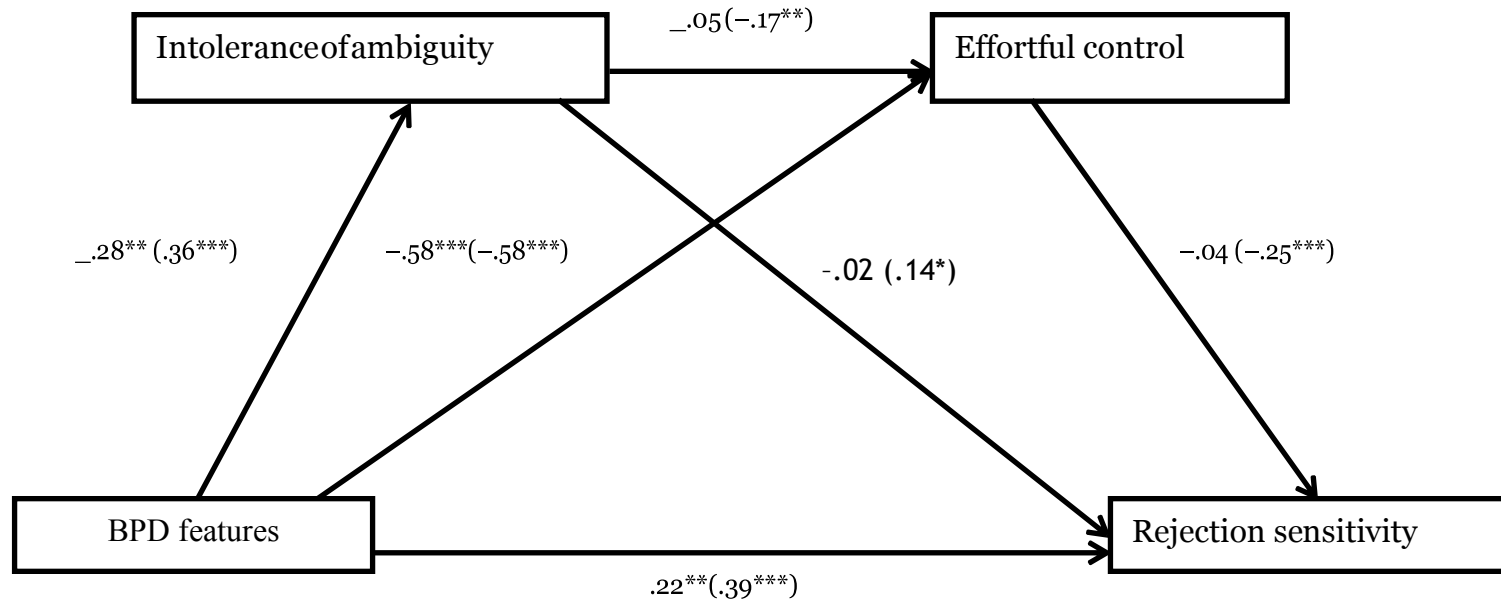
Figure 5. Indirect effect of rejection sensitivity on BPD features through effortful control and intolerance of ambiguity.



Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

BPD = Borderline personality disorder

Figure 6. Indirect effect of borderline personality features on rejection sensitivity through intolerance of ambiguity and effortful control



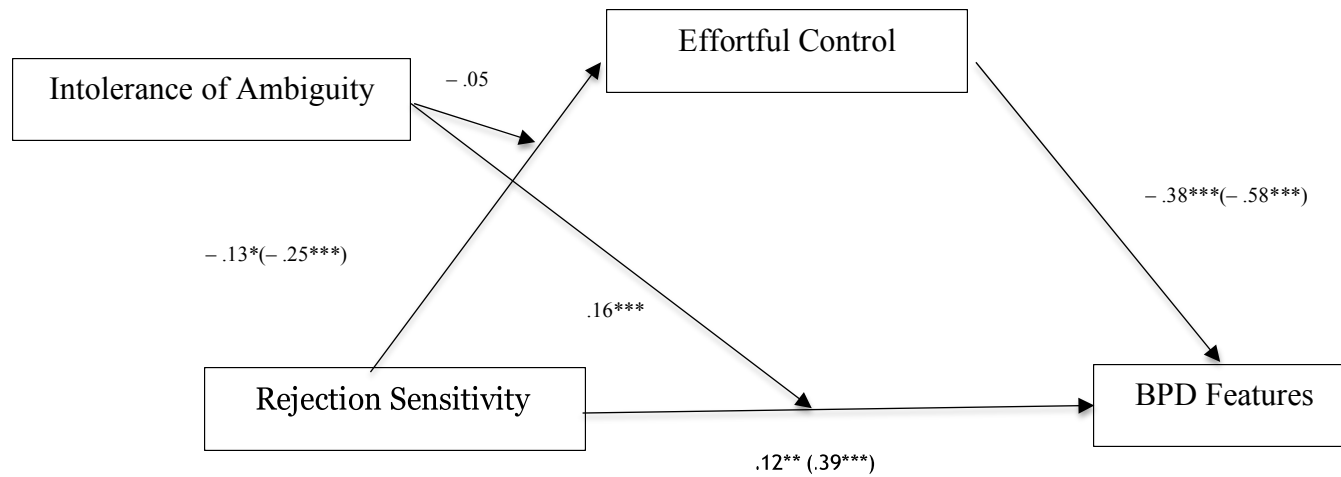
Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

BPD = Borderline personality disorder.

2.3.4. A Moderated Mediation Analysis

To examine the moderating role of intolerance of ambiguity, the moderated mediation model (Fig 7) was tested. There was a significant indirect effect of rejection sensitivity on BPD features through effortful control and intolerance of ambiguity ($R^2 = .56$, $F(6, 249) = 53.39$, $p < .001$). In this model, the path between rejection sensitivity and BPD features and between rejection sensitivity and effortful control were moderated by intolerance of ambiguity. The direct effect of rejection sensitivity on BPD features after controlling the mediator and moderator was still statistically significant ($b = .12$, $p = .009$). The moderating effect of intolerance of ambiguity on the association between rejection sensitivity and effortful control was not significant ($b = -.05$, $p = .41$). However, the moderating effect of intolerance of ambiguity on the association between rejection sensitivity and BPD features was significant ($b = .16$, $p < .001$). This finding suggests that rejection-sensitive individuals are more likely to manifest BPD features when they are more intolerant to ambiguity.

Figure 7. Moderated Mediation Analysis: Intolerance of ambiguity and effortful control between rejection sensitivity and BPD features.



Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

BPD = Borderline personality disorder.

2.4. Discussion

The current study aimed to investigate the mediating and moderating roles of intolerance of ambiguity and effortful control capacities on the positive association between rejection sensitivity and BPD features. As predicted, the results revealed that rejection sensitivity predicted the level of effortful control, intolerance of ambiguity, and BPD features. Individuals with higher rejection sensitivity were more likely to have lower effortful control capacities, lower tolerance of ambiguity, and a higher level of BPD features. Mediation analyses revealed that intolerance of ambiguity and effortful control accounted for the relation between rejection sensitivity and BPD features. Further, the moderated mediation model found that intolerance of ambiguity also affected the direction and/or strength of the association between rejection sensitivity and BPD features.

Due to the earlier negative experiences during childhood, such as rejection by primary caregivers, people develop hypersensitivity to detect potential threats and learn to associate even ambiguous social cues as threats. As rejection hypersensitive individuals tend to expect negative consequences would happen in the future (Feldman & Downey, 1994), their attention may be more likely to focus on ambiguous and negative social cues (e.g., insensitive behaviours of their partners). When they perceive ambiguities, they may consider such cues as indicators of malicious or negative intentions, focus on the negative aspects of the events/behaviours, and expect negative outcomes (e.g., rejection) to follow. If they focus on the negative sides of potential threats, it may elevate negative affect such as worry (Dugas et al., 2003) and anger (Fracalanza et al., 2014). Due to the elevated negative affect, their attention may be too disturbed by the threats to

focus on other aspects of the event, which may result in the further disturbance in effortful control capacities. As it was found in the current data that an increase in intolerance of ambiguity predicted a decrease in effortful control, those individuals who were less tolerant of ambiguous social cues were more likely to have difficulties in suppressing an inappropriate initial response, shifting attention away from negative aspects of the potential threats, and acting in a more appropriate manner in social situations.

The current study has supported that these cognitive negative biases (i.e., anxious expectation of rejection), cognitive closure (i.e., intolerance of ambiguity) and impaired effortful control increased the risk of development of BPD features. The indirect association between rejection sensitivity and BPD features through effortful control (Fig 4) was consistent with the previous findings (Ayduk et al., 2008). However, there was no study that investigated the role of intolerance of ambiguity in the association between rejection sensitivity, effortful control, and BPD features. In summary, the current findings indicated that rejection-sensitive individuals were more likely to be intolerant of ambiguity as they were more likely to expect negative consequences when they encountered uncertain situations. Although there are possibilities of both positive and negative outcomes in the ambiguous social situations, rejection-sensitive individuals are more likely to focus on negative aspects and expect the possibility of negative consequences. As social interactions always contain a certain level of uncertainty, for instance, about the true intentions underlying other people's behaviours, rejection hypersensitive individuals are more likely to expect malicious intentions of others and/or negative outcomes, and so respond in a more intolerant manner

(i.e., hostility). As those individuals are less likely to regulate their initial maladaptive response by suppressing, shifting attention to different aspects/possibilities, or acting in a more socially appropriate way, this negative and maladaptive response to social situations may lead to a development of BPD features.

Limitations

Although the current study supported the hypothesis, a number of limitations in this study should be addressed. First, although this study established mediational and moderated mediation models, the use of cross-sectional design was not ideal to examine the directionality. Therefore, it has to be emphasized that any causal claim cannot be made from this finding. Experimental studies are required to establish causation or determine the directionality of the association. Second, although the current study aims to investigate the association between rejection sensitivity and BPD features, the current subjects contained an insufficient number of individuals with a high level of BPD symptoms. Further, the current study recruited mostly student samples from a nonclinical population; hence, the results are highly biased due to a lack of generalizability to a wider population. Although past literature suggests that considerable impairments can be seen in a non-clinical population (Clifton & Pilkonis, 2007), future studies should be replicate the current study in the clinical population as well as non-student samples.

Third, the current study relied solely on self-report measurements collected at one point in time. Unlike the previous chapter, the current study has shown that all predictive variables were associated with the outcome variable;

hence, the shared method variance may have confounded the findings. Future studies should employ a different methodology rather than only self-report questionnaires.

Fourth, male and female subjects were not equally distributed in the current study. As past study has suggested that BPD was more prevalent in women than men (Lieb, Zanarini, Schmahl, Linehan, & Bohus, 2004), this gender imbalance might be an issue. Gender effects on BPD features might have some confounding effects on the association between rejection sensitivity and BPD features. To support the gender effect, previous research investigating the effect of age and gender differences on the PAI-BOR scale has found that female subjects were more likely to score higher on affective instability, identity problems, and negative relationships comparing to male subjects (De Moor, Distel, Trull, & Boomsma, 2009). However, the current study did not find the gender effect on any of PAI-BOR subscales (BPD features). Both male and female participants showed an equal level of BPD features. This finding may suggest that the current subjects were not representative samples. However, a recent study has shown that there was no gender bias on some measurements of BPD features (Paggeot & Huprich, 2018), which supported the current findings.

Finally, although the current study hypothesized that elevated negative emotions in response to ambiguous social stimuli due to heightened rejection sensitivity would lead to impairments in effortful control, participants' emotional state (i.e., anxiety) was not assessed. Hence, the negative association between intolerance of ambiguity and effortful control remains unclear. Although the emotional state was not measured, depressive and anxious symptoms were

measured using a self-report measurement and controlled in the analyses. In order to examine the role of negative emotional arousal in response to ambiguous social cues, future empirical studies should assess the subjects' emotional response (i.e., the state of anxiety) in the presence of potential social threats.

Overall Conclusions

There is substantial evidence suggesting the important role of rejection sensitivity in understanding the development of BPD features negative consequences such as interpersonal difficulties. A large number of past research and clinical reports have shown that rejection hypersensitive individuals were more likely to show a higher level of BPD features. As described previously, a certain level of rejection sensitivity is adaptive to avoid negative social consequence (i.e., social rejection) and important to have healthy interpersonal relationships. However, once hypersensitivity to rejection becomes beyond a normal level, even non-threatening social stimuli (uncertainty) can be seen as threats and the elevated fear and anxious expectations of future rejection may disturb self-regulating capacities such as effortful control which helps to build a healthy interpersonal relationship.

As fear of rejection, disturbed effortful control, and intolerance of ambiguity were found to be associated with core features of BPD, how those cognitive factors may explain the difficulties BPD patients frequently experience should be further examined using different methodology. Future studies should experimentally investigate the impacts of rejection sensitivity on cognitive capacities, particularly self-regulation, among individuals with high BPD features in ambiguous and negative social interactions.

3. Effects of Attachment on Learning: The role of BPD features

3.1. Introduction

Interpersonal difficulties have been considered to be one of the core symptoms of borderline personality disorder (BPD) underlying a variety of other cognitive and behavioural symptoms in BPD patients (Lazarus et al., 2014; Sanislow et al., 2002). Many BPD symptoms are captured within interpersonal contexts, and the severity of symptoms tend to increase when they perceive real/imagined social rejection or loss (Levy et al., 2005). A robust literature suggested that the developmental factors play an important role in BPD patients' interpersonal hypersensitivity (Ayduk et al., 2008; Gunderson & Lyons-Ruth, 2008). To explain the link between rejection sensitivity and BPD features, the importance of the developmental factors (i.e., attachment) was found in the study 1, and the role of cognitive factors was found in the study 2. However, the effect of underlying developmental factors in the cognitive functions are not well investigated. Hence, the present study aims to investigate whether activating the attachment system has an impact on social learning among those with BPD features.

BPD and Early Dropout from Treatment

Although previous studies have shown that BPD features change over time and by treatment, high dropout rates (15-77%) have been found and reported in different treatment settings in past research (De Panfilis et al., 2012; Rüsçh et al., 2008). There are many studies reporting the high rate of treatment dropout among BPD patients, but the causal factors for the early dropout are still not well understood. Previous research has investigated the predicting factors associated

with the treatment dropout rates of BPD patients. Those studies have found that patients' socioeconomic status, treatment history, symptom severity, co-morbid disorders, and personality features (De Panfilis et al., 2012; Rüsçh et al., 2008). However, this evidence is still controversial in terms of generalizability due to the variety in the population background (age, sex, co-morbid disorders), the study setting (inpatient/outpatient), and treatment details (types, length) (Rüsçh et al., 2008). In addition, the theoretical framework explaining the treatment dropout or efficacy is still not well understood.

Social Learning

As described in the literature review, the critical factor for the therapeutic efficacy is the individuals' capacity to learn from the therapists (Dixon-Gordon et al., 2018). Given that counselling and psychotherapies require discussing their personal experience including childhood memories and current interpersonal relationships, the psychological treatment may activate the attachment system and elevate emotional arousal. As a result, the activation of the attachment system may hinder their cognitive capacity to learn from the therapies due to emotional arousal (Dixon-Gordon et al., 2018). As described earlier, affect dysregulations, which lead to impulsive behaviours, are the core characteristic of BPD patients (Linehan, 1993; Paris 2002). Schulze and colleagues (2011) have found that affective instabilities negatively impact on learning, which are consistent with other studies (Dixon-Gordon et al., 2018; Lieb et al., 2004; Pesic et al., 2014). A number of studies have investigated the learning capacities in BPD patients using the Go/No-go task, a contingency learning paradigm. In response to the presented visual cues, participants need to activate actions (Go) or withhold actions (No-

go). As participants are not informed about the action contingencies for each stimulus (Go/No-go), they need to learn them by trial and error. BPD patients were found to make more errors compared to healthy individuals (Nigg et al., 2005) particularly in the No-go condition where they had to inhibit actions (Rentrop et al., 2008). Guitart-Masip and colleagues (2012) investigated the effects of learning the probabilistic outcomes (reward/punishment) on actions (go/no-go) using the same contingency learning paradigm (GNG). In their study, there were four conditions including “Go to Win (G2W)”, “Go to Avoid Punishment (G2AP)”, “No-go to win (NG2W)”, and “No-go to avoid punishment (NG2AP)”. Participants received rewards (i.e., money) when they activated actions in the G2W condition. Also, they received rewards when they withheld actions in the NG2W. On the other hand, participants were punished (i.e., losing money) when they activated actions in the NG2AP condition. Further, participants were punished when they withheld actions in the G2AP condition. Results found that people performed significantly better in the “Go” condition than “No-go” condition suggesting that response inhibition was more challenging than activation of actions. There was no significant difference in performance between reward and punishment conditions. However, there was a significant interaction indicating that the performance improved in the condition where they had to activate actions to achieve rewards (G2W) compared to the condition where they had to activate actions to avoid punishment (G2AP). Further, they were better at withholding actions to avoid punishment (NG2AP) compared to withholding actions to achieve rewards (NG2W). Hence, the action inhibition was found to be more cognitively challenging. However, those previous research has focused only

on cognitive aspects, and neglected the affective or interpersonal relationship aspects.

Present Study and Hypotheses

The aim of the current study is to investigate whether the effects of attachment stimuli on the inhibitory task and learning differ among individuals with high BPD features compared to those with low BPD features. As those with high BPD features are more likely to be insecurely attached, they were expected to perform worse with the inhibitory task and learn less from stimuli due to epistemic hypervigilance in response to the picture of their attached figure (mother). On the other hand, those with low BPD features were expected to perform in the same way on the inhibitory and learning task with the picture of their mothers and a stranger. Previous studies suggest that rewards improved learning when they had to activate actions, and punishment improved learning when they had to withhold actions which were congruent to Pavlovian influence (Guitar-Masip et al., 2012). Therefore, the current study only used two conditions including G2AP and NG2W as the past research has shown the effects of the other two conditions.

3.2. Materials and Methods

3.2.1. Participants and procedure

The current study was advertised on the UCL psychology subject pool (SONA) system and the participant pool of a computational psychiatry study hosted by the UCL Department of Clinical, Educational and Health Psychology and the Institute of Neurology. In total, ninety-six healthy volunteers (74 females and 22 males; age range 18-49; M_{age} 24.95, SD 6.19) participated in the study.

Overall, the ethnicity of participants in the study was Caucasian (51%), Asian (35.4%), African/Caribbean (3.1%), mixed (9.4%), and other (1%). All participants signed the consent forms before partaking in the study, which was approved by the UCL ethics board.

After recruitment, researchers contacted them via telephone/emails. When they agreed to take part in the study, researchers asked them to send a photo of their mothers for one of the computer tasks. Hence, all participants consented to the use of their mothers' photo. Participants were invited to come to the lab and told that the study would include questionnaires, computer tasks, and interaction tasks, which would take about an hour to complete. After signing the consent form, participants were given a demographic form and the questionnaires assessing their personality traits. Following that, participants were asked to start the modified GNG.

3.2.2. Materials

Personality Assessment Inventory-Borderline Features Scale

BPD features were assessed using the PAI-BOR (see Study 1). In the current subjects, a high internal reliability was found (Cronbach's $\alpha = .84$).

Modified Go/No-Go paradigm

The present study used a modified version of the GNG task which was employed in the previous study (Guitart-Masip et al., 2012). This modified GNG task was created to examine whether activation of attachment system had an effect on contingency learning. To activate the attachment system, participants' caregivers (mother) photo was used as stimuli. Prior to a participation of the study, researchers asked participants to send a photograph of their mothers. As the

previous study (Guitart-Masip et al., 2012) had two (Go/No-go) by two (reward/punishment) conditions, it would have been eight conditions in total if we were to add another factor (mother/stranger). Hence, the current study reduced the number of conditions by eliminating G2W and NG2AP conditions because the within-subject design would be too confusing and complicated for subjects to perform the GNG tasks in many different conditions. G2W and NG2AP conditions were selected to be eliminated because these conditions were Pavlovian-congruent conditions, but G2AP and NG2W were Pavlovian incongruent conditions. Hence, we contemplated that Pavlovian incongruent conditions would have more space for attachment effects on learning.

Participants would start the modified GNG paradigm with practice trials to become familiar with the instruction. Participants were first asked to press the space-bar as quickly as possible when they saw a circle on the screen to practice the speed requirement in the task. Then participants received feedback whether they pressed the space-bar fast enough. Once participants understood how quickly they had to press the space bar to submit their response (Go/No-go), the testing trials would start with instructions. In total, there were 144 trials which followed three phases; a fractal cue, a target detection task, and the feedback. In the first phase, a photograph of a person (participants' mother/stranger) holding a sheet with an abstract fractal image appeared on the screen. There were in total four different abstract fractal images which were presented one at a time. Hence, eight types of photographs were used in the first phase (2 people x 4 fractal images). Each photograph in the first phase indicated the conditions whether participants had to activate actions (Go) or withhold actions (No-go) in the second phase (a

target detection task). Following the photograph with a fractal cue, an image of a circle appeared on the screen. This circle signalled that actions (Go/No-go) were required by either pressing or not pressing the space-bar. After the actions were chosen, participants received one of three types of feedback (win/neutral/loss). Feedback was given by a green arrow pointing upwards indicating that participants won £1, a yellow bar indicating that they did not win or lose any money, and a red arrow pointing downwards indicating that they lost £1 (see Appendix D). The feedback given was probabilistic in which 80% of accurate responses and 20% of inaccurate responses were rewarded in the win condition. The remaining 20% of accurate responses and 80% of inaccurate responses did not lead to any outcomes. In the loss condition, 80% of accurate responses and 20% of inaccurate responses did not lose £1. Participants were only informed that the correct responses for each fractal cue might be either go or no-go (Guitart-Masip et al., 2012), but not aware of the conditions they were given. Hence, participants were told that they had to learn the pattern of the abstract fractal cues by trial and error. The fraction of correct responses was not only calculated by averaging the total scores, but was also weighted by dividing the responses into the first and the second half of the trials. As the learning curve changes as the trials continue, the scores in the first half and the second half of the trials were not counted in the same way. The first half was weighted more heavily, but less in the second half of the trials (Moutoussis & Nolte, in prep).

3.2.3. Statistical Analytic Plan

First, the Pearson correlation coefficients were calculated among all variables (BPD scores, the fraction of correct responses) with age. To assess the

gender effect on variables, a series of t-tests were conducted. A three-way ANCOVA on the total GNG performance with attachment (mother/stranger), condition (NG2W/G2AP), and BPD features (high/low) as between-subjects factors with age as a covariate was conducted. Then, a four-way ANCOVA on the fraction of correct response with time (first half/second half), attachment (mother/stranger), condition (NG2W/G2AP), and BPD features (high/low) as a between-subject factor with age as a covariate was conducted to examine whether participants learnt stimulus-response associations. Due to limited statistical power to conduct a four-way analysis to detect effects, independent-samples t-tests were conducted to explore the effect of BPD features on each condition. To measure the learning rate, the difference scores were calculated by subtracting the scores of the first-half from the second-half of the trials. Then, a three-way ANCOVA on the learning rate with attachment (mother/stranger) and condition (NG2W/G2AP) as repeated factors and BPD features (high/low) as a between-subject factor with age as a covariate was conducted. To further explore the effect of different aspects of BPD features on learning, subscales of PAI-BOR were analysed separately using two-way ANCOVA analyses.

3.3. Results

3.3.1. Descriptive Statistics

The means, standard deviation, and Cronbach's α of the PAI-BOR (BPD features) scores (Table 5) and means and standard deviations of GNG performance (Table 6) were presented. In the current study, the PAI-BOR scores ($M = 23.77$, $SD = 10.00$) were similar to the previous research ($M = 26.71$, $SD = 14.70$) among healthy participants (Gardner & Qualter, 2009). The means and

standard deviation of the fraction of correct response were also calculated and presented (Table 6).

Table 5. Descriptive statistics: means, standard deviations, and Cronbach’s alpha coefficients of subscales and total scores of the PAI-BOR.

Variables	Mean	SD	α
Identity problems	6.89	3.19	.59
Interpersonal problems	6.56	3.29	.60
Affective instability	6.53	3.55	.76
Self-harm	3.69	3.24	.75
Total	23.77	10.00	.84

Note. PAI-BOR = Personality Assessment Inventory –Borderline Features Scale.

Table 6. Descriptive statistics of the fraction of correct response.

Variables	Mother	Stranger
	Mean (SD)	Mean (SD)
GNG performance		
No-Go to Win – total	.65 (.32)	.64 (.30)
First half	.48 (.33)	.45 (.29)
Second half	.77 (.34)	.77 (.36)
Go to Avoid Punishment- total	.69 (.21)	.67 (.21)
First half	.61(.20)	.61 (.21)
Second half	.72 (.27)	.73 (.26)
Learning rate		
No-Go to Win	.29 (.32)	.32 (.35)
Go to Avoid Punishment	.11 (.25)	.12 (.26)

3.3.2. Person Correlations and Regression Analyses

The results of Pearson correlation coefficients between age and BPD features (Table 7) found that age was significantly related to identity problems, a subscale of BPD features ($r = -.32, p = .002$). Age was also associated with the fraction of correct responses in the Mother G2AP condition in the first half ($r = -.22, p = .03$), the Mother NG2W condition in the second half ($r = -.39, p < .001$), the Mother G2AP in the second half ($r = -.22, p = .04$), the Stranger NG2W condition in the second half ($r = -.24, p = .02$), the Stranger G2AP in the second half ($r = -.25, p = .02$), and the learning rate on the Mother NG2W ($r = -.29, p = .004$). Hence, age was treated as a covariate in the main analyses. Independent samples t-tests found that there was no significant gender difference on the fraction correct and BPD features.

Table 7. Bivariate correlations between age and the PAI-BOR subscales, and the fraction of correct response.

Variable	Age
Identity Problems	– .32**
Interpersonal Problems	– .15
Affective instability	– .01
Self-harm	– .16
PAI-BOR total	– .21
Mother NG2W first half	– .12
Mother NG2W second half	– .39**
Stranger NG2W first half	– .09
Stranger NG2W second half	– .24*
Mother G2AP first half	– .22*
Mother G2AP second half	– .22*
Stranger G2AP first half	– .19
Stranger G2AP second half	– .25*
Learning rate -Mother NG2W	– .29**
Learning rate -Stranger NG2W	– .18
Learning rate -Mother G2AP	– .06
Learning rate -Stranger G2AP	– .10

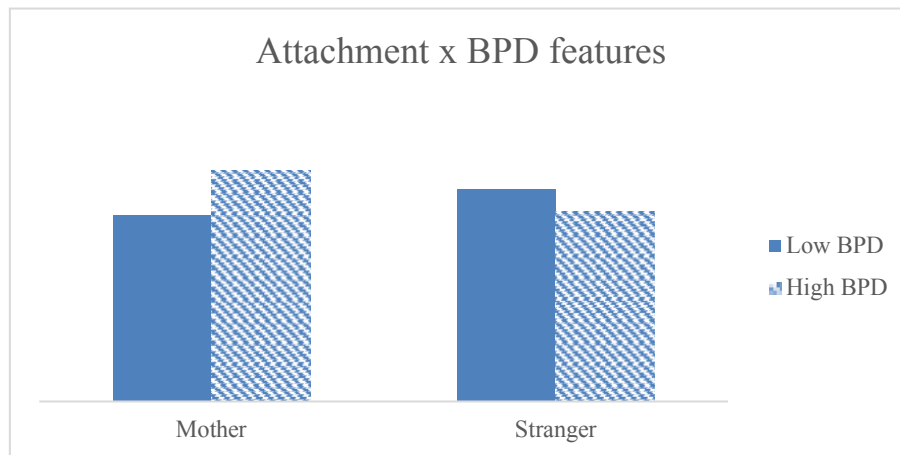
Note. NG2W= No go to win; G2AP= Go to Avoid punishment. PAI-BOR = Personality Assessment Inventory – Borderline Features Scale.

* $p < .05$, two-tailed , ** $p < .01$, two-tailed

3.3.3. GNG performance

A three-way ANCOVA on the total GNG performance with condition (NG2W/G2AP) and attachment (mother/stranger) as repeated factors and BPD features as between-subjects factor with age as a covariate found a marginally significant attachment by BPD features interaction ($F(1,88) = 2.91, p = .09, \eta_p^2 = .03$, observed power = .39). Individuals with high BPD performed better with a picture of their mothers ($M = .68, SD = .03$) than a stranger ($M = .64, SD = .03$); whereas, those with low BPD features performed worse with a picture of their mothers ($M = .64, SD = .03$) than a stranger ($M = .65, SD = .03$) (Fig 8).

Figure 8. An interaction between attachment and BPD features on the fraction of correct response.

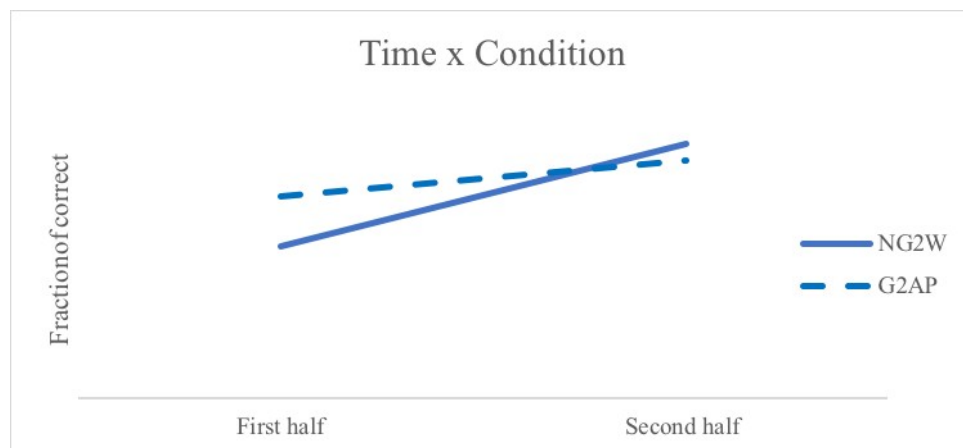


Note: BPD = Borderline Personality Disorder features.

A four-way ANCOVA on the fraction of correct with time (first half/second half), conditions (NG2W/G2AP), attachment (Mother/Stranger) as repeated factors and BPD features (high /low) as a between-subject factor with age as a covariate found a significant main effect of time ($F(1,88) = 26.25, p < .001, \eta_p^2 = .23$, observed power = 1.00) and a significant time by condition interaction ($F(1,88) = 6.26, p = .01, \eta_p^2 = .07$, observed power = .70). A

significant main effect of time indicated that the performance on the GNG task improved in the second half of the trials than the first half of the trials. Although people performed better in the G2AP ($M = .61, SD = .02$) than NG2W ($M = .46, SD = .03$) condition during the first half of the trials, they performed worse in the G2AP ($M = .72, SD = .03$) than the NG2W condition ($M = .77, SD = .03$) in the second half of the trials (Fig 9).

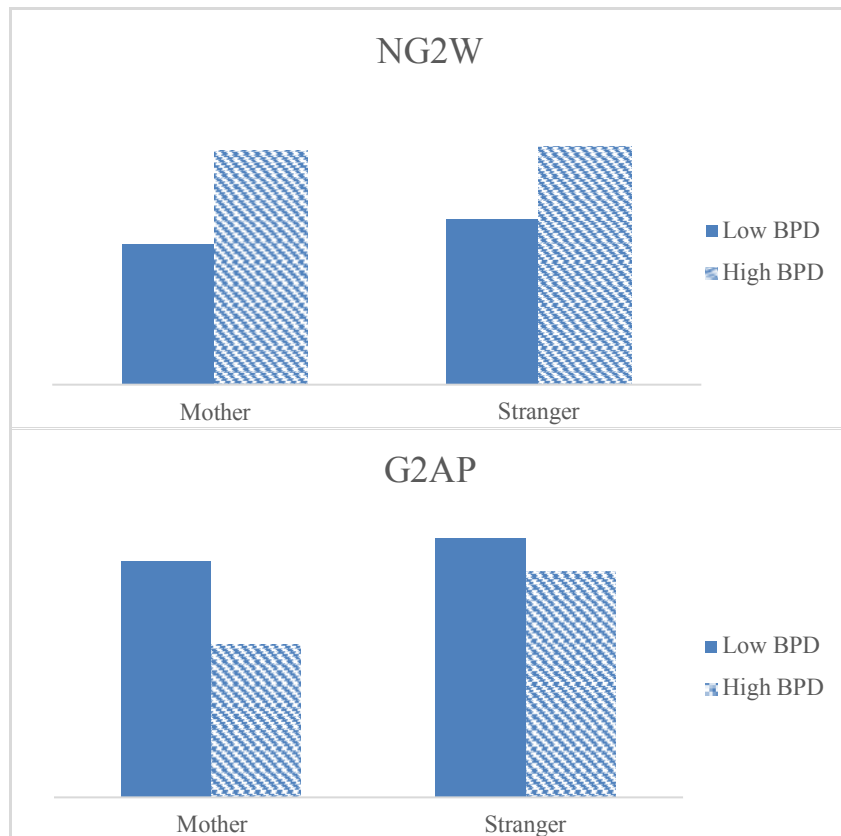
Figure 9. Time by condition interaction on the fraction of correct response.



Note: G2AP = Go to Avoid Punishment. NG2W = No-go to Win.

Although it was not statistically significant, people with high BPD features ($M = .63, SD = .04$) performed better in the NG2W condition than people with low BPD features ($M = .60, SD = .04$). However, those with high BPD features ($M = .66, SD = .03$) performed worse comparing to people with low BPD features ($M = .67, SD = .03$) in the G2AP condition ($F(1,88) = .48, p = .49, \eta_p^2 = .01$, observed power = .11). The direction of effects was same between the conditions using the picture of their mother's and strangers (Fig 10).

Figure 10. Interactions between condition, attachment, and BPD features on the fraction of correct response.



Note: BPD = Borderline Personality Disorder features. G2AP = Go to Avoid Punishment. NG2W= No-go to Win.

As the statistical power was limited to run a four-way ANCOVA, independent-samples t-tests to detect the effect of BPD features on each condition were separately conducted. It was found that there was a marginally significant effect of BPD features only on the attachment NG2W condition, $t(89) = -1.92$, $p = .06$, Cohens' $d = .40$. It indicated that people with high BPD features performed differently from those with low BPD features only when they performed the NG2W condition using the picture of their mothers.

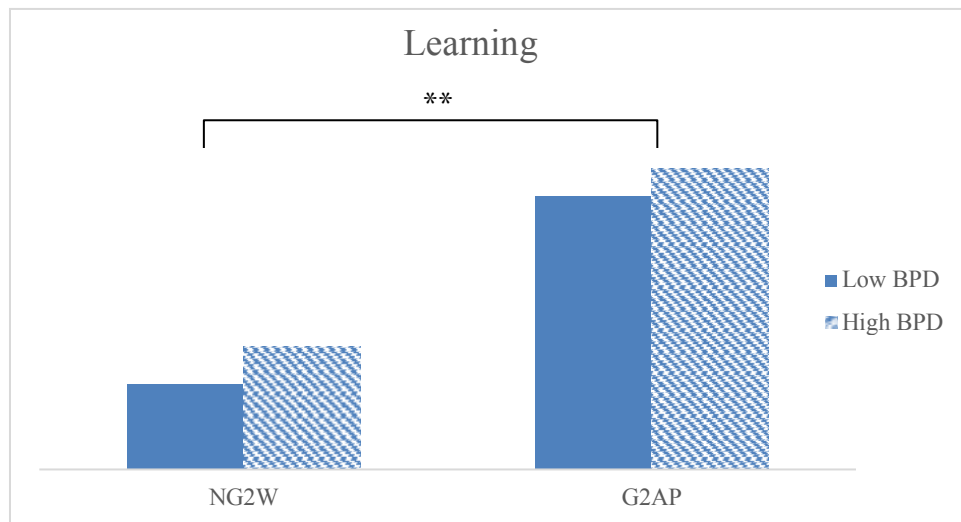
Although it was not statistically significant, people with high BPD features performed better on the attachment condition ($M = .66$, $SD = .03$) than

the stranger condition ($M = .63, SD = .03$), but people with lower BPD features scored higher on the stranger condition ($M = .64, SD = .03$) than attachment ($M = .63, SD = .03$) condition ($F(1,88) = 2.04, p = .16, \eta_p^2 = .02$, observed power = .29) (Fig 8). People with high BPD features performed better with the picture of their mothers rather than strangers, but people with low BPD features performed better with the picture of strangers compared to their mothers.

3.3.4. Learning

As described in the statistical analysis plan, difference scores were used as learning scores. A three-way ANCOVA found a significant main effect of condition ($F(1,88) = 6.26, p = .01, \eta_p^2 = .07$, observed power = .70). Participants learned significantly worse at the NG2W condition ($M = .11, SD = .02$) than the G2AP ($M = .31, SD = .03$) condition (Fig 11).

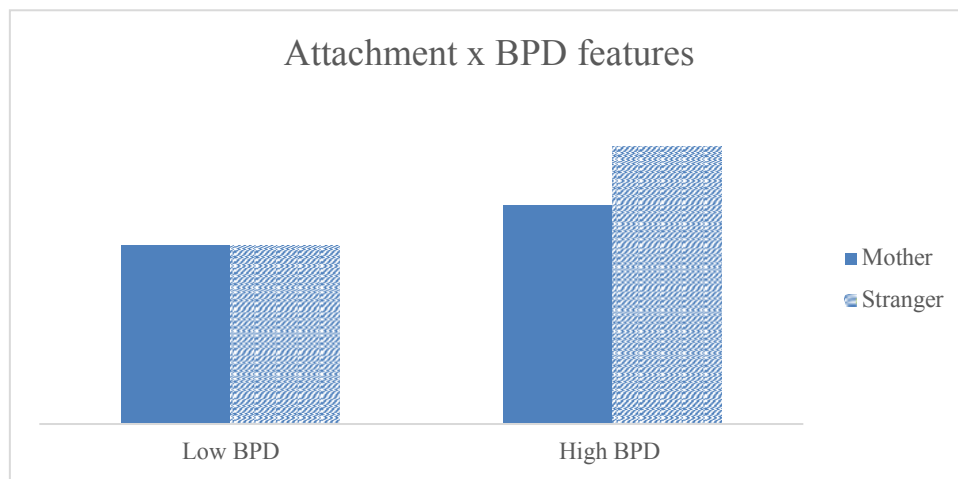
Figure 11. Learning difference in each condition.



Note: BPD = Borderline Personality Disorder features. G2AP = Go to Avoid Punishment. NG2W = No-go to Win

Although the interaction was not statistically significant, individuals with low BPD features did not perform differently between the condition using the picture of their mothers and ($M = .19, SD = .03$) and the stranger's picture ($M = .19, SD = .03$). On the other hand, those with high BPD features learned worse with the picture of their mothers ($M = .21, SD = .03$) than the picture of strangers ($M = .24, SD = .04$). Hence, the effect of attachment (mother/stranger) was only shown among people with high BPD features (Fig 12).

Figure 12. An interaction between attachment and BPD features on the learning rate.



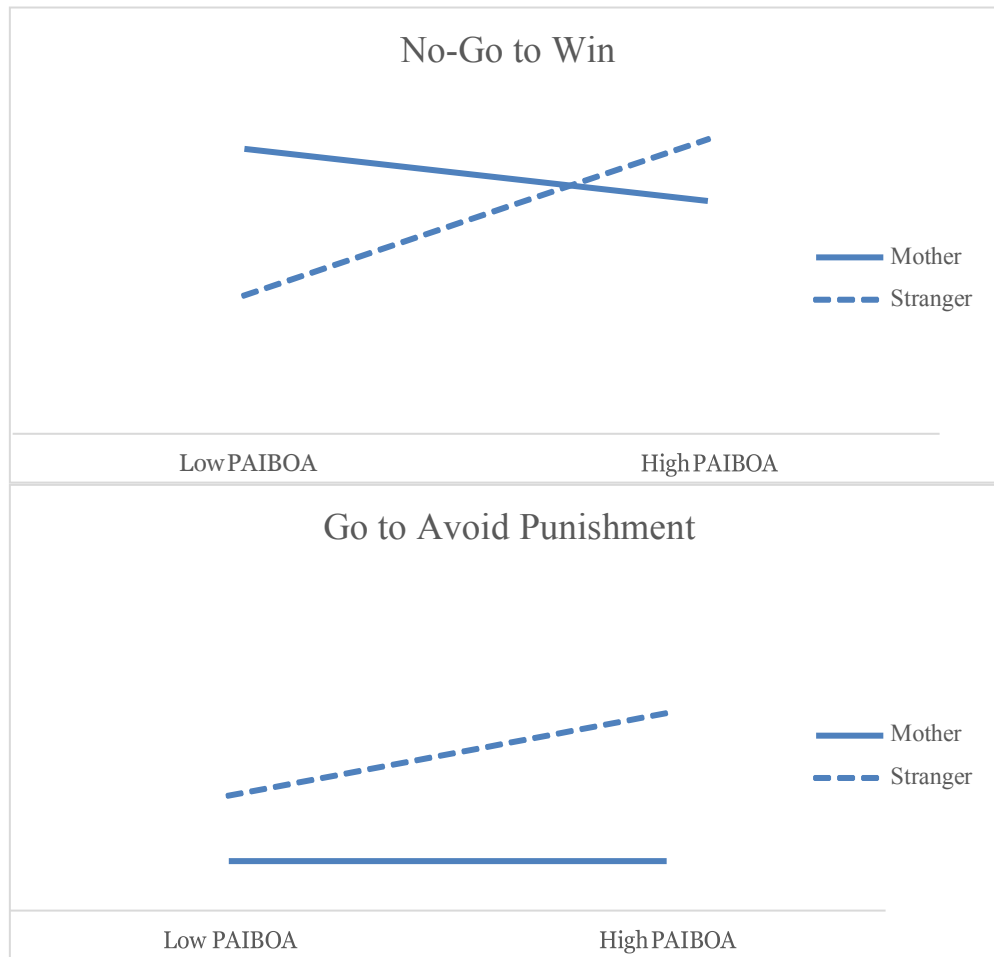
Note: BPD = Borderline Personality Disorder features

3.3.5. Secondary Analyses - BPD subscales

To investigate the effect of different aspects of BPD features on learning, separate analyses were conducted among four subscales of PAI-BOR. A two-way ANCOVA on the learning rate with attachment (mother/stranger) and condition (NG2W/G2AP) as repeated factors and age and interpersonal problems of BPD features (PAIBON) as covariates found a significant main effect of condition

($F(1,90) = 6.47, p = .01, \eta_p^2 = .07$, observed power = .71). People learnt better in the G2AP condition ($M = .31, SD = .03$) than NG2W condition ($M = .11, SD = .02$). A two-way ANCOVA on the learning rate with attachment (mother/stranger) and condition (NG2W/G2AP) as repeated factors and age and self-harm tendency of BPD features (PAIBOS) as covariates found a significant main effect of condition ($F(1,90) = 4.70, p = .03, \eta_p^2 = .05$, observed power = .57). A two-way ANCOVA on the learning rate with attachment (mother/stranger) and condition (NG2W/G2AP) as repeated factors and age and affective symptoms of BPD features (PAIBOA) as covariates were conducted. Results found a significant effect of condition ($F(1,90) = 6.20, p = .02, \eta_p^2 = .06$, observed power = .69) and a significant attachment by condition by affective symptoms interaction ($F(1,90) = 4.32, p = .04, \eta_p^2 = .05$, observed power = .54). People with higher affective instability learnt worse with a presence of their mothers' pictures, but better with a picture of strangers comparing to those with low affective instability in the NG2W condition. On the other hand, people learnt better with a picture of a stranger than their mothers in the G2AP condition regardless of the affective instability (Fig 13).

Figure 13. Interaction plot for attachment and PAI-BOA (affective instability) on learning rates.



3.4. Discussion

Cognitive impairments in BPD patients have been reported in a number of clinical reports and past literature. Particularly, BPD patients were found to impair inhibitory controls (Nigg et al., 2005) and social learning (Ruocco, 2005), which may explain the treatment efficacy among people with BPD features. As there is little research investigating the cognitive functions from developmental and social perspectives, the current study aimed to investigate whether activating

the attachment system had an effect on the inhibitory task and contingency learning among those with BPD features.

As BPD patients were found to be associated with insecure attachment styles (Agrawal, Gunderson, Holmes, & Lyons-Ruth, 2004; Bakermans-Kranenburg & van IJzendoorn, 2009; Levy, 2005; Levy, Meehan, Weber, Reynoso, & Clarkin, 2005), the stimuli presented with the picture of participants' mothers were predicted to hinder inhibitory capacities and learning among those with high BPD features. However, results found that there was a non-significant trend where people with high BPD features performed better on the GNG task when the stimuli were presented with the picture of their mother compared to the picture of a stranger. On the other hand, those with low BPD features performed better when the stimuli were presented with the picture of a stranger than their mothers. Findings regarding the learning rate were somewhat surprising. Although overall learning rate was better among those with high BPD features than those with low BPD features, people with high BPD features learnt better from stimuli presented with a stranger's picture than their mothers. Those with low BPD features learnt from stimuli with a picture of a stranger in an equal level as the stimuli with their mothers. However, when the BPD features were analysed separately, affective instability has shown different effects on the learning rate depending on the presence of attached figure and condition.

No-go to Win condition (NG2W)

Results found a significant effect of condition on the overall GNG accuracy indicating that people performed better at "Go-to avoid punishment" condition than "No-go to win" condition suggesting that the inhibitory task was

more challenging. These two conditions contained two axes of control contributing to the decision-making process including valence (reward/punishment) and action (Go/No-go). Guitart-Masip (2012) has shown that the action had a main effect, but not valence, on decision-making and learning. It suggests that the participants in the current study performed differently depending on the condition due to the selection of actions instead of the valence; hence, the results indicated that inhibitory control was more challenging than the activation control.

The GNG performance improved in the second half than the first half, which shows that people learnt the patten of the stimuli through trials and errors. Although people performed better on the G2AP in the first half of the trials, they became better on the NG2W than the G2AP condition in the second half of the trials. It may be because the G2AP was easier than the NG2W condition to learn the stimuli. Hence, the learning occurred in the early stage of the trials. On the other hand, NG2W was more challenging to learn the stimuli in the first half; hence people eventually learned in the second half of the trials. This suggests that inhibitory control may suppress other cognitive functions and slow down the learning.

Attachment and BPD features

There was no main effect of attachment indicating that the presence of their attached figure or a stranger on the stimuli did not have an effect on the inhibitory/activation control and learning in general. However, the effect of attachment differed depending on the level of BPD features.

Although it was not statistically significant, participants with high BPD features performed better at inhibitory/activation control task when the stimuli were presented with the picture of their mothers than a stranger. However, those with low BPD features performed better when the stimuli were presented with a stranger than their mothers. This finding was contradictory to the hypothesis where the presence of their attached figure was expected to hinder inhibitory/activation control. Given that this finding was not statistically significant, any conclusive argument cannot be made.

Affective instability, condition, and attachment interaction

There was no main effect of BPD features; however, affective instability modified the effect of attachment on the learning rate in each condition. An increase in affective instability improved learning from a stranger, but impaired learning from their mothers in the inhibitory task (NG2W). On the other hand, an elevated level of affective instability improved learning from a stranger and their mothers in the activation condition (G2AP). This indicates that the presence of their attached figure had an effect only when they had to inhibit actions.

As difficulties to regulate affect has been linked to impulsivity among people with BPD features (Koenigsberg et al., 2001), the activation of the attachment system might have an effect only in the inhibitory task. Elevated affective response caused by the picture of their mothers might have impaired the self-control capacities to inhibit actions to achieve desirable outcomes. This finding was consistent with the hypothesis where people with high BPD features were expected to perform worse in the inhibitory task (NG2W condition) due to

their impulsivity. The inhibitory capacity was further suppressed in response to the presence of their attached figures due to their insecure attachment style.

The current study did not find a significant effect of overall BPD features on inhibitory/activation control capacities or learning. Instead, only affective instability had an effect, which may suggest two things. It might be because any other BPD features (identity disturbance, self-harm tendency, interpersonal problems) had nothing to do with self-control capacities or learning, but affective stability was an important aspect of self-control and learning. Hence, trigger the attachment system might have suppressed cognitive capacities due to the elevated negative affect among those with impaired affective control.

An alternative possible explanation is that epistemic hypervigilance in response to the presence of attached figures might have an effect on learning among those with affective instability. Given that BPD patients were more likely to have preoccupied attachment style and less likely to trust their attached figures (Bakermans-Kranenburg & IJzendoorn, 2009), those with higher affective instability were also less likely to trust their attached figures. If they did not trust their attached figures as the source of information, they were likely to learn the cues associated with the attached figures. Hence, the increased epistemic mistrust might have hindered learning from their attached figures compared to a stranger in a more challenging cognitive task.

Limitations

There are a number of limitation that should be addressed in the current study. First, there was a gender bias in the current samples as participants' gender was not equally distributed. Gender bias may have a confounding effect on the

results as past research has shown that female participants were more likely to have higher PAI-BOR scores on affective instability, identity problems, and negative relationships than male participants. In addition, younger female participants were more likely to score higher on affective instability and identity problems compared to older female participants (De Moor et al., 2009). Although the independent-samples t-tests did not find any gender effect on the PAI-BOR score and the GNG performance, the affective instability, not other BPD features, had an effect on learning might have been due to the over-represented young female subjects in the current sample. Future study should include additional male subjects to control for the gender effect on learning.

Second, it is not clear whether the manipulation of the task using a picture of the participants' mothers and a stranger was effective in activating the attachment system. The current study did not assess any affective response after the manipulation was introduced. Hence, it is not clear whether any affective response occurred, and what emotional response occurred due to the picture of their mothers. Although there was an effect of the picture of their mothers on learning among those with higher affective instability, the reason for this effect was still unclear. Future research should examine what kind of affective response could be caused by the presence of their attached figures, and whether this affective response had an effect on learning.

Third, the data analysis used in the present study has some limitations. Although splitting the continuous variables into two groups based on the mean score (high/low) is a common methodology in psychological experiments, the use of mean split has been criticized in the previous study as it would lose valuable

information, effect size and power (MacCallum et al., 2002). Hence, the secondary analyses used BPD features as continuous variables. In addition, there is some criticism over the use of difference score due to the increased risk of Type I and Type II error (Phillips, 2012). However, the current study did not have enough statistical power to examine the effect of attachment on learning by using a four-way analysis. Hence, difference scores were used to reduce the factor from the analysis to increase the power. Future study should run a power-calculation prior to the study and secure adequate power to detect the effect.

Fourth, the current study excluded two other conditions (Go to Win/ No-go to avoid punishment) from the previous study; hence, the assumption that the effect of condition was due to the action (Go/No-go) rather than the valence (reward/punishment) was not justified by the data. Although the assumption was based on the previous finding where the valence did not have a main effect on learning, this study found an action by valence interaction (Guitart-Masip et al., 2012). Thus, the effect of the valence cannot be ignored. In the current study used conditions where each action (Go/No-Go) was paired with only one valence (reward/punishment), the main effect of action and valence could not be analysed. Therefore, it is not clear whether the main effect of condition was due to the action or the valence of the condition. Future study should include the other two conditions to examine the main effect of action and valence on learning.

Fifth, although the current study aimed to investigate the role of attachment system on cognitive capacities, participants' adult attachment style was not assessed. Based on the previous research (Bakermans-Kranenburg & IJzendoorn, 2009), it was speculated that the current non-clinical participants with

low BPD features were securely attached, and those with high BPD features were insecurely attached. However, there was no evidence to indicate the adult attachment style of the current participants. In addition, the current study only used the picture of the participants' mothers (not any other attached figure) without knowing whether they were securely or insecurely attached to their mothers. Hence, it is not clear whether the picture of their mothers induced positive or negative affect. Future research should assess the participants' adult attachment style to examine the effect of attachment style on learning among those with high BPD features.

At last, the current study had a small sample size which limited the statistical power to detect significant effects. Although there were some significant effects, the effect size of the findings was all relatively small, and the detected power was also small. Hence, there were possible type I error (false positive), where there was no real effect, but the false effect was detected, as well as type II error (false negative), where a true effect was not detected. A number of factors contributing to the power of the study including the sample size, the study design, statistical analyses used, the effect size, and the alpha level (Clark-Carter, 1997). As the current study has limitations in all these factors, the current findings might have been due to chance including the type I and type II errors. Future study should address the limitations listed above.

Overall Conclusions

Considerable evidence indicating the important role of attachment system on self-control capacities and social learning among people with BPD features.

The current study found potential effects of the attachment system on the inhibitory control and learning among people with BPD features.

In general, people learn equally well from their attached figures (mother) and a stranger. The presence of their mothers did not affect their inhibitory and activation control. However, the presence of their mothers had different effects on people with BPD features. The effect of BPD features, particularly the affective instability, on learning was prominent during the inhibitory task with the presence of their mothers. Response inhibition became more challenging when the stimuli were associated with their mothers. Although the current findings cannot make any conclusive argument, the inhibitory task might have become more challenging because they did not trust their mothers, or their emotional reactions hindered the cognitive capacities.

Although the current study partially supported the hypotheses, there were a number of points that could not be explained or justified due to the limitations of the study. The current study did not have enough evidence to fully explain why the presence of the pictures of the participants' mothers had an effect on learning. It was also not clear why there was a different effect on the NG2W and G2AP condition. Further, the current study found the important role of affective instability, but the change in affect in response to the picture of participants' mothers was not captured. Thus, future study should address the limitations and use a different methodology to capture the effect of attachment system on different aspects of social cognition among those with high BPD features.

4. Effects of Ambiguous Social Interactions on Effortful Control and Mentalizing: The Role of BPD

4.1. Introduction

As described in the previous chapter, the disturbance in interpersonal relationships is one of the core characteristics of BPD patients, and they seem to be particularly sensitive to negative (i.e., rejection) or uncertain social situations (Baer, Peters, Eisenlohr-Moul, Geiger, & Sauer, 2012; Fertuck et al., 2013; Mitchell, Dickens, & Picchioni, 2014). The study 2 supported that the intolerance of ambiguity and effortful control played an important role in explaining the link between rejection sensitivity and BPD features. Although the affective-cognitive mechanism has been suggested to play a role in their interpersonal difficulties, the impact of uncertain social interactions on cognition among individuals with BPD features is still unclear. Hence, the present study aims to investigate the effect of negative and uncertain social interactions on effortful control and mentalizing, which are important social cognition for interpersonal interactions. The current study employed a behavioural interaction using real confederates to increase the ecological validity of the social stimuli.

Hypersensitivity to rejection and ambiguity

Individuals with BPD have been found to rate highly in rejection sensitivity, where they are more likely to expect rejection and therefore interpret ambiguous information in this light (Ayduk et al., 2008; Pietrzak, Downey, & Ayduk, 2005). BPD patients are more vigilant towards potential rejection-relevant cues (Berenson et al., 2011; Gunderson et al., 2018; Staebler et al., 2011; Veen & Arntz, 2000). According to Downey, Khouri and Feldman's (1997) Rejection

Sensitivity model, individuals who have both a biological disposition to rejection sensitivity and experiences of painful rejection in the past, are more likely to have an increased sensitivity to the possibility of future rejection and are thus motivated to protect themselves from it. Despite its intended function, self-protecting behaviours can prevent significant relationships from being formed and sabotage new relationships, leading to the detection of further cues of rejection (Berenson et al., 2009). Hypersensitivity to rejection may lead BPD patients to perceive ambiguous cues as threats due to their negative attribution bias (Lobbestael & McNally, 2016). As a result, BPD patients exhibit maladaptive response to uncertainty (Mortensen et al., 2016). When they over-focus on rejection cues and interpret ambiguous cues as rejection, effortful control needs to suppress the negative cognitive biases and shift attention to other aspects of the situations.

Effortful control in BPD

However, a number of clinical reports and research have suggested that BPD patients manifest impairments of a wide range of cognitive capacities such as effortful control (Ayduk et al., 2008; Baer et al., 2012; De Panfilis et al., 2013; Hagenhoff et al., 2013). Effortful control is important in overriding and inhibiting automatic or habitual reactions in a controlled manner in order to give expression to a more socially appropriate response (Botvinick et al., 2001; Casey et al., 2002; De Panfilis et al., 2015). Poor attentional control may lead to emotional dysfunction in two ways, disengagement or inhibitory difficulties can lead to the experience of negative emotions, whilst the limited ability to shift attention to stimuli related to safety and relief may prevent the individual from otherwise

experiencing positive emotions (Von Ceumern-Lindenstjerna et al., 2010; Derryberry & Reed, 2002).

Individuals with BPD have been found to frequently engage in thought suppression, which subsequently results in the individual being more preoccupied about the thought matter they were initially trying to avoid (Wegner & Zanakos, 1994). Given that the less effortful control was associated with an increase in BPD features in the study 2, BPD patients may end up experiencing more negative emotions and stress due to over-focus on negative aspects of social stimuli. In addition, increased rates of rumination, a repetitive thinking style has been found in BPD patients (Baer & Sauer, 2011). This repetitive thinking style leads to over-interpretation of social stimuli, hypermentalizing.

Social cognition

Another important impairment in BPD patients is social cognition (Franzen *et al.*, 2011; Mier *et al.*, 2014), particularly mentalizing, which enables individuals to speculate other people's mental state in the social situations. Mentalizing requires inference of both mental and emotional states of the others. It is considered as an important component of social cognition as it entails the understanding of the facial expression of emotions and the knowledge about the other's perspective. Given that past literature showed mixed results regarding social cognition in BPD patients, it is possible that their social cognitive capacities vary depending on the given social situations. As suggested by Fonagy and colleagues (2009), mentalizing consists of four polarities, and good mentalizing needs to be balanced between those polarities. However, the activation of the attachment system due to stress elevates emotional arousal and

triggers the switch from the controlled mentalizing to the automatic mentalizing. Of the negative stimuli that individuals with BPD are sensitive to, the fear of abandonment and intolerance of uncertainty may trigger the imbalance of mentalizing. When mentalizing becomes unbalanced due to the stress (i.e., rejection), individuals may misinterpret social cues, which leads to impaired interpersonal relationships. It is plausible that those individuals with BPD features experience emotional arousal which leads to over-interpretation of social stimuli in response to ambiguous and rejecting social interactions due to suppressed attentional control.

The Present Study and Hypotheses

Past findings regarding effortful control and social cognitive capacities in BPD patients are still mixed, and the impact of social interactions on social cognition for those with BPD features is less known. Therefore, the present pilot study aims to investigate the effects of negative and ambiguous social interactions on effortful control and mentalizing using the emotional Stroop task and the modified RMET among the nonclinical population. As previous studies have found impaired effortful control and impulsivity among individuals with BPD features (Mathews & MacLeod, 2005; Wilson et al., 2007), participants with higher levels of BPD features were expected to be more impulsive (faster and less accurate) on the emotional Stroop task. Given that increased rates of rumination were found to be associated with BPD features (Baer & Sauer, 2011), individuals with higher levels of BPD features are expected to show the tendency to overanalyze (more accurate and more emotional words selected on the modified RMET) before social interactions.

As proposed by Fonagy and colleagues (2006; 2009; 2015), BPD patients are expected to present hypermentalizing in response to distress. Given that BPD patients were particularly sensitive to rejection (Gunderson et al., 2018) and ambiguous cues (Lobbestael & McNelly, 2015), participants with higher levels of BPD features were expected to exhibit disturbed effortful control and hypermentalizing (less accurate and more emotional words selected on the RMET) following ambiguous and exclusive interactions due to perceived threats compared to inclusive interactions.

4.2. Materials and Methods

4.2.1. Participants and procedure

The current study was advertised on the SONA system, and 47 participants were recruited and completed the first part of the study. However, 5 participants withdrew from the study; hence, 42 participants were invited to the lab to complete the second part of the study. Participants were either compensated with course credits within the UCL psychology department or payment of £10 for their participation. The age range of the participants was 18 to 48 ($M_{age} = 25.89$, $SD = 7.45$). 29 participants (62%) were female and 18 participants (38%) were male. Overall, the ethnicity of participants was: White (31.9%), Black (4.3%), Hispanic (2.1%), Mixed (4.3%), and Asian (57.4%). All the participants signed the informed consent before participating in the experiment. The ethics approval was granted from the University College London Research Ethics Committee.

Procedure

The experiment was advertised on the UCL Psychology SONA page describing that the study was divided into two parts, in which the first part of the

study was completed at home and the second part of the study was completed at the laboratory. Researchers contacted participants once they signed up on the SONA system via email. After participants gave a consent to participate in the study, researchers sent an online survey via Qualtrics containing several questionnaires regarding the demographic information and personality traits. Once they completed the online survey, participants were invited to come to the lab to complete the second part of the study including behaviour interactions and computer tasks.

Participants were randomly allocated to three experimental conditions including an inclusion, exclusion, and ambiguous condition. When arriving at the experimental room with a table, two chairs, and a computer, participants were informed that the study would involve completing a few computer tasks and interaction tasks with the other participant. However, they were informed that the other participant for the interaction had not arrived yet; hence, they would start the study with the computer tasks. After the participant signed a hard copy of the consent form, he/she first started the emotional Stroop task on the computer using the Qualtrics. Participants were asked to read the instruction and explain back the instruction to the experimenter to check if he/she understood the task. Following the emotional Stroop task, participants completed the modified RMET (baseline assessment) on the computer. The first practice trial was done with a researcher to make sure the participants understood the instruction.

Once the modified RMET was completed, the experimenter told participants that the other participant was ready to do the interaction task with them. Then a researcher asked the participant if it was alright to bring the other

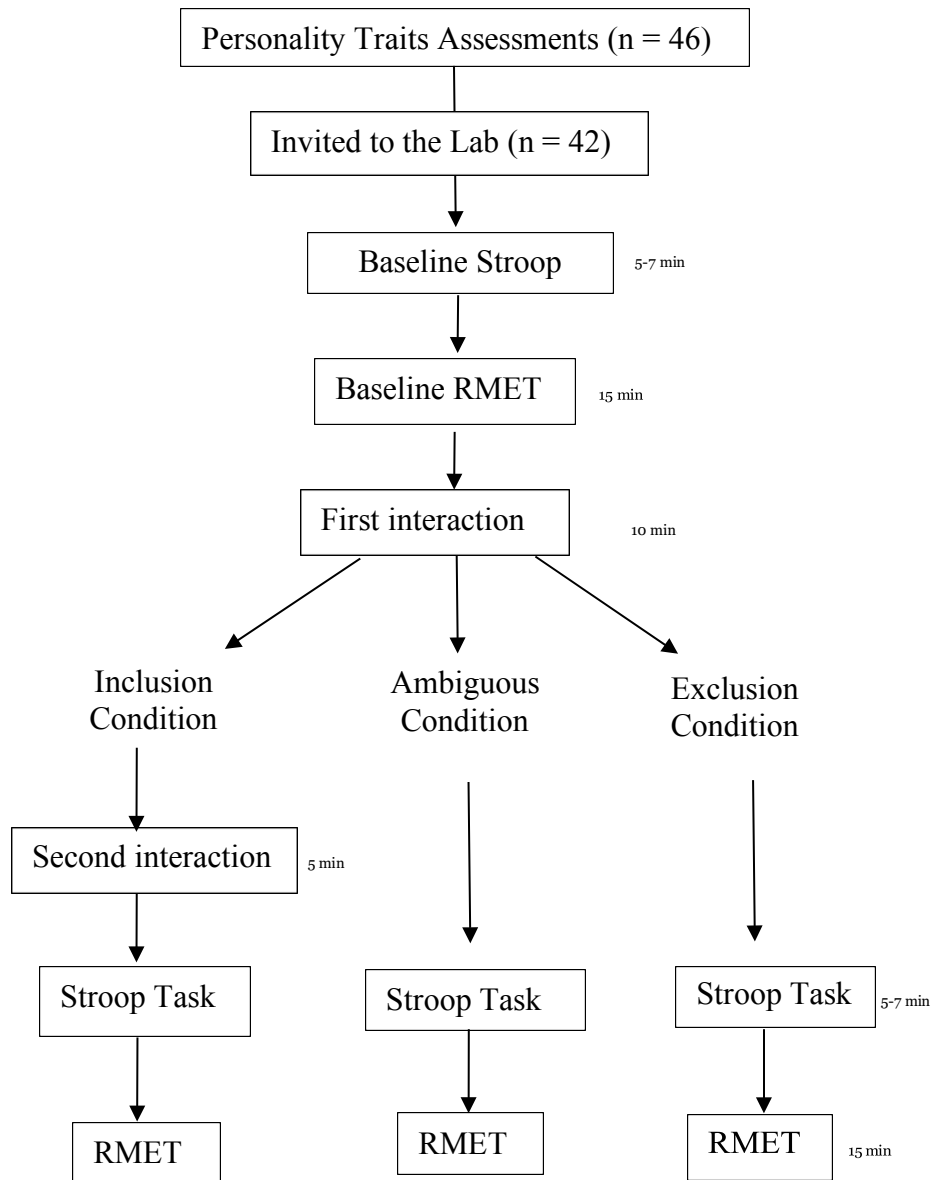
participant in his/her experimental room due to the room size difference. An experimenter and a confederate would be blind to the participant's level of rejection sensitivity or BPD features, and a confederate was blind to the condition. A minute later, a confederate with the experimenter entered the room where participants were waiting. After the experimenter introduced the name of the confederate and the participant, the experimenter brought an envelope where only the confederate's name was in. The experimenter picked the confederate's name from the envelope and asked the confederate to start the interaction with a participant as if it was randomly chosen. In reality, a confederate always started the interaction task. A confederate and a participant received a list of topics that they would be asked to discuss with each other (see Appendix E). They were told that there were two interactions; the first interaction for 10 minutes and the second interaction for 5 minutes. Within the 10 minutes in the first interaction, each person was instructed to discuss a minimum of three topics until the experimenter came back to the room (see Appendix F).

Following the interaction, a researcher came to the room and asked the confederate to go back to her initial experimental room. The participant was left alone in the room for 5-10 minutes. After the break, the experimenter came back to the room and asked the participant if they were happy to start the second interaction. Once they agreed to continue the second interaction, the manipulation of the condition was introduced. Participants in the inclusion condition ($n = 21$) would start the second interaction in the same procedure as the first interaction. In the rejection condition ($n = 11$), participants did not have the second interaction and were informed that the confederate refused to have the second interaction

because the confederate did not feel comfortable to continue the discussion with the participant. In the ambiguous condition ($n = 10$), participants did not have the second interaction and were informed that the confederate had to leave the study without telling a reason (see Appendix G).

After the interaction task, participants were asked to complete the last two computer tasks which included the emotional Stroop task and the modified RMET (Fig 14). Following computer tasks, the researcher conducted a brief interview to check whether the manipulation was successful. Once all tasks were completed, all participants were debriefed and told that the confederates were researchers; hence, any feedback received during the interactions were parts of the study.

Figure 14. Procedure of the current study



4.2.2. Materials

The Personality Assessment Inventory-Borderline Features Scale

To measure BPD traits, the PAI-BOR (Morey, 1991) scale was used (see Study 1). The PAI-BOR raw score of 38 represents the presence of clinical BPD symptoms ($n = 7$). In the current study, the high internal reliability was found (Cronbach's $\alpha = .88$). The low BPD and high BPD group were created based on the median split (PAI-BOR = 24.0).

The Emotional Stroop Task

In order to measure attentional control, the emotional Stroop task (Williams, Mathews, & MacLeod, 1996) was employed. As this was an online Stroop task, participants did not verbally name the colour or the word. Instead, for each trial, there was one word on the screen that was either written in black or coloured font. If the word was in black font, participants were instructed to select the word itself (e.g., Music) from five options (red, blue, green, purple, Music). If the word was written in the coloured font, participants were instructed to select the colour (e.g., Red). The word was presented simultaneously with 5 answer options where the order of the questions and answer options were both randomised. The font used was bold, Calibri at size 18.

There are 5 negative interpersonal-related words (Unwanted, Ignored, Rejected, Disliked, and Avoided), 5 negative non-interpersonal-related words (Cancer, Disaster, Pain, Poison, and Accident) and 5 neutral words (Pavement, Suitcase, Curtain, Calendar, and Chair). Word stimuli used in the task are chosen from the past study by Benson and colleagues (2009) investigating rejection sensitivity in BPD patients. All 15 words were presented in black, red, blue, green

and purple–coloured font, producing 75 trials. The task was timed so that after 400 milliseconds, the trial page would expire, and the next trial would be loaded. Therefore, participants were asked to answer as quickly as possible.

The Qualtrics will record the time of the first click and the last click when participants selected answer choices. If participants selected the answer choice only once, the time recorded for the first click and the last click would be the same. If participants could not select the answer choice within 400 milliseconds, the participant was considered to spend 400 milliseconds for the word.

The modified Reading the Mind in the Eyes Test

The Reading the Mind in the Eyes Test (RMET) (Baron-Cohen *et al.*, 2001) was used to assess participants' ability to refer to others' mental states. The original RMET contains 36 pictures of 18 males and 18 females' pictures. Each participant is presented with 36 black-and-white face images with the eyes and surrounding areas from just above the eyebrows to the bridge of the nose.

A previous study by Harkness and colleagues (2005) categorised the pictures of faces used in the RMET into three mental state valences: positive (eight items), negative (12 items) and neutral (16 items). As a number of studies have employed this categorization and found that BPD patients' disturbance in neutral facial stimuli (Savage & Lenzenweger, 2018; Fertuck *et al.*, 2009), the current study also included the valence of the facial stimuli as a factor in the analyses.

Given the inconsistent findings in the direction of the BPD traits' effects on mentalization, we aimed at investigating the mentalization capacity using a modified RMET paradigm to provide more insights into the matter. The original

RMET task only assesses the ability to estimate affective states of others based on the facial stimuli; hence the evidence of the cognitive capacity of inferring intentions remains limited. Although the original RMET was created to assess the emotional inference aspect of the theory of mind, the current study aims to quantify the level of mentalizing by adding more options to select emotional words to describe the mental state of the person in the photo.

In the modified RMET task, there are two groups of emotion-descriptive words. The first group replicates the original RMET to examine the accuracy of emotional inference in which participants are required select only one emotional word from four answer choices (one correct word and three distracter words) to indicate what the person in the photo is feeling or thinking. In the second group, there are eight additional emotional words including the four emotional words in the first question (total 12 emotional words). The second group assesses the mentalizing capacity by recording the total number of mental states items that are selected from 12 descriptive words (see Appendix H). In the second group, participants are allowed to select more than one word describing the mental state of the person in the picture. The more mental states words, the more analytic ones are to others' mental states by capturing what the others think, feel, infer and so on. If participants associated more emotional words to describe the mental state of the person in the picture, they are considered to be overanalysing. If those with higher levels of BPD features associated more emotional words (overanalysing), but less accurate, on the modified RMET than individuals with lower levels of BPD features, they are considered to be hypermentalizing. The 36 pictures were randomly divided into two groups: the first half ($n = 18$) was presented prior to

the lab experiment, and the second half ($n = 18$) was presented after the interaction task in order to prevent participants from habituating to the photos. Each photo was 15 cm x 6 cm, which was adjusted accordingly by Qualtrics on the computers. The current study has found a high internal consistency (Cronbach's $\alpha = .95$) on the RMET total score.

Behaviour interactions

In the behavioural interaction task, there were three conditions (inclusion /exclusion/ ambiguous). Both confederates and participants were given a list of discussion topic including four types of topics: positive personal (e.g., what is your achievement that you feel most proud of in life?), positive non-personal (e.g., what is your favourite cuisine?), negative personal (e.g., what was your sad experience?), and negative non-personal (e.g., what is your least favourite type of food?). There are three questions in each type of topics; hence, there are total 12 discussion topics (see Appendix E). A confederate always started the interaction and select a more personal topic. A pilot testing was conducted to select the list of topics prior to the current study. The manipulation of the condition was introduced after the first interaction.

In the inclusion condition, a confederate came back for the second interaction as they were happy to continue interactions. Hence, there was a total two interaction where the initial interaction took 10 minutes, and the second interaction took 5 minutes. In the rejection condition, the experimenter told the participant after the initial interaction that the confederate did not feel comfortable with the discussion with the participant so refused to continue the second interaction task. In the uncertain condition, the experimenter told the participant

that the confederate needed to stop the study; hence, the second interaction could not be continued due to the confederate not being present. It was emphasized that the confederate did not make it clear why they had to leave the study when the participant asked further questions regarding the confederate's reasons for withdrawal from the study. Hence, it was unclear whether the confederate left the study because of the personal reasons (i.e., the confederate did not enjoy the discussion with the participant) or external reasons (i.e., unforeseen personal reasons) (see Appendix G).

4.2.3. Statistical Analyses

The means and standard deviations of all outcome variables in each condition were calculated and presented (Table 8). Pearson correlation coefficients were calculated between age and the baseline assessments of the emotional Stroop task (accuracy and the reaction time) and the modified RMET (accuracy and the total number of words selected). As age was correlated with the emotional Stroop task, age was controlled in the main analyses. Independent-samples t-tests on the pre-assessments of the emotional Stroop task and the modified RMET were conducted to assess the gender difference.

A number of two-way ANCOVA on the emotional Stroop performance (accuracy/total reaction time/first reaction time) were conducted with the type of the word stimuli (neutral/non-personal negative/personal negative) as a repeated factor and BPD features as covariates. As the type of word stimuli had no main effect or interaction effect with BPD features, the type of words was not included as a factor in the main analyses.

Similarly, a series of two-way ANCOVA on the modified RMET

performance (accuracy/total number of words selected) were also conducted to examine the effect of valence (positive/negative/neutral) and BPD features. When the effect of the BPD total features was not detected, the effect of each subscale of the BPD features was analysed in addition. As there was no significant valence by BPD features interaction, valence was excluded from the main analyses on the RMET accuracy and the modified RMET total.

A series of linear regression analyses were conducted to assess the association between BPD features and the emotional Stroop performance and the modified RMET performance (Table 2). In addition, to assess whether the tendency to overanalyse facial stimuli was associated with the accuracy in the mental decoding capacity, a linear regression analysis was conducted between the modified RMET total score and the RMET accuracy.

In the main analyses, a three-way ANCOVA was conducted on the emotional Stroop task performance (accuracy/total reaction/first reaction) with time (pre/post) as a repeated factor, condition (inclusion/ambiguous/exclusion) as a between-subject factor, and BPD features and age as covariates. Further, a three-way ANCOVA was conducted on the modified RMET performance (accuracy/total) with time (pre/post) and the valence of the facial stimuli (positive/negative/neutral) as repeated factors, condition (inclusion/ambiguous/exclusion) as a between-subject factor, and BPD features was a covariate.

4.3. Results

4.3.1. Descriptive Statistics and Bivariate Correlations

The means, median, and standard deviation of the PAI-BOR were calculated ($M = 25.98$, $Median = 24.00$, $SD = 12.10$). The means and standard deviation of the emotional Stroop task performance (total reaction time, first reaction time, accuracy), and the modified RMET performance (accuracy, total number of emotional words) in each condition (inclusion/rejection/ambiguous) between the low BPD group and the high BPD group are presented (see Table 8).

Bivariate correlational analyses found that age was significantly correlated with the emotional Stroop total reaction time ($r = .47$, $p = .004$) and the first reaction time ($r = .45$, $p = .007$). Hence, age was treated as a covariate in the following analyses.

Table 8. Descriptive statistics for outcome measurements

Variable	Before interaction		After interaction	
	Low BPD	High BPD	Low BPD	High BPD
	M (SD)	M (SD)	M (SD)	M (SD)
RMET accuracy				
Inclusion	12.38 (2.93)	13.83 (1.94)	12.69 (1.84)	13.17 (0.75)
Exclusion	11.50 (2.65)	12.67 (1.37)	14.00 (0.82)	13.40 (1.14)
Ambiguous	12.00 (2.16)	10.33 (4.16)	13.67 (1.53)	12.20 (0.84)
RMET total				
Inclusion	49.64 (21.33)	45.29 (10.39)	48.85 (19.08)	49.57 (7.32)
Exclusion	44.75 (19.10)	56.50 (16.63)	51.50 (17.60)	60.00 (10.37)
Ambiguous	43.80 (15.85)	42.20 (19.31)	42.80 (12.19)	46.80 (16.15)
Stroop Total Reaction Time				
Inclusion	160.08 (11.42)	154.12 (13.83)	157.34 (11.22)	152.56 (14.21)
Exclusion	169.24 (17.90)	153.62 (17.25)	155.85 (2.89)	141.81 (9.14)
Ambiguous	157.22 (18.29)	168.67 (18.99)	152.19 (21.1)	148.93 (11.45)
Stroop First Reaction Time				
Inclusion	151.52 (11.84)	143.41 (18.18)	142.86 (11.7)	145.82 (16.41)
Exclusion	147.36 (12.44)	145.30 (17.15)	146.92 (3.48)	132.22 (13.38)
Ambiguous	146.01 (15.42)	154.88 (17.58)	139.88 (14.18)	143.10 (17.78)
Stroop Accuracy				
Inclusion	67.62 (5.53)	67.20 (3.56)	64.69 (6.01)	66.43 (8.34)
Exclusion	67.25 (4.57)	57.80 (16.92)	65.75 (5.12)	65.00 (6.12)
Ambiguous	64.00 (3.37)	64.00 (5.10)	60.20 (6.30)	63.00 (7.75)

4.3.2. Baseline Difference

Gender difference

A series of independent-samples t-tests found that there was no significant gender difference in the emotional Stroop task (reaction time and accuracy) and the modified RMET (total score and accuracy). Hence, gender was not controlled in the main analyses.

The emotional Stroop Accuracy

A two-way ANCOVA found a marginally significant main effect of BPD features ($F(1, 33) = 3.54, p = .069, \eta_p^2 = .10$, observed power = .48). Those participants with higher BPD features were more likely to make errors on the emotional Stroop task. Separate analyses of the subscale of BPD features found that identity problems had a significant effect on the emotional Stroop accuracy ($F(1, 34) = 4.43, p = .04, \eta_p^2 = .12$, observed power = .53). As predicted, participants with identity problems, BPD features, were more likely to be inaccurate in the emotional Stroop task. As the type of word stimuli had no main effect or interaction between BPD features on the emotional Stroop accuracy, the type of words was excluded from the main analyses.

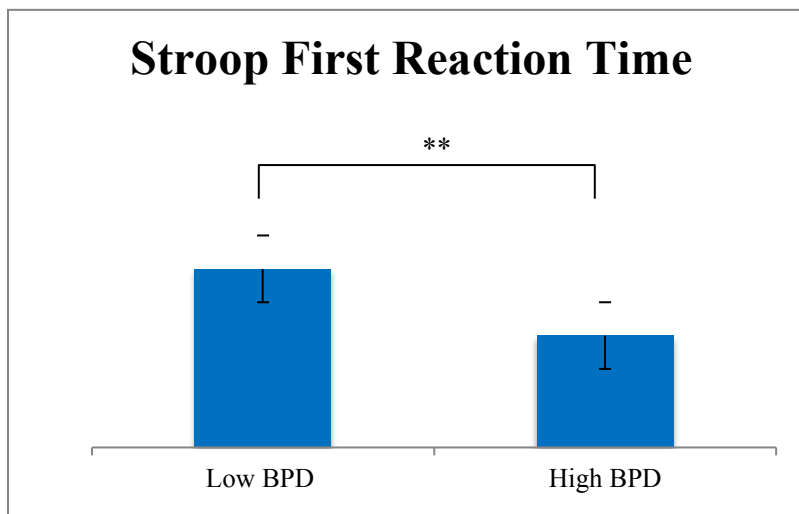
The emotional Stroop Total Reaction Time

A two-way ANCOVA found that there was no main effect of the type of the words or BPD features on the emotional Stroop total reaction time. As the type of words had no main effect or interaction with BPD features, the type of words was not included in the main analyses on the emotional Stroop total reaction time.

The emotional Stroop First Reaction Time

A two-way ANCOVA found that there was a significant main effect of BPD features ($F(1, 36) = 5.29, p = .03, \eta_p^2 = .13$, observed power = .61). As predicted, participants with higher levels of BPD features reacted faster than those with lower levels of BPD features. As the type of word had no main effect or interaction effect with BPD features, it was excluded from the main analyses.

Figure 15. First reaction time between the low and high BPD groups.



Note: BPD = Borderline Personality Disorder features

The RMET Accuracy

A two-way ANCOVA found that there was a significant main effect of valence ($F(1, 44) = 12.39, p = .001, \eta_p^2 = .22$, observed power = .93). Participants were significantly more accurate on the neutral facial expression ($M = 6.17, SE = .35$) compared to the positive facial expressions ($M = 2.72, SE = .16$) and negative facial expressions ($M = 2.78, SE = .16$). As there was no significant effect of BPD total features, the subscales of BPD were separately analysed. Results found that there was a significant effect of identity problems ($F(1, 44) = 4.73, p = .04, \eta_p^2 =$

.10, observed power = .57). As predicted, individuals with higher levels of BPD symptoms, identity problems, were more accurate on the RMET. However, there was no significant interaction between valence and BPD features; hence, valence was excluded in the main analyses on the RMET accuracy.

The modified RMET Total Score

A two-way ANCOVA revealed that there was a significant main effect of valence ($F(1, 44) = 32.75, p < .001, \eta_p^2 = .43$, observed power = 1.00).

Participants associated significantly more emotional words with neutral facial expressions ($M = 27.37, SE = 1.59$) compared to positive facial expressions ($M = 9.57, SE = .53$) and negative facial expressions ($M = 12.24, SE = .76$).

Inconsistent with the hypothesis, BPD features did not have any effect on the baseline of the modified RMET total. As there was no significant interaction between valence and BPD features, valence was not included as a factor in the main analyses on the modified RMET total.

4.3.3. Linear Regression

Results found that BPD features were significantly associated with neutral words on the Stroop first reaction time ($R^2 = .11, \beta = -.34, F(1,39) = 4.93, p = .03$) and the accuracy ($R^2 = .14, \beta = -.37, F(1,35) = 5.70, p = .02$). Also, BPD features were associated with the accuracy of negative personal words ($R^2 = .19, \beta = -.44, F(1,36) = 8.53, p = .006$). Participants with high BPD features were more likely to be faster on the neutral words and less accurate on the neutral and negative personal words on the emotional Stroop task (Table 9). Results revealed that the total RMET score was not associated with the accuracy on the RMET ($R^2 = .06, \beta = .25, F(1,39) = 2.68, p = .11$).

Table 9. Linear regression analyses between BPD features and baseline outcome measurements

Independent variable	<i>B</i>	<i>R</i>²	<i>SE</i>	<i>t</i>	<i>β</i>
Stroop total reaction time	– .23	.03	.22	– 1.03	– .17
Neutral words	– .10	.04	.08	– 1.25	– .20
Non-personal words	– .10	.03	.10	– 1.00	– .16
Personal words	– .02	.002	.09	– .24	– .04
Stroop first reaction time	– .22	.03	.21	– 1.05	– .18
Neutral words	– .16	.11	.07	– 2.22	– .34*
Non-personal words	– .15	.09	.08	– 1.91	– .30
Personal words	– .06	.01	.08	– .72	– .12
Stroop accuracy	– .22	.10	.11	– 1.96	– .32
Neutral	– .09	.14	.04	– 2.39	– .37*
Non-personal words	– .06	.06	.04	– 1.54	– .25
Personal words	– .13	.19	.04	– 2.92	– .44**
RMET total	.10	.00	.24	.41	.06
Positive face	.03	.01	.05	.72	.11
Negative face	.06	.02	.07	.91	.14
Neutral face	.004	.00	.14	.03	.005
RMET accuracy	.02	.01	.04	.65	.10
Positive face	.01	.02	.01	.97	.14
Negative face	.01	.02	.01	.88	.13
Neutral face	.01	.002	.03	.31	.05

4.3.4. Main Analysis

The Emotional Stroop Accuracy

A three-way ANCOVA found that there was no significant main effect of time, condition, and BPD features on the emotional Stroop accuracy. Subscales of BPD features were also analyzed separately; however, none of the BPD features had any effect on the emotional Stroop accuracy. This was inconsistent with the hypothesis.

The Emotional Stroop Total Reaction Time

A three-way ANCOVA found that there was a marginally significant main effect of BPD features ($F(1, 26) = 3.22, p = .08, \eta_p^2 = .11$, observed power = .41) on the emotional Stroop total reaction time where those with higher BPD features were more likely to be faster on the emotional Stroop task. Identity problems were found to have a significant main effect on the emotional Stroop total reaction time ($F(1, 26) = 12.35, p = .002, \eta_p^2 = .32$, observed power = .92). Interpersonal problems also had a significant main effect on the emotional Stroop total reaction time ($F(1, 26) = 5.78, p = .02, \eta_p^2 = .18$, observed power = .64). Impulsive reactions in participants with higher levels of BPD features observed in the reaction time were consistent with the hypothesis. However, inconsistent with the hypothesis, the effects of ambiguous and negative interactions did not differ from the effect of inclusive interactions on the emotional Stroop task among those with higher levels of BPD features compared to those with lower levels of BPD features.

The Emotional Stroop First Reaction Time

A three-way ANCOVA found that there was a significant main effect of identity problems ($F(1, 23) = 6.42, p = .02, \eta_p^2 = .20$, observed power = .68) on the emotional Stroop first reaction time. Participants with higher identity problems responded faster than those with lower identity problems.

The RMET Accuracy

A three-way ANCOVA found that there was a marginally significant main effect of time ($F(1, 28) = 3.99, p = .06, \eta_p^2 = .13$, observed power = .49) where participants improved accuracy in assessing others' mental state after interactions ($M = 13.25, SE = .25$) compared to the baseline ($M = 12.27, SE = .53$). Although enhanced mentalizing capacities were predicted among individuals with higher levels of BPD features, the accuracy of mentalizing did not differ depending on the level of BPD features.

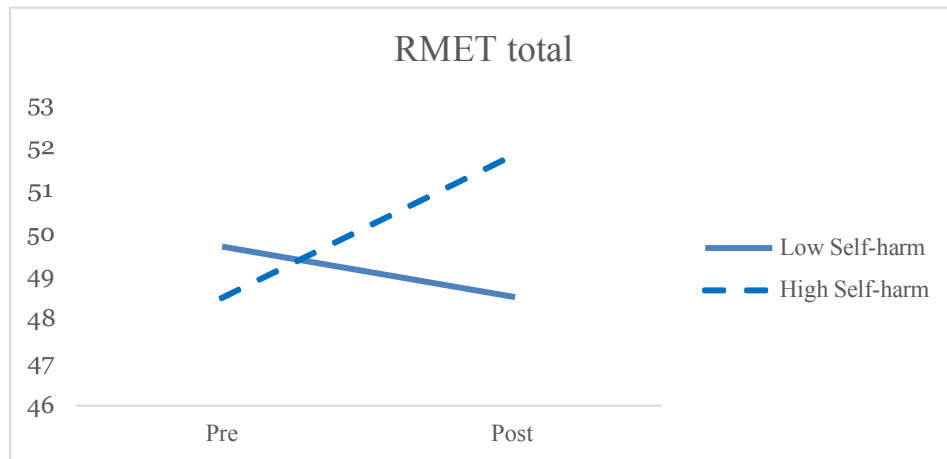
The modified RMET Total Number of Words Selected

A three-way ANCOVA found that there was a significant interaction between time and self-harm tendencies ($F(1,35) = 3.99, p = .05, \eta_p^2 = .10$, observed power = .49). Although participants with lower self-harm tendencies did not show a tendency to overanalyse, those with higher self-harm tendencies are more likely to over-analyse facial stimuli after interactions (Fig 16).

The tendency to overanalyse facial cues among those with higher BPD features in response to interpersonal interactions was consistent with the hypothesis.

Inconsistent with the hypothesis, the type of the interaction (inclusive, ambiguous and exclusive interactions) did not have different effects on mentalizing (the accuracy and the total number of words selected).

Figure 16. Interaction between time and self-harm tendencies.



4.4. Discussion

The present study aimed to investigate the effect of ambiguous social interactions on the effortful control and mentalizing among healthy individuals with BPD features.

As predicted, participants with higher BPD features, particularly interpersonal and identity problems, were faster and less accurate in the emotional Stroop task, which suggested that they were less likely to regulate their impulsive reactions. Although the ambiguous social interactions were predicted to impair the effortful control among participants with high BPD features, the reaction time or the accuracy on the emotional Stroop did not change after any of the social interactions.

Although previous research has suggested the impaired accuracy in the mental decoding capacities among BPD patients (Daros, Zakzanis, & Ruocco, 2013; Donegan et al., 2003; Dyck et al., 2009; Minzenberg, Fan, New, Tang, & Siever, 2008), the current study has found that participants with higher BPD features (identity problems) were more accurate on the RMET. Hence, they

showed an enhanced capacity to estimate the mental state of others. Given that the accuracy on the RMET improved after social interactions, participants' social cognition may have activated, which enhanced the capacity to accurately estimate others' emotional state. Individuals with higher BPD features (self-harm symptoms) showed a tendency to overanalyse facial stimuli following the interactions. It is possible that social interaction may have activated their attachment system due to a perceived threat, which led to the tendency to overanalyse social stimuli as a coping strategy.

Limitations

However, prior to considering the implications of the current study, some limitations should be noted. First, a small number of participants were recruited in the current study; hence, there was not enough statistical power. Although the current study initially aimed to recruit more participants, it was not possible due to the limited availabilities of confederates. Although the sample size was limited, some effects of BPD features were found in the emotional Stroop task and the modified RMET. Hence, future study should replicate the current study in a larger sample.

Second, the current samples were recruited from the non-clinical population and the majority of the participants were university students. Hence, the current findings cannot be generalized to a wider population. Particularly, there were only seven participants who scored above the clinical cut-off on the PAI-BOR. Hence, the severe BPD features were not detected in the current sample. The current study has to be first replicated in a larger community sample.

In addition, a future study should recruit from a clinical population as well to capture the effect of severe BPD symptoms.

Third, the current study did not have any post-interaction assessment to check whether the manipulation of the social interactions was successful. Whether ambiguous and negative social interactions were successful in inducing negative emotional arousal was unknown. In addition, a researcher did not assess whether the deception of the study was successful. Future studies have to conduct a brief interview or questionnaires to capture the participants' perceptions of the interactions.

Fourth, although the manipulation check was not possible to be conducted, the manipulation of the social interactions using confederates seemed to be unsuccessful. Given that the main effect of condition was not found in any analyses, the manipulation of the behavioural interactions did not have any effect on the effortful control or mentalizing. As there were some differences on the RMET performance after social interactions compared to the baseline, social interactions had some effects on mentalizing. However, there was no significant difference between inclusive, ambiguous, and clear exclusive interaction. There are two possible reasons for non-significant effects of the condition. It may be because the manipulation of the type of interaction was not successful, or because participants did not believe that the confederates were real participants. In either case, this may be due to the nature of the current methodology. Behavioural paradigm using confederates are hard to standardize the interaction; hence, each interaction may have a different effect depending on a number of factors (i.e., the confederate mood, the confederates' impression of the participants, interaction

with the participants etc). Also, there were six confederates in the current study; hence, each participant had interactions with a different confederate. As it was already difficult to keep one confederate's interaction consistent throughout the study, it was not feasible to keep all six confederates' interactions consistent. Although the script of the interaction was provided prior to the experiments to keep each interaction as consistent as possible, each confederate had a different way of interacting with participants due to the restricted amount of time for training. Future study should employ a more well-validated interaction paradigm.

Fifth, the current study employed a new methodology to capture hypermentalizing using the modified RMET, which was not validated. Although the reliability test was conducted and found a high internal consistency (Cronbach's $\alpha = .93$) in the current subjects, this methodology needs further validation. A future study should replicate the current finding, but also employ a different methodology to capture mentalizing to cross-validate the current methodology.

Overall Conclusions

Although it is difficult to draw any definite conclusion from the current findings due to a number of limitations in the methodology, the current findings shed new light on the impact of social interactions on people with BPD features. This study found that the disturbance in attentional control and enhanced mental state decoding capacities were significantly associated with the extent of BPD features. As consistent with the findings described in the previous chapter, the disturbance in effortful control was associated with BPD features. Investigating attentional control can provide some insight into the aetiology and maintenance of

BPD, potentially by mediating the reaction and employment of maladaptive behaviours in response to rejection- and other BPD-related cues. As such, further investigations into attentional control and BPD are encouraged.

In addition, the current study was the first attempt to quantify the level of mentalizing to capture hypermentalizing. As the methodology was not validated, the findings need to be interpreted with caution. However, the current findings showed a potential impact of social interactions on hypermentalizing in individuals with BPD features. This needs to be replicated using a more robust interaction task in a larger sample in the next chapter.

5. Effects of Unexpected and Exclusive Social Interactions on Effortful

Control and Mentalizing: The role of BPD features

5.1. Introduction

As described in the previous chapters, interpersonal hypersensitivity in people with BPD features are well captured in numerous studies (Gunderson et al., 2008). Particularly, the past literature has shown the importance of their early negative interpersonal experience (i.e., abuse). People with BPD features tend to experience more aversive interactions, they become more hypersensitive to interpersonal threats throughout their childhood. Hence, multiple factors contribute to their interpersonal hypersensitivity.

Given that heightened rejection sensitivity in people with BPD features are well reported in clinical and empirical research (Ayduk et al., 2008; Boldero et al., 2009; Butler et al., 2002; Fertuck et al., 2013; Meyer et al., 2005; Miano et al., 2013; Rosenbach and Renneberg, 2011; Staebler et al., 2011), any social cues that they learned to associate with rejection are perceived as a threat among those with BPD features. In response to a perceived threat, people with BPD features tend to react in a maladaptive way which leads to cognitive (Renneberg et al., 2012), affective (Chapman et al., 2014; Lobbestael and McNally, 2016), and behavioural (Berenson et al., 2011) disturbance. However, neurological research has suggested that the brain regions that are activated in response to social rejection, the dACC and insula, are also responsible in detecting other stimuli such as expectancy violation and uncertainty in addition to social pain (Botvinick et al., 2004; Eisenberger et al., 2015). Hence, BPD patients may feel threatened when they encounter unexpected social interactions as well as rejection. As a result,

they have disturbed cognitive, affective, and behavioural response. To support that, recent research has suggested that BPD patients have an abnormal expectation within interpersonal contexts.

Distorted Expectations of Social participation

A previous study (Renneberg et al., 2012) has found that patients with BPD had a distorted perception of social participation where BPD patients felt more rejection and reacted intensely even when they were objectively included in the social interaction through Cyberball. BPD patients felt they received fewer ball tosses and they were more ignored compared to healthy individuals regardless of the type of social interactions. Hence, BPD patients felt they were excluded even when they were included in the social interactions. Further, another study (De Panfilis et al., 2015) has found that BPD patients' negative emotions were only reduced following over-inclusive interactions, but not after the normal inclusive interactions. This suggests that their expectation of social inclusion is distorted. Hence, BPD patients' maladaptive emotional reactions in social interactions may be due to their heightened rejection sensitivity and an expectancy violation. One of the negative consequences of the elevated emotional arousal which plays an important role in interpersonal relationships is social cognition, particularly mentalizing.

Mentalizing and BPD

The capacity to be aware of and understand one's own mental states and refer others' mental state and intentions, mentalizing, is critical to facilitate effective interpersonal relationships (Bateman & Fonagy, 2004). While social cognitive capacities underpinning social interchange are expected to be involved,

past literature finds mixed evidence where some studies showing enhanced (Fertuck et al., 2009; Frick et al., 2012; Scott et al., 2011) and others showing hindered social-cognitive capacities (Levine et al., 1997; Unoka et al., 2011; Richman & Unoka, 2015) in BPD patients. More recent research has suggested that mentalizing is a multidimensional construct (Fonagy & Luyten, 2009), which requires to maintain a balance to be most effective and enable healthy social interactions. Hence, BPD patients do not simply lose the capacity to mentalize per se, but instead, their mentalizing may be imbalanced due to stress caused by threatening social stimuli. A recent review (Luyten & Fonagy, 2015) on cognitive and affective neuroscience studies have suggested that stress/emotional arousal and the activation of attachment system may contribute to the balance of mentalizing. In response to threatening stimuli, BPD patients may experience stress and emotional arousal (i.e., anxiety), which activates their attachment system. Due to their maladaptive attachment strategies, emotional arousal may not be regulated, and lead to ineffective mentalizing as a result. However, little study has captured the change of social cognitive capacities depending on the types of social stimuli in people with BPD features. Hence, it is critical to understand what social stimuli could be perceived as threats among people with BPD features and how those threatening social stimuli would impact on their social cognition. As social cognition, mentalizing, can be imbalanced due to threatening social stimuli, the elevated emotional arousal and cognitive biases need to be regulated to maintain the effective mentalizing. Thus, self-control capacities are essential to fix the imbalanced mentalizing particularly when they experienced emotionally challenging situations.

Effortful Control

Effortful control is the intentional narrowing of attentional and behavioural capacities with the aim of regulating and guiding behaviour towards a specific goal (Rothbart & Posner, 2015). To explain the link between effortful control impairments and interpersonal difficulties in BPD patients, we are suggesting that the combination of emotion regulation difficulties, rejection sensitivity, and a vulnerability of effortful control may explain the long-term social difficulties that individuals with BPD experience.

As BPD patients have difficulties with affect regulation (Conklin et al., 2006), their attention may focus on negative aspects when they are unable to downregulate their emotional arousal in social situations. They then may fail to disengage their attention from perceived negative social cues such as rejection-relevant cues. Their elevated affective reactions make them focus excessively on rejection cues that serve see others' behaviours as rejecting which in turn further intensifies their emotional arousal. Consistent with these assumptions, past studies have shown attentional biases in BPD patients (Arntz et al., 2000; Wingenfeld et al., 2009).

The Present study and Hypotheses

The current study aims to investigate the effect of exclusive and unexpected social interactions on effortful control and mentalizing among individuals with higher levels of BPD features compared to those with lower levels of BPD features. As behavioural interactions in Study 4 was not successful, the Cyberball paradigm was used as an interaction task. As preliminary findings in Study 4 indicated impulsivity in individuals with identity problems (BPD

features), those with higher levels of BPD features were expected to show more impulsivity (faster and more errors in the emotional Stroop task) than those with lower levels of BPD features before interactions.

Previous research has found the increased rates of rumination (Baer & Sauer, 2011) and the tendency to hypermentalize (Sharp et al., 2011) in individuals with BPD features. Furthermore, preliminary results in Study 4 suggested enhanced mentalizing in individuals with identity problems (BPD features). Therefore, participants with higher levels of BPD features were expected to show a higher tendency to overanalyse facial cues (more accurate and more words selected in the modified RMET) than those with lower levels of BPD features before interactions.

Given that BPD patients are hypersensitive to social rejection (Gunderson et al., 2018) and expectation violation (De Panfilis et al., 2015), individuals with higher levels of BPD features were expected to perceive exclusive and unexpected social interactions as threats and experience distress. As Fonagy and colleagues (2006; 2009; 2015) has proposed, distress induced by exclusive and unexpected social interactions was expected to impair effortful control (more errors and faster reactions in the emotional Stroop task) and mentalizing (more errors and more words selected in the RMET) in people with higher levels of BPD features compared to those with fewer BPD features.

5.2. Materials and Methods

5.2.1. Participants and procedure

188 participants (132 females and 56 males; age range 18-52 years old; $M_{\text{age}} = 23.13$ $SD = 6.23$) were recruited from the UCL psychology subject pool

(SONA) and participated in the first part of the study (online survey). However, 63 participants withdrew from the study and did not partake the second part of the study (lab study). Those who withdrew from the study ($n = 63$) did not differ from those who partook the second part of the study based on the demographic and BPD features. In total, 125 participants were invited to the lab to complete the second part of the study. Although the current study recruited only non-clinical participants, two participants had a diagnosis of mental illness. Hence, their data were excluded from the study. Overall, the ethnic background of participants ($n = 123$) were White/Caucasian (36.2%), African/Caribbean (4.8%), Asians (51.6%), mixed (6.4%), Hispanic (0.5%), and others (0.5%). The current study was approved by the UCL Research Ethics Committee board. The informed consent form was obtained from every participant.

Procedure

The current two-part study was advertised on the UCL SONA system to recruit from UCL students and the community. Once participants signed up on the SONA system, a researcher contacted via email and the consent to participate in the study was obtained. Then, a researcher sent an online survey including questionnaires (demographic information, psychopathology, and personality traits) using Qualtrics. When participants completed the first part of the study (online survey), course credits were provided. Then participants were invited to the lab to complete the second part of the study where they played two computer tasks (the emotional Stroop and the modified RMET) before and after having a brief virtual interaction task (Cyberball).

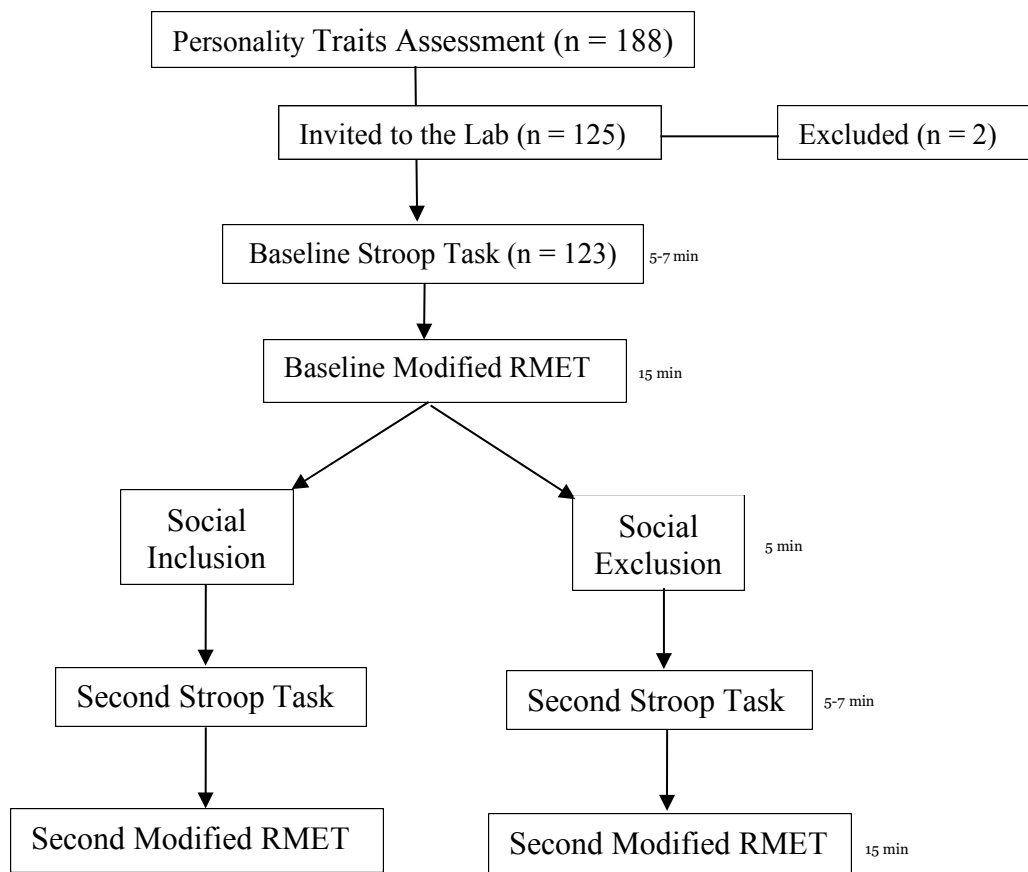
When participants arrived at the lab, they were asked to complete the

consent form explaining the use of a photograph in the study. A researcher then took a picture of participants although the picture was never used in reality.

Participants were first asked to complete the emotional Stroop task using the Qualtrics. After participants read the instruction, they were asked to explain the instruction to the researcher to make sure participants understood the task. Following the emotional Stroop task, they completed the modified RMET task. There was a practice question on the modified RMET where participants completed with a researcher. Once participants completed the baseline assessments of the emotional Stroop and the modified RMET, participants were randomly allocated to an expected inclusion /exclusion condition and unexpected inclusion/exclusion manipulated by the Cyberball paradigm. Hence, there were four conditions.

After the interaction task (Cyberball), participants were asked to complete the emotional Stroop and the modified RMET task again. Although the study aimed to manipulate the expectations of the social interactions, the manipulation was not successful; hence, the simplified procedure is presented in the flowchart (Figure 17). After the computer tasks were completed, a researcher conducted a brief interview to check whether the manipulation was successful. Once the study was completed, participants were compensated with course credits (UCL students) or £10 (non-UCL students).

Figure 17. Procedure of the current study.



5.2.2. Materials

The Personality Assessment Inventory-Borderline Features Scale

The Personality Assessment Inventory-Borderline Features Scale (PAI-BOR: Morey, 1991) was used to assess participants' level of BPD features (see Study 1). In the current study, the median (PAI-BOR = 24.00) split was used to divide participants into two groups: the high and low BPD group. There were only 14 participants who scored above the clinical cut-off scores (PAI-BOR > 38).

The Emotional Stroop Task

Participants' level of effortful control was assessed using the emotional Stroop task by Qualtrics (see Study 4).

The modified Reading the Mind in the Eyes Test

Participants' mentalizing capacity was assessed using the modified RMET (see Study 4). A high internal consistency (Cronbach's $\alpha = .93$) was found on the RMET total in the current sample.

The Cyberball Paradigm

Social interactions were manipulated by the Cyberball paradigm (Williams et al., 2002), a brief online ball-tossing game. Participants were told that there were two other participants to play the ball-tossing game; however, there were no other participants in reality. Participants were informed that they could see other participants' pictures, but they could not see their own. Hence, on the screen, there were three avatars with two pictures of confederates (one male and one female, see Appendix I). Participants' photos were only requested to facilitate the cover story, but were not used in the study.

During the Cyberball paradigm, 30 balls were tossed among three players including participants and two confederates. Social interactions were manipulated based on the number of ball tosses that participants received. In the inclusion condition, the ball tosses were equally distributed among all players where participants received one-third of total ball tosses ($n = 10$). On the other hand, participants received only two balls out of 30 balls tosses in the exclusion condition. To manipulate the expectation of the social interactions, there were expected and unexpected conditions using the Cyberball. In the expected inclusion condition, participants were told that they would receive 10 balls in total and actually received 10 balls during the interaction. Hence, their expectations and the reality matches in the condition. However, in the unexpected inclusion

condition, participants were told that they would receive two balls during the game. However, in reality, they received 10 balls from the confederates; hence, their expectations were violated. In the expected exclusion condition, participants were told they would receive two balls from the confederates, and they did in the interaction. However, in the unexpected exclusion condition, they were told that they would receive 10 balls from the other participants, but received only two balls in the actual interaction.

When participants received the ball from the other confederate, they were asked to pass the ball to one of the other two confederates. The use of pictures of participants and confederates was to facilitate the cover story. Once participants completed the study, they were debriefed that there were no other participants and their pictures were never used.

A Brief Interview

After all computer tasks were completed, a researcher conducted a brief interview to check whether the deception and manipulation (expected inclusion/unexpected inclusion/expected exclusion/unexpected exclusion) were successful. First, participants were asked to estimate the percentage of ball tosses they expected to receive from the other two players prior to the interactions (0% to 100%). If they expected to receive a fair amount of ball tosses, they should have expected to receive 33% of ball tosses. In addition, participants were asked to estimate the percentage of ball tosses they actually received during the interactions. Participants in the inclusion condition received 33% of ball tosses, whereas, those participants in the exclusion condition received 6.7% of ball tosses (2 out of 30 ball tosses).

In addition, participants were asked whether they believed that they had interacted with other participants. For those participants who reported that they doubted the existence of other participants, a researcher asked how certain they were regarding the absence of other participants. None of the current participants was absolutely certain about the presence of other participants. Hence, the deception was effective in the current study.

5.2.3. Statistical Analyses

The means and standard deviations of all outcome variables in each condition were calculated and presented (Table 10). To assess whether the manipulation of the expectation and perception of social interactions was successful, the brief interview was analyzed between four conditions (expected inclusion/unexpected inclusion/expected exclusion/unexpected exclusion). A one-way ANOVA on the expected amount of ball tosses to receive before the interaction task started was conducted. Another one-way ANOVA on the perceived amount of ball tosses during the interaction task was also conducted.

To assess whether age was correlated with any of the dependent variables, Pearson correlation coefficients were calculated. As age was correlated with the modified RMET total score, age was treated as a covariate in the analyses on the modified RMET. To examine the gender effect, a series of independent-samples t-tests were conducted on each baseline assessment of the emotional Stroop task and the modified RMET. As there was a gender difference in the RMET total score, gender was controlled in the main analyses.

A series of two-way ANOVA on the emotional Stroop baseline performance (accuracy, total reaction time, and first reaction time) were

conducted to examine the effect of the type of words (neutral/non-personal negative/personal negative) between the high BPD group and low BPD group. A two-way ANOVA on the modified RMET accuracy with valence (positive/negative/neutral) as a repeated factor between those with high BPD features compared to the low BPD group. A two-way ANCOVA on the modified RMET total number of words selected was also conducted with valence (positive/negative/neutral) as a repeated factor and age and gender as covariates between participants with high BPD features compared to those with low BPD features.

The results on the baseline assessments found that there was no interaction between BPD features and the type of word stimuli on the Stroop task. Also, there was no interaction between BPD features and valence of facial stimuli on the modified RMET. Hence, the type of words was not included in the main analyses on the emotional Stroop performance. Also, valence of facial stimuli was excluded from the main analyses on the modified RMET performance. To examine whether the tendency to over-analyze facial expressions is associated with the increase in accuracy on the RMET, linear regression analyses were conducted between the total number of words and the accuracy. To assess whether BPD features are associated with outcome variables before interactions, linear regression analyses were conducted.

In the main analysis, a three-way ANOVA on the emotional Stroop performance (accuracy, total reaction time, first reaction time) with time (pre/post) as a repeated factor and condition (inclusion/exclusion) and BPD features (high/low) as between-subject factors was conducted. A three-way

ANOVA on the RMET accuracy with time (pre/post) as a repeated factor and condition (inclusion/exclusion) and BPD features (high/low) as between-subject factors was conducted. Then a three-way ANCOVA on the modified RMET total score with time (pre/post) as a repeated factor, condition (inclusion/exclusion) and BPD features (high/low) as between-subject factors, and age and gender as covariates was conducted. At last, the difference score between the expected amount of ball-tosses and the perceived amount of ball-tosses was calculated to assess the potential expectation violation. Then a two-way ANCOVA on the difference score of the ball-tosses with condition (inclusion/exclusion) as a between-subject factor and BPD features as a covariate was conducted.

5.3. Results

5.3.1. Manipulation check

To assess whether the participants' expectation was successfully manipulated, a one-way ANOVA was conducted on the expected percentage of ball-tosses. Results found that the amount of ball-tosses they expected to receive before the interaction started was not significantly different in each condition ($F(1,123) = .90, p = .44, \eta_p^2 = .02$, observed power = .24). In the expected inclusion condition, participants expected to receive slightly more than a fair amount of ball tosses ($M = 36.06, SD = 8.35$). In the unexpected inclusion condition, participants expected to receive almost a fair amount of ball tosses ($M = 34.39, SD = 6.83$). In the expected exclusion condition, participants expected to receive slightly more than a fair amount of ball tosses ($M = 35.70, SD = 9.53$). In the unexpected exclusion condition, participants expected to receive a fair number of ball-tosses ($M = 33.85, SD = 5.02$). Hence, the expectation of social

interactions was not successfully manipulated.

On the other hand, results found a significant difference in the perceived amount of ball tosses they received in each condition ($F(1,123) = 106.29, p < .001, \eta_p^2 = .73$, observed power = 1.00). In the expected inclusion condition, participants thought they received slightly more than a fair number of ball-tosses ($M = 34.00, SD = 10.57$). In the unexpected inclusion condition, participants felt they received slightly less than a fair number of ball-tosses ($M = 29.39, SD = 9.40$). In the expected exclusion condition, participants thought they received an extremely unfair number of ball-tosses ($M = 6.02, SD = 4.26$). In the unexpected exclusion condition, they also felt they received an extremely small number of ball-tosses ($M = 7.09, SD = 4.82$). As there was no significant difference between the expected and the unexpected condition, the expectation was not treated as a factor in the main analyses. However, there was a significant difference in the perceived number of ball-tosses between the inclusion and exclusion condition. Hence, the condition (inclusion/exclusion) was treated as a factor in the analyses.

5.3.2. Descriptive Statistics and Bivariate Correlations

The means, median, and standard deviations of the PAI-BOR were calculated ($M = 25.39$, Median = 24.00, $SD = 10.73$). The means and standard deviations of the emotional Stroop task (total reaction time, first reaction time, the accuracy) and the modified RMET (the accuracy and the total number of emotional words selected) in each condition (inclusion/exclusion) between the low BPD group and high BPD group were calculated and presented (Table 1). Bivariate correlational analyses between age and outcome variables found that age was significantly correlated with the total number of emotional words

selected in the modified RMET ($r = -.18, p = .03$). Hence, age was treated as a covariate in the main analysis on the modified RMET total.

Table 10. Descriptive Statistic.

Variable	Before interaction		After interaction	
	Low BPD	High BPD	Low BPD	High BPD
	M (SD)	M (SD)	M (SD)	M (SD)
RMET Total	51.99 (15.35)	51.93(16.06)	54.47 (14.26)	54.79 (13.25)
Inclusion	52.84 (16.90)	50.48 (16.15)	56.72 (14.04)	51.77 (11.00)
Exclusion	50.39 (13.36)	52.95 (14.72)	52.21 (14.36)	58.26 (14.90)
RMET Accuracy	12.28 (2.41)	12.10 (2.31)	13.03(2.28)	13.41 (2.28)
Inclusion	12.41 (2.52)	12.40 (2.01)	12.93 (2.27)	13.54 (2.43)
Exclusion	11.91 (2.17)	11.67 (2.53)	13.13 (2.32)	13.25 (2.12)
Stroop Total	126.98 (31.49)	121.21 (31.27)	111.72 (25.30)	102.80 (22.41)
Inclusion	135.11 (31.16)	113.88 (29.72)	118.13 (26.89)	99.45 (21.95)
Exclusion	116.76 (29.23)	127.69 (31.65)	105.52 (22.38)	107.00 (22.67)
Stroop First	117.95 (31.13)	111.06 (30.65)	102.16 (25.68)	92.71 (22.76)
Inclusion	124.31 (30.96)	106.47 (30.93)	106.77 (28.52)	90.46 (23.41)
Exclusion	111.31 (30.23)	115.69 (29.98)	97.81 (22.21)	95.83 (21.93)
Stroop Accuracy	66.68 (5.80)	65.53 (4.80)	65.47 (6.35)	65.31 (5.83)
Inclusion	66.44 (5.69)	66.74 (4.20)	63.90 (6.62)	67.00 (4.78)
Exclusion	66.97 (5.99)	64.28 (5.15)	67.03 (5.76)	63.15 (6.42)

Note. PAI-BOR = Personality Assessment Inventory-Borderline Feature scale.
RMET = Reading the Mind in the Eyes Test.

5.3.3. Baseline Difference

Gender difference

A series of independent-samples t-tests found that there was a significant gender difference in the modified RMET total score; $t(183) = -2.57, p = .01$. Female participants were found to associate more emotional words ($M = 53.85, SD = 14.88$) than male participants ($M = 47.47, SD = 16.73$). Hence, female subjects showed a higher tendency to overanalyze facial stimuli. Gender was controlled in the main analyses on the modified RMET total. However, there was no gender difference in the emotional Stroop performance (the accuracy and the total reaction time) and the RMET accuracy.

The Emotional Stroop Accuracy

A two-way ANOVA on the emotional Stroop accuracy found a significant main effect of BPD features ($F(1,147) = 3.98, p = .05, \eta_p^2 = .03$, observed power = .51). As predicted, participants with high BPD features ($M = 21.89, SE = .20$) were significantly less accurate than those with low BPD features ($M = 22.45, SE = .20$). There was no main effect of the type of word stimuli or interaction between BPD features and the type of words on the emotional Stroop accuracy. Hence, the type of word was not treated as a factor in the main analyses.

The Emotional Stroop Total Reaction Time

A two-way ANOVA on the emotional Stroop total reaction time found a significant main effect of the type of word stimuli ($F(1,161) = 10.34, p = .002, \eta_p^2 = .06$, observed power = .89). Participants spent less time on the emotional Stroop task in response to negative personal words ($M = 40.83, SE = .84$) compared to neutral words ($M = 41.33, SE = .85$) and non-personal negative words ($M = 41.94,$

$SE = .83$). However, there was no interaction between BPD features and the type of words; hence, the type of words was not included in the main analyses. As the reaction time did not differ depending on the BPD features, the hypothesis was not supported.

The Emotional Stroop First Reaction Time

A two-way ANOVA on the emotional Stroop first reaction time revealed a significant main effect of the type of words ($F(1,165) = 10.53, p = .001, \eta_p^2 = .06$, observed power = .90). Participants responded significantly faster on the negative non-personal word stimuli ($M = 38.98, SE = .82$) compared to neutral word ($M = 38.35, SE = .82$) and negative personal words ($M = 38.02, SE = .83$). However, there was no significant interaction between BPD features and the type of word stimuli; hence, the type of words was excluded from the main analyses.

The RMET Accuracy

A two-way ANOVA on the RMET accuracy revealed a significant main effect of valence ($F(1,185) = 482.42, p < .001, \eta_p^2 = .72$, observed power = 1.00). Participants were more accurate in judging the emotions of the neutral faces ($M = 6.74, SE = .15$) than negative faces ($M = 2.60, SE = .07$) and positive faces ($M = 2.44, SE = .08$). However, there was no significant interaction between the BPD features and valence. Hence, valence was not included in the main analyses. As there was no main effect of BPD features, enhanced mentalizing capacities among individuals with higher levels of BPD features were not supported.

The Modified RMET Total Score

A two-way ANCOVA on the RMET total found a significant main effect of valence ($F(1,176) = 15.33, p < .001, \eta_p^2 = .08$, observed power = .97).

Participants associated more words to neutral facial stimuli ($M = 28.58, SE = .70$) than negative facial stimuli ($M = 13.01, SE = .33$) and positive facial stimuli ($M = 10.79, SE = .25$). However, there was no interaction between BPD features and valence of the facial stimuli. Hence, valence was excluded from the main analyses. As there was no main effect of BPD features, a higher tendency to overanalyze facial cues in individuals with higher levels of BPD compared to those with lower levels of BPD features were not supported.

5.3.4. Linear Regression Analyses

Results found that the modified RMET total score was not associated with the RMET accuracy ($R^2 = .01, \beta = .10, F(1,174) = 1.83, p = .18$). Hence, the tendency to overanalyze facial stimuli was not associated with the accuracy in estimating the mental state of others.

Results found that BPD features were not significantly associated with any of the outcome variables before interactions (Table 11).

Table 11. Results of regression analyses between Borderline Personality Disorder features and outcome variables.

Independent variables	B	R^2	SE	t	β
Stroop accuracy	-.06	.01	.04	-1.45	-.12
Stroop Total Reaction Time	-.15	.003	.24	-.65	-.05
Stroop First Reaction Time	-.14	.002	.23	-.61	-.05
RMET Accuracy	.004	.00	.02	.23	.02
RMET Total	.07	.002	.11	.61	.05

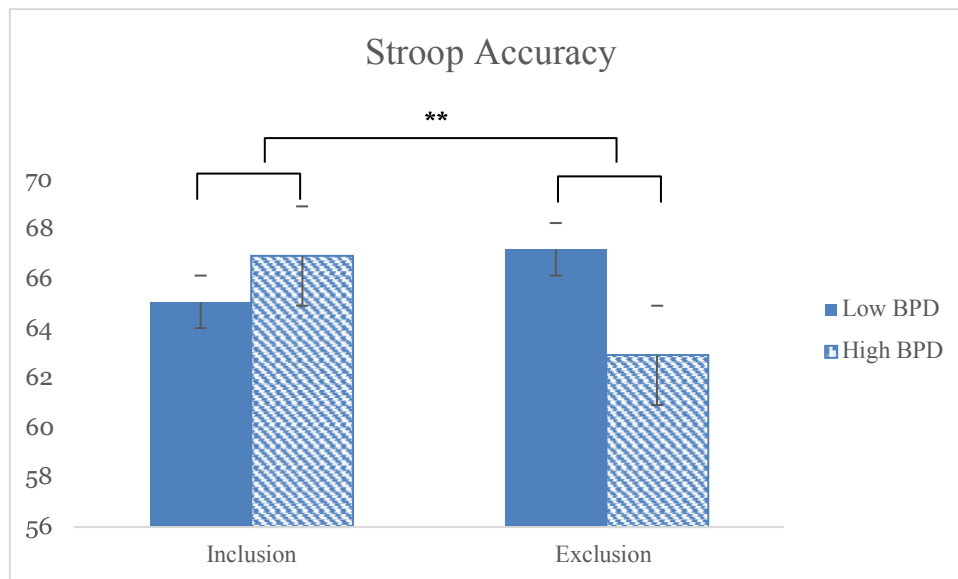
Note. RMET = Reading the Mind in the Eyes Test.

5.3.5. Main Analysis

The Emotional Stroop Accuracy

As predicted, results on the emotional Stroop accuracy found a significant interaction between condition by BPD features ($F(1, 115) = 10.16, p = .002, \eta_p^2 = .08$, observed power = .89). In the inclusion condition, individuals with high BPD features were more accurate than those with low BPD features. However, those with high BPD features were less accurate than those with low BPD features in the exclusion condition (Fig 18).

Figure 18. Interaction between conditions and the level of BPD features on the emotional Stroop task accuracy.



Note. BPD = Borderline Personality Disorder.

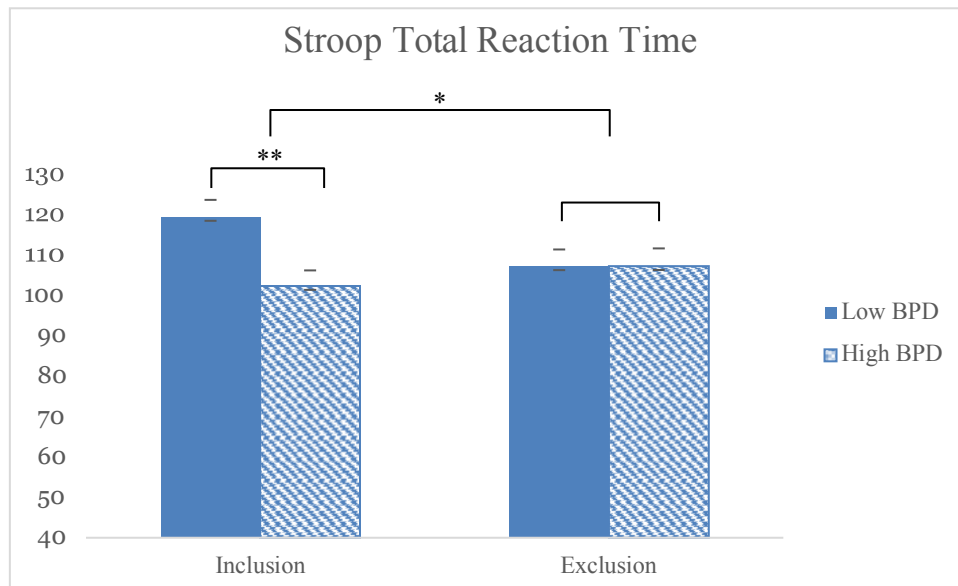
* $p < .05$, ** $P < .01$.

5.3.5.2. The Emotional Stroop Total Reaction Time

Results on the emotional Stroop total reaction time found a significant BPD features by condition interaction ($F(1,117) = 4.33, p = .04, \eta_p^2 = .04$, observed power = .54). Following the inclusive interactions, individuals with high

BPD features were significantly faster on the emotional Stroop task than those with low BPD features. On the other hand, there was no difference between participants with low BPD features and high BPD features following exclusive interactions (Figure 19). Although only exclusive social interactions were expected to impair effortful control in those with higher levels of BPD features, results indicated that inclusive interactions had the similar effect as exclusive social interactions in individuals with higher levels of BPD features.

Figure 19. Interaction between conditions and the level of BPD features on the emotional Stroop task reaction time.



Note. BPD = Borderline Personality Disorder.

* $p < .05$, ** $P < .01$.

There was also a significant main effect of time ($F(1,117) = 18.66, p < .001, \eta_p^2 = .14$, observed power = .99) and a main effect of BPD features ($F(1,117) = 4.31, p = .04, \eta_p^2 = .04$, observed power = .54). Participants became significantly faster after having interactions ($M = 107.12, SE = 2.12$) compared to the baseline ($M = 110.95, SE = 2.09$). Participants with higher levels of BPD

features were significantly faster ($M = 104.76$, $SE = 2.89$) than those with lower levels of BPD features ($M = 113.31$, $SE = 2.93$). Impulsivity shown in the faster reaction time in those with higher levels of BPD features was consistent with the hypothesis.

The Emotional Stroop First Reaction Time

Results on the emotional Stroop first reaction time found a significant main effect of BPD features ($F(1,118) = 6.56$, $p = .02$, $\eta_p^2 = .05$, observed power = .72). Individuals with high BPD features were significantly faster ($M = 94.70$, $SE = 2.98$) than those with low BPD features ($M = 105.55$, $SE = 3.01$) to respond on the emotional Stroop task. Also, there was a significant main effect of time ($F(1,118) = 43.45$, $p < .001$, $\eta_p^2 = .27$, observed power = 1.00). Participants responded significantly faster after the interactions ($M = 97.84$, $SE = 2.17$) compared to the baseline ($M = 102.40$, $SE = .2.13$). There was a marginally significant interaction between BPD features and condition ($F(1,118) = 3.62$, $p = .059$, $\eta_p^2 = .03$, observed power = .47). The direction of the effect was same as the total reaction time (Figure 19).

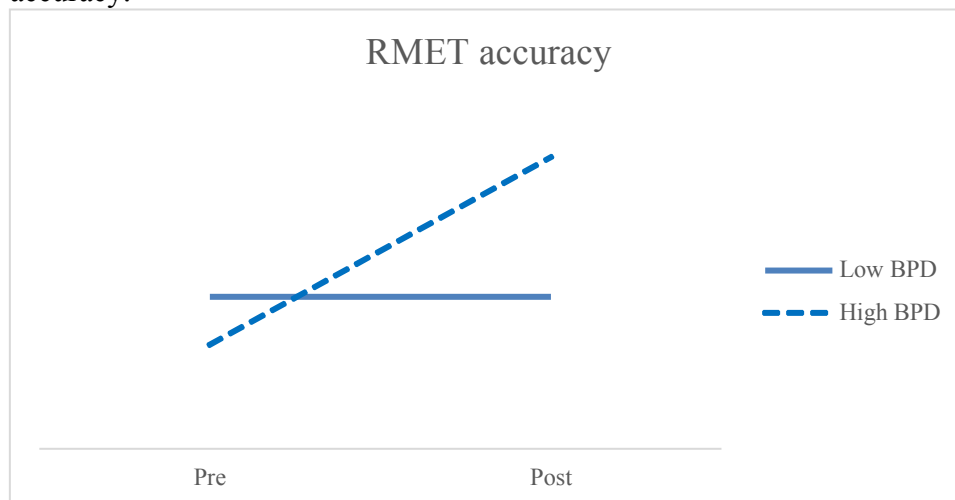
The RMET Accuracy

Results on the RMET accuracy found a significant interaction between time and BPD features ($F(1, 116) = 4.59$, $p = .03$, $\eta_p^2 = .04$ observed power = .57). Although participants with low BPD features were more accurate on the RMET than the high BPD group before social interactions, those with high BPD features became more accurate following social interactions than the low BPD group (Figure 20). Although inclusive and exclusive interactions were expected to have a different effect on mentalizing, results found no difference in the accuracy on

the RMET in individuals with higher levels of BPD features. Also, distress induced by social interactions were expected to impair mentalizing (more errors); however, interactions improved mentalizing accuracy in individuals with higher levels of BPD features.

There was also a significant main effect of time ($F(1,116) = 28.64, p < .001, \eta_p^2 = .20$, observed power = 1.00) where people became more accurate on the RMET after interactions ($M = 13.29, SE = .21$) compared to before interactions ($M = 12.12, SE = .20$).

Figure 20. Interaction between time and the level of BPD features on the RMET accuracy.



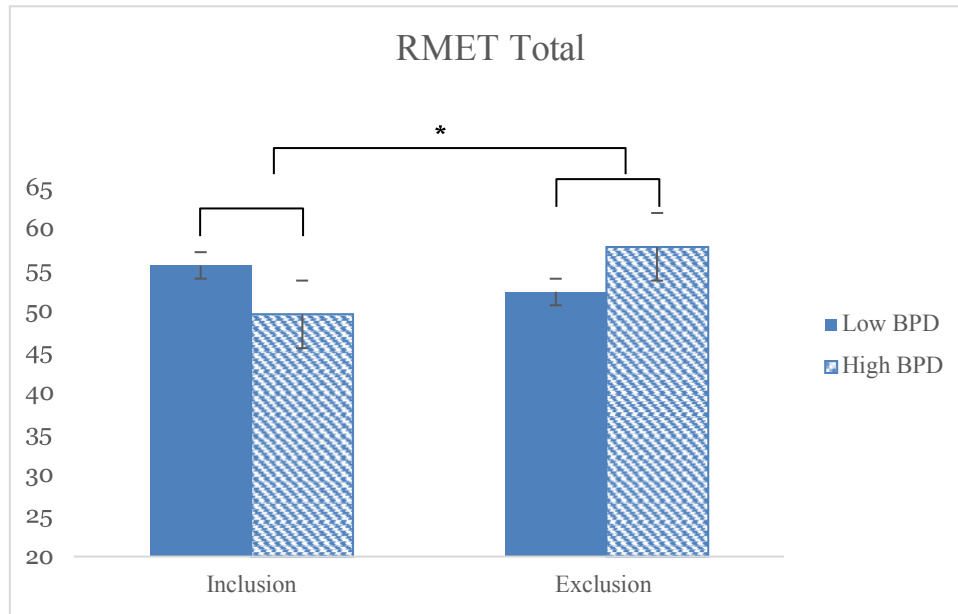
Note. BPD = Borderline Personality Disorder. RMET = Reading the Mind in the Eyes Test.

The Modified RMET Total Number of Words Selected

Results on the modified RMET total score found a significant interaction between condition and BPD features ($F(1, 110) = 7.21, p = .008, \eta_p^2 = .06$, observed power = .76). In the inclusion condition, participants with high BPD features associated less emotional words than those with low BPD features.

However, those with high BPD features associated more emotional words than those with low BPD features following exclusive interactions (Figure 21).

Figure 21. Interaction between conditions and the level of BPD features on the RMET total score.



Note. BPD = Borderline Personality Disorder. RMET = Reading the Mind in the Eyes Test.

* $p < .05$, ** $P < .01$.

5.3.6. Expectation Violation

Results on the difference score between the expected amount of ball-tosses and the amount of perceived ball-tosses found that there was a significant main effect of condition ($F(1, 120) = 15.92, p < .001, \eta_p^2 = .12$, observed power = .98). The gap between participants' expected amount of ball-tosses and perceived ball-tosses was significantly larger in the exclusion condition ($M = 27.92, SE = 1.35$) than the inclusion condition ($M = 3.46, SE = 1.28$). Therefore, participants' expectations were violated in the exclusion condition. However, BPD features did

not predict the level of expectations or perception of ball-tosses.

5.4. Discussion

The present study investigated the effect of social exclusion on the cognitive capacities including effortful control and mentalizing among individuals with BPD features. Results found that there was no difference in effortful control capacities assessed by the emotional Stroop task and the mentalizing assessed by the RMET between those with high BPD features compared to individuals with low BPD features. Some of the previous studies found that BPD patients were slower than healthy participants on the emotional Stroop task (Arntz, Appels, & Sieswerda, 2000; Wingenfeld et al., 2009). However, any significant difference between participants with high BPD features and low BPD features was not found in the current study. In addition, many studies had found impaired mentalizing capacities in BPD patients, the current subjects with high BPD features did not significantly differ from those with low BPD features on the RMET accuracy before the social interactions.

On the other hand, social interactions had a different effect on the emotional Stroop task and the modified RMET among participants with high BPD features compared to those with low BPD features. Participants with low BPD features were faster and more accurate on the task requiring EC after exclusive interactions compared to inclusive interactions. On the other hand, individuals with high BPD features did not differ in the reaction time, but less accurate on the emotional Stroop task after the exclusive interactions compared to the inclusive interactions. When people encounter threatening social situations (i.e., rejection), they need to focus on the social stimuli and control their impulsive actions to

behave in a more socially appropriate way. This is supported by the findings among the low BPD group where they were faster to react without impairing the accuracy on the task requiring self-control. Hence, they were paying more attention on the task when they experienced social rejection compared to non-threatening social interactions (inclusion). However, those with high BPD features responded as fast as the low BPD group, but less accurate on the emotional Stroop task following the exclusive interactions indicating that they had an impaired EC to regulate their impulsivity. Thus, these findings suggest that the negative social interactions enhanced EC among individuals with low BPD features. Whereas, social exclusive interactions impaired EC among individuals with high BPD features. Participants became faster to respond on the emotional Stroop task following the interactions. This is most likely due to the practice effects because the stimuli used in the emotional Stroop task before and after the social interactions were the same.

On the modified RMET task, all participants, but particularly those with high BPD features, became more accurate at estimating the emotional state of others after having brief interactions. Given that the facial stimuli used at the baseline and after the interactions were different, the improved accuracy on the RMET was not simply due to the practice effect. This finding suggests that social interactions may have activated their social cognitive capacities to infer other's mental state, and those with high BPD features were found to be particularly sensitive to social interactions.

When individuals with high BPD features experienced positive social interactions (inclusion), they associated less emotional words than the low BPD

features. Hence, they did not show any tendency to overanalyse facial cues. However, when they experienced negative social interactions, they showed a tendency to over-elaborate mental state of others through facial stimuli compared to the low BPD group. This suggests that social rejection may have activated their attachment system leading to emotional arousal to give a warning that they need to fix the negative situations. In response, they may overestimate all possible emotional states of others to increase the chance of accurately judging others' mental state, which may lead them to overanalysing interpersonal cues.

Limitations

There are a number of limitations in the present study. First, the stimuli used in the emotional Stroop task (words and colours) were identical before and after the social interactions. Participants may have habituated to stimuli, which may explain the shortened reaction time after the interaction. The emotional Stroop task became easier as they continued; hence, they reacted faster in the second time compared to their baseline. Future study should not use the same stimuli to avoid the habituation effect.

Second, the manipulation of participants' expectation was not successful. Although a researcher told participants regarding the number of ball tosses they were supposed to receive during the interaction before the interaction task started, participants still expected to receive a fair amount of ball tosses regardless of the instruction given by the researcher. During the brief interview after the experiment was finished, a researcher reminded participants about the instruction given prior to the interaction regarding the amount of ball tosses they were supposed to receive. Participants still confirmed that the researcher' instruction

did not change their expectation of the social interactions. Hence, the manipulation was not successful to change the participants' expectation of social interactions. A future study needs to improve the cover story of the deception, or employ a different methodology to manipulate expectations to assess the effect of expectancy violation on the cognition.

Third, the subjects in the current study were recruited only from a non-clinical population. In addition, the majority of the participants were young university students. The biased samples in the current study may limit the generalizability of the findings to a wider general population and clinical population. The findings regarding the emotional Stroop task somewhat contradicted to past studies. Although previous research has shown that BPD patients were found to be slower than healthy controls on the emotional Stroop task (Arntz, Appels, & Sieswerda, 2000), the current participants with high BPD features were faster than those with low BPD features. The inconsistent findings may be due to the difference in the severity of BPD features captured in the current subjects and the clinical population. Given that there were only 14 participants who scored above the clinical cut-off score based on the PAI-BOR, there were not enough "real" BPD symptoms captured in the current study. Future study should replicate the finding among the clinical population.

Fourth, there are some scholars who have criticized the ecological validity of the Cyberball paradigm (Novembre, Zanon, & Silani, 2015). However, the brief interview after the study confirmed that the majority of participants believed that they had virtual interactions with real participants. Hence, they felt negative emotions following exclusive interactions. Further, a number of neuroimaging

studies have found that the Cyberball paradigm was successful in inducing the social pain which was shown in the neuroactivities (Eisenberger & Lieberman, 2003). However, another behavioural paradigm to have direct interactions using confederates, instead of virtual interactions, should be adapted in the future study to increase the ecological validity of the manipulation.

Fifth, the current study aimed to capture hypermentalizing using the modified RMET. However, this methodology and conceptualization of hypermentalizing have not been validated with other existing measurements. The Movie for Assessment of Social Cognition (MASC) is the only measurement that allows assessing hypermentalizing. In the MASC, participants watch a short film which stops at various points and asks participants to answer the character's feelings and motivations for their actions in the clip. The MASC conceptualized "hypermentalizing" based on the quality of the participants' interpretation of each scene. However, the current research aims to quantify hypermentalizing; therefore, the conceptualization of hypermentalizing was different from the MASC. Although the current study has shown the high internal consistency (Cronbach's Alpha .93), future studies should validate the findings on the modified RMET with the MASC.

Sixth, although gender was controlled in the analyses, imbalanced gender in the current samples may limit to capture the potential gender effects. Given that BPD is more prevalent among female patients compared to male patients (Lieb et al., 2004), gender effect may be particularly important in investigating BPD features. Future studies should recruit more balanced samples to control potential gender effects.

Last, the current study assessed participants' BPD features using only a self-report measurement (the PAI-BOR). Self-report measurements are often criticized due to their vulnerability to potential biases (i.e., response bias). Also, the information collected by self-reports are limited to the information that is consciously available to participants at the time of collection (Okada & Oltmanns, 2009). However, the PAI-BOR is well validated and has shown its clinical utility and substantial psychometric evaluations (Blais, Baity, & Hopwood, 2010; Morey et al., 2002; Sharp et al., 2012).

Overall Conclusions

The current study has shown the different effect of social interactions on effortful control and mentalizing among individuals with high BPD features compared to those with low BPD features. Social rejection may have activated the attachment system among those with high BPD features, which may have elevated the emotional arousal. As a consequence, they have shown the impaired cognitive capacities to control for interfering stimuli and the tendency to overanalyse social cues. On the other hand, those with low BPD features have shown the improved effortful control capacities and the suppressed tendency to overanalyze social cues. Therefore, social rejection may have a negative impact on self-control capacities and social cognition only among those with high BPD features.

6. Effects of Social Interactions on Hypermentalizing in BPD patients

6.1. Introduction

Interpersonal difficulties have been well recognized as the core features of BPD patients (Gunderson et al., 2018; Gunderson & Lyons-Ruth, 2008; Lazarus, Cheavens, Festa, & Zachary Rosenthal, 2014; Skodol et al., 2002; Wilson, Stroud, & Emily Durbin, 2017), and have been linked to self-harm and increased suicide risk in particular (Brodsky, Groves, Oquendo, Mann, & Stanley, 2006). A number of manifestations of impulsivity and emotional instability associated with BPD have been observed within interpersonal contexts (Gunderson & Lyons-Ruth, 2008).

BPD patients' heightened sensitivity to social threats is often the trigger for abnormal emotional reactions (i.e., anxiety) and cognitive biases (i.e., mental state attribution biases). Maladaptive social cognition, particularly impairments in mental state decoding capacities, has been considered to be the underlying factor of other emotional and behavioral problems (Gunderson & Lyons-Ruth, 2008; Lazarus et al., 2014; Roepke, Vater, Preißler, Heekeren, & Dziobek, 2012; Skodol et al., 2002). However, past findings regarding BPD patients' social cognitive capacities are rather mixed. Whereas some studies have found enhanced social cognition (Fertuck et al., 2009; Frick et al., 2012; Scott, Levy, Adams, & Stevenson, 2011), others have shown impaired social cognitive capacities in BPD patients (Unoka, Fogd, Füzy, & Csukly, 2011).

Inconsistent findings may be related to differences in the study populations and methods used to assess social cognitions (Richman & Unoka, 2015). Hence, the current study aims to fill the gap in the literature by examining

the change in social cognition due to interpersonal interactions in BPD patients compared to healthy individuals.

Rejection hypersensitivity in BPD patients

As they experience more negative social interactions, their threat monitoring system may become so sensitive and even react to ambiguous social cues. As a consequence, they will be constantly alerted, and the elevated emotional distress may lead to further cognitive disturbance and behavioural consequences (i.e., self-harm) (Berenson et al., 2016).

Even in response to innocent social interactions, rejection hypersensitive individuals, such as BPD patients, tend to perceive harmless social cues as threatening, misinterpret others' intentions, and experience intense negative emotional arousal (Euler et al., 2018). These intense affective reactions may lead to further maladaptive cognition and behaviours which contribute to interpersonal difficulties (Staebler, Helbing, Rosenbach, & Renneberg, 2011). BPD patients' hypersensitivity to rejection has been described in numerous clinical research and reports (Arntz & Veen, 2001; Rosenbach & Renneberg, 2011; Wilson et al., 2017). In response to threatening social cues (i.e., video clips about relationship crisis), BPD patients showed extreme evaluations of others (all good/ all bad) (Veen & Arntz, 2000), and attribute ambiguous cues as threatening (Lobbestael & McNally, 2016).

A recent pilot study has found that BPD patients perceived even inclusive social interactions as threatening (Euler et al., 2018). These findings suggest that BPD patients' rejection sensitivity is so hypersensitive that even ambiguous and objectively positive social stimuli (i.e., inclusive social interactions) are perceived

as threatening. Although BPD patients' maladaptive response to social cues they associated with threat has been well captured, the underlying mechanism is still not well understood. One of the important factors that may explain BPD patients' interpersonal difficulties is related to impairments in social cognitive functioning (Roepke et al., 2012).

Mentalizing in BPD patients

Being aware and understanding one's own intentions and other's intentions based on the observable behaviours given in the social situations are important to facilitate effective social interactions. Bateman and Fonagy (2004) have argued that impairments in mentalizing contribute to interpersonal difficulties in BPD patients. To understand the intention behind individual's behaviours, people use both their own understanding of the context in the given situations and external cues they observe from other's behaviours (i.e., facial expressions). Therefore, the negative cognitive biases in BPD patients (i.e., negative attribution) may contribute to ineffective mentalizing.

However, as noted, past research findings regarding the mentalizing capacity of BPD patients are rather mixed where some research suggest BPD patients have enhanced mentalizing capacities, whereas, other research findings suggest otherwise. Harkness and colleagues (2005) have suggested that mental state decoding capacities may differ depending on the emotional valence of social stimuli. Therefore, they divided the RMET into three valence categories: positive, negative, and neutral. Robust evidence has indicated that BPD patients tend to be less accurate and show negative biases when they assess neutral (Daros, Zakzanis, & Ruocco, 2013; Donegan et al., 2003; Dyck et al., 2009; Minzenberg, Fan, New,

Tang, & Siever, 2008) and negative facial expressions (Unoka et al., 2011). A recent meta-analysis has shown that BPD patients were significantly worse than healthy individuals on the RMET total accuracy score as well as neutral valence (Richman & Unoka, 2015). Therefore, BPD patients' capacity to assess the mental state of others may be impaired when they perceive threatening social stimuli (i.e., ambiguous/negative facial expressions).

More recently, it has been proposed that mentalizing is a multidimensional construct (Fonagy & Luyten, 2009). Effective mentalizing typically requires a balance between these dimensions (e.g., integrating cognitive and affective information). Based on this conceptualization, BPD patients' exceptional performance on the RMET task could be considered to be due to imbalanced mentalizing favouring external information rather than internal information. This tendency may be particularly prominent in BPD patients as it has been suggested that BPD patients are more likely to focus excessively on external cues (i.e., others' observable behaviours) due to their limited capacity for computing internal states (i.e., their own feelings).

A recent literature review has suggested that hypermentalizing may be the core feature of social cognitive impairments in BPD patients (Sharp & Vanwoerden, 2015). Fonagy and colleagues (2009) have argued that stress/arousal and the activation of the attachment system contribute to the imbalance of mentalizing (i.e., hypermentalizing) in BPD patients. Hence, the attachment system may be activated in response to interpersonal stress, which may lead to hypermentalizing. BPD patients may over-analyse social stimuli (hypermentalizing) as a coping strategy to increase the probability to accurately

assess others' mental state in response to perceived threats. As increased rates of rumination was found to be a risk factor for severe BPD symptoms (Baer & Sauer, 2011) and suicidal ideation and attempts (Rogers & Joiner, 2017), hypermentalizing is suggested to be an important risk factor for severe BPD symptoms.

The Present Study and Hypotheses

The present study aimed to investigate the effects of social interactions on mentalizing in BPD patients compared to healthy participants. Mentalizing was assessed by using a modified RMET before and after brief inclusive and exclusive social interactions. The Cyberball paradigm, a virtual ball-tossing game was used to manipulate the social interactions. The original RMET was modified by adding more emotional words to assess the tendency towards over-interpretation of others' mental state. Those who associated more emotional words to interpret facial expressions, they were considered to be over-analyzing the facial stimuli.

Given that BPD patients are hypersensitive to social information (Gunderson & Lyons-Ruth, 2008), it was hypothesized that BPD patients would be more accurate in the mental state decoding as assessed by the RMET before social interactions compared to healthy participants. As effortful control was disturbed among people with BPD features shown in the study 2 and study 5, BPD patients are expected to over-focus on threatening cues, which leads to overinterpretation of social stimuli. In addition, as rumination was found to be an important risk factor for severe BPD symptoms (Baer & Sauer, 2011; Rogers & Joiner, 2017), BPD patients were expected to exhibit hypermentalizing in response to threats.

Given that BPD patients were found to perceive both inclusive and exclusive interactions as threatening (Euler et al., 2018), BPD patients were predicted to be less accurate and to present a stronger tendency towards hypermentalizing in response to both inclusive and exclusive interactions compared to healthy participants. On the other hand, as healthy individuals were not expected to perceive inclusive interactions as threatening, they were expected to present the impaired mental decoding capacities only following exclusive interactions.

Further, as BPD patients have been found to perceive non-threatening cues (ambiguous stimuli) as threatening (Lobbestael & McNally, 2016), BPD patients were expected to show hypermentalizing in response to both ambiguous and negative social stimuli on the RMET.

In addition, an increase in the tendency to over-analyse facial cues was predicted to be associated with an enhanced accuracy in the RMET among healthy individuals. Hence, among healthy individuals, a tendency to overanalyse facial cues was expected to enhance accuracy in mental decoding capacities. On the other hand, an increase in over-interpretative tendency was expected to be associated with a lower accuracy in the RMET among BPD patients.

6.2. Materials and Methods

6.2.1. Participants and procedure

Healthy participants were recruited from the UCL psychology subject pool (SONA) system. BPD patients were recruited from a large-scale computational psychiatry study, “Probing Social Exchanges – a Computational Neuroscience Approach to the Understanding of Borderline and Anti-Social Personality

Disorder”, which was hosted by the Department of Clinical, Educational and Health Psychology and the Institute of Neurology at UCL. BPD patients were recruited from the outpatients and community services in North London and Greater London. In total, 22 BPD patients and 28 healthy participants (18 males and 32 females; age range 18-55 years; $M_{age} 25.5 SD 9.6$) were recruited and completed the study. The ethics were given by Research Ethics Committee for Wales and the UCL Research Ethics Committee.

Overall, the ethnic background of current subjects were White/Caucasian (38.7%), African/Caribbean (8.0%), Mixed (2.0%), Mixed (16.0 %), and Asian (36.0%). The signed voluntary informed consent forms were obtained from all participants before participating in the study. All participants were compensated with £10 per hour for their time, and travel costs were reimbursed.

Procedure

A researcher contacted BPD patients who previously showed interests in participating in other research studies via e-mail/phone to introduce the study and ask whether they had any interests in taking part in the current research. Healthy individuals were contacted by a researcher once they signed up on the SONA system. All participants were requested to send a photograph of their face before coming to the lab. Participants were informed that the photo of their face would be used in one of the computer tasks where they would interact with two other participants. It was emphasized that a photo was not a requirement to participate in the study; hence, participants could refuse to send a photo if they did not feel comfortable with sharing such personal information. In reality, there was no other participant; hence, none of the photos was used. Three participants refused to send

their photos, however, they participated in the study. Once participants indicated the interests, a researcher sent the study information to the participants prior to the study appointment day.

On arrival, all participants signed the consent form describing the study details including the use of photos. Participants first completed the online survey including demographic information and personality traits. As BPD patients already completed the questionnaires regarding the demographic and personality traits in the other study (*Probing Social Exchanges - a Computational Neuroscience Approach to the Understanding of Borderline and Anti-Social Personality Disorder*), their data was shared. Participants then started the baseline assessment of the modified RMET by Qualtrics followed by the instruction. All participants completed the first practice trial with a researcher to make sure they understood the instruction. After the baseline assessment was completed, participants were randomly allocated to two conditions: social inclusion and exclusion condition manipulated by the Cyberball paradigm. After the brief interaction, participants were asked to complete the post-assessment of the modified RMET.

Following the modified RMET, a researcher conducted a brief interview regarding the social interaction to check whether the manipulation was successful. Once the study was completed, all participants were debriefed and explained regarding the deception in the study.

6.2.2. Materials

The modified Reading the Mind in the Eyes Test

The modified Reading the Mind in the Eyes Test (RMET) (Baron-Cohent et al., 2001) was used to assess one of the aspects of mentalizing, the ability to estimate affective states of others based on the facial stimuli (see Study 4). In the current subjects, high internal consistency was found among the RMET accuracy (Cronbach's $\alpha = .75$) and total scores (Cronbach's $\alpha = .92$).

The Cyberball Paradigm

Inclusive and exclusive social interactions were manipulated using the Cyberball paradigm (see Study 5).

A Brief Interview

After all computer tasks were completed, a researcher conducted a brief interview to check whether the deception and manipulation were successful (see Study 5).

6.2.3. Statistical Analyses

The means and the standard deviations of outcome variables in each condition were calculated (Table 12). An independent-samples t-test was conducted to assess whether the manipulation was successful between the inclusion and exclusion condition. Bivariate correlational analyses were conducted to assess whether age was correlated with the modified RMET performance. As age was correlated with the modified RMET total score, age was treated as a covariate in the main analysis on the modified RMET total score. An independent-samples t-test was conducted to assess the gender effect on the baseline RMET performance.

Then, a two-way ANOVA on the RMET baseline accuracy with valence (positive/negative/neutral) as a repeated factor between BPD patients and healthy individuals was conducted. A two-way ANCOVA on the RMET baseline total score with valence as a repeated factor and age as a covariate was conducted between BPD patients and healthy individuals. Further, linear regression analyses were tested to determine whether the RMET accuracy was associated with the total number of emotional words selected. In the main analyses, a four-way ANOVA on the RMET accuracy with time (pre/post) and valence (positive/negative/neutral) as repeated factors, and condition (inclusion/exclusion) and diagnosis (BPD/control) as between-subject factors was conducted. A four-way ANCOVA on the modified RMET total score with time (pre/post) and valence (positive/negative/neutral) as repeated factors, condition (inclusion/exclusion) and diagnosis (BPD/control) as between-subject factors, and age as a covariate was conducted.

Finally, expectation violation was assessed by calculating the difference score between the expected amount of ball-tosses and the perceived amount of ball-tosses. Then a two-way ANOVA on the difference score of the ball-tosses with condition (inclusion/exclusion) and diagnosis (BPD/control) as between-subject factors was conducted.

6.3. Results

6.3.1. Manipulation Check

To assess whether participants perceived rejection and inclusion during the interactions, their estimated number of ball-tosses they received was analysed. Results found that there was a significant difference in each condition; $t(48) =$

38.48, $p < .001$. Participants in the exclusion condition felt they received significantly fewer ball-tosses ($M = 7.15$, $SD = 4.90$) compared to the participants in the inclusion condition ($M = 30.39$, $SD = 9.31$). Hence, the manipulation was successful.

6.3.2. Descriptive Statistics and Bivariate Correlations

The mean and standard deviation of the RMET performance (accuracy and a total number of words selected) in each condition were calculated and presented (see Table 12). Bivariate correlational analyses found that age was not significantly correlated with the RMET accuracy, but was significantly correlated with the baseline modified RMET total score ($r = .29$, $p = .04$). Hence, age was treated as a covariate in the main analysis on the modified RMET total score.

Table 12. Means and standard deviations of the RMET in each condition.

	Healthy		BPD patients	
	Before	After	Before	After
RMET total	35.39 (8.91)	40.04 (8.99)	56.41 (14.10)	61.50 (17.23)
Inclusion	38.14 (8.39)	41.29 (9.82)	55.17 (17.29)	57.08 (19.44)
Exclusion	32.64 (8.84)	38.79 (8.25)	57.90 (9.68)	66.80 (13.18)
RMET accuracy	10.14(3.62)	11.29 (3.13)	13.36 (2.56)	14.05 (3.26)
Inclusion	11.64 (2.68)	12.71 (2.70)	13.58 (2.19)	13.25 (3.60)
Exclusion	8.64 (3.89)	9.86 (2.93)	13.10 (3.03)	15 (2.67)

6.3.3. Baseline Differences

Gender effect

An independent-sample t-test found that there was no significant difference between male and female participants on the RMET accuracy, $t(48) = -1.70, p = .10$, and the total number of emotional words selected, $t(48) = -.92, p = .36$.

The RMET Accuracy

A two-way ANOVA on the RMET accuracy found a significant valence by diagnosis interaction ($F(1,48) = 4.27, p = .04, \eta_p^2 = .08$, observed power = .53) (Fig. 22). The difference in the RMET accuracy between BPD patients and healthy individuals was larger in neutral facial expressions compared to positive or negative facial expressions. There was also a significant main effect of valence ($F(1,48) = 83.05, p < .001, \eta_p^2 = .63$, observed power = 1.00). Participants were more accurate in judging ambiguous faces ($M = 6.41, SD = .30, CI [5.81, 7.02]$) compared to negative faces ($M = 2.73, SD = .13, CI [2.47, 3.0]$) and positive faces ($M = 2.61, SD = .15, CI [2.31, 2.91]$).

Also, as predicted, there was a significant main effect of diagnosis ($F(1,48) = 12.51, p = .001, \eta_p^2 = .21$, observed power = .93). BPD patients ($M = 4.46, SD = .23, CI [4.0, 4.91]$) were significantly more accurate compared to healthy individuals ($M = 3.38, SD = .20, CI [2.98, 3.79]$) in estimating others' emotional states on the RMET. An enhanced ability to mentalize

The modified RMET Total Score

A two-way ANCOVA on the modified RMET found a significant valence by diagnosis interaction ($F(1,47) = 8.33, p = .006, \eta_p^2 = .15$, observed power =

.81) (Fig. 24). BPD patients associated significantly more emotional words compared to healthy individuals particularly when they saw ambiguous faces. There was also a significant main effect of valence on the RMET total ($F(1,47) = 15.82, p < .001, \eta_p^2 = .25, \text{observed power} = .97$).

Participants showed a stronger tendency to overanalyze in response to neutral faces ($M = 24.78, SD = .99, CI [22.79, 26.77]$) compared to negative faces ($M = 11.64, SD = .44, CI [10.76, 12.53]$) and positive faces ($M = 9.54, SD = .39, CI [8.76, 10.31]$). As predicted, a significant main effect of diagnosis ($F(1,47) = 33.44, p < .001, \eta_p^2 = .42, \text{observed power} = 1.00$) was also found. BPD patients presented a significantly higher tendency to overanalyze facial stimuli as expressed in a significantly higher number of words associated with the facial expressions ($M = 18.98, SD = .89, CI [17.18, 20.77]$) compared to healthy individuals ($M = 11.66, SD = .78, CI [10.10, 13.23]$).

6.3.4. Linear Regression analyses

A linear regression analysis found that the baseline RMET total number of words selected was significantly associated with the baseline RMET total accuracy ($R^2 = .18, \beta = .36, F(2,47) = 5.12, p = .01$), which suggested that individuals who had a higher tendency to overanalyse mental state of others were more likely to be accurate at detecting the emotional state of the others. This association was then examined among BPD patients and healthy controls separately.

Among healthy individuals, there was a positive association between the total number of words selected and the RMET accuracy ($R^2 = .65, \beta = .82, F(2,27) = 22.70, p < .001$) which suggested that healthy individuals who associated more

emotional words were more likely to be accurate on the RMET. On the other hand, the baseline total number of words selected was negatively associated with the RMET accuracy ($R^2 = .37$, $\beta = -.59$, $F(2,21) = 5.50$, $p = .004$) among BPD patients, which indicated that BPD patients who had a higher tendency to over-analyse facial expressions were less likely to be accurate in assessing the mental state of others.

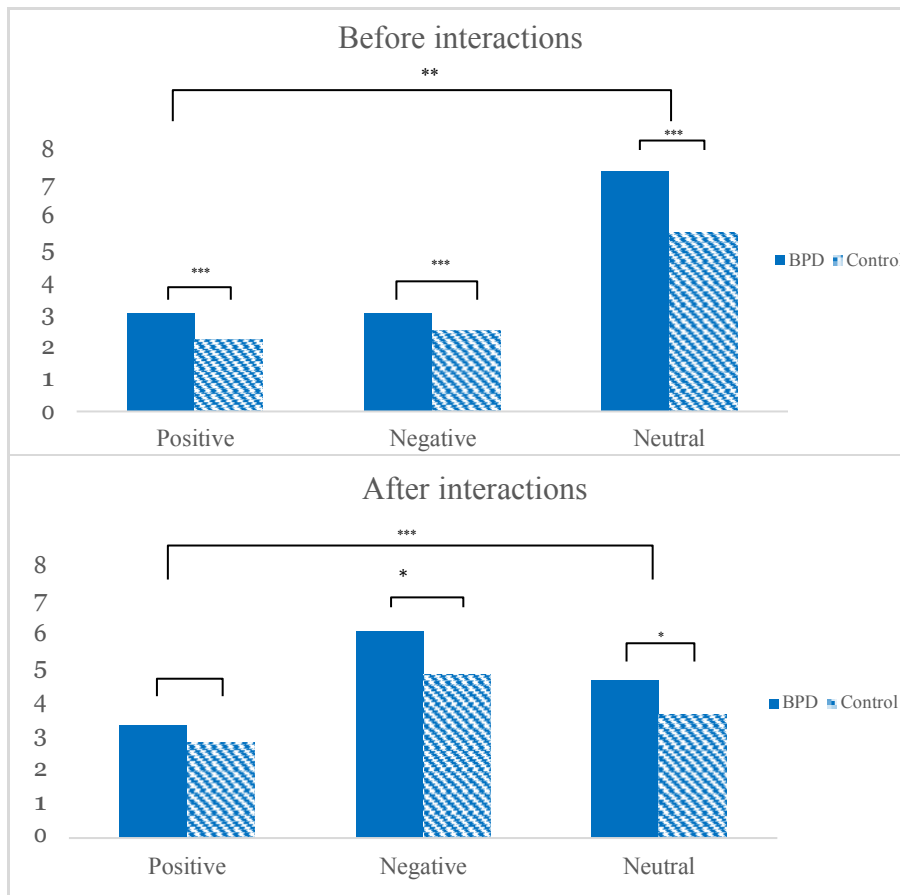
6.3.5. Main Analysis

The RMET Accuracy

A four-way ANOVA on the RMET accuracy found a significant time by valence by diagnosis interaction ($F(1,46) = 4.74$, $p = .04$, $\eta_p^2 = .09$, power observed = .57) and time by valence interaction ($F(1,46) = 136.69$, $p < .001$, $\eta_p^2 = .75$, observed power = 1.000) (Fig. 22).

Participants became more accurate at judging the emotions of positive and negative faces, but less accurate at judging the ambiguous faces after the social interactions. The difference between BPD patients and healthy controls increased after the social interactions in response to positive and negative facial expressions. On the other hand, the difference in the accuracy between BPD patients and healthy individuals decreased on the ambiguous faces.

Figure 22. Interaction between time, valence and diagnosis on the RMET accuracy.

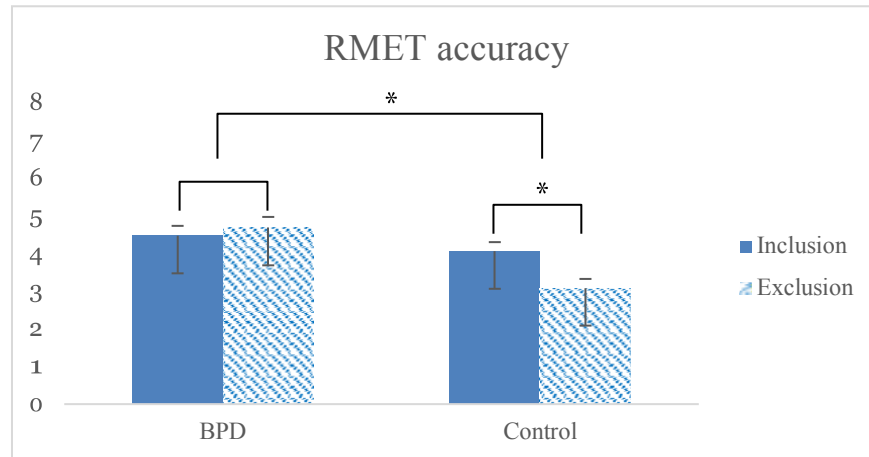


Note. BPD = Borderline Personality Disorder.

* $p < .05$, ** $p < .01$, *** $p < .001$.

Further, there was a significant diagnosis by condition interaction ($F(1,46) = 5.4, p = .03, \eta_p^2 = .11, \text{observed power} = .62$)(Fig.23). Healthy individuals became significantly worse on the RMET accuracy after exclusive social interactions compared to after inclusive social interactions; whereas, BPD patients did not differ in accuracy after exclusive and inclusive social interactions.

Figure 23. Interaction between condition and diagnosis on the RMET accuracy.



Note. BPD = Borderline Personality Disorder.

* $p < .05$, ** $p < .01$, *** $p < .001$.

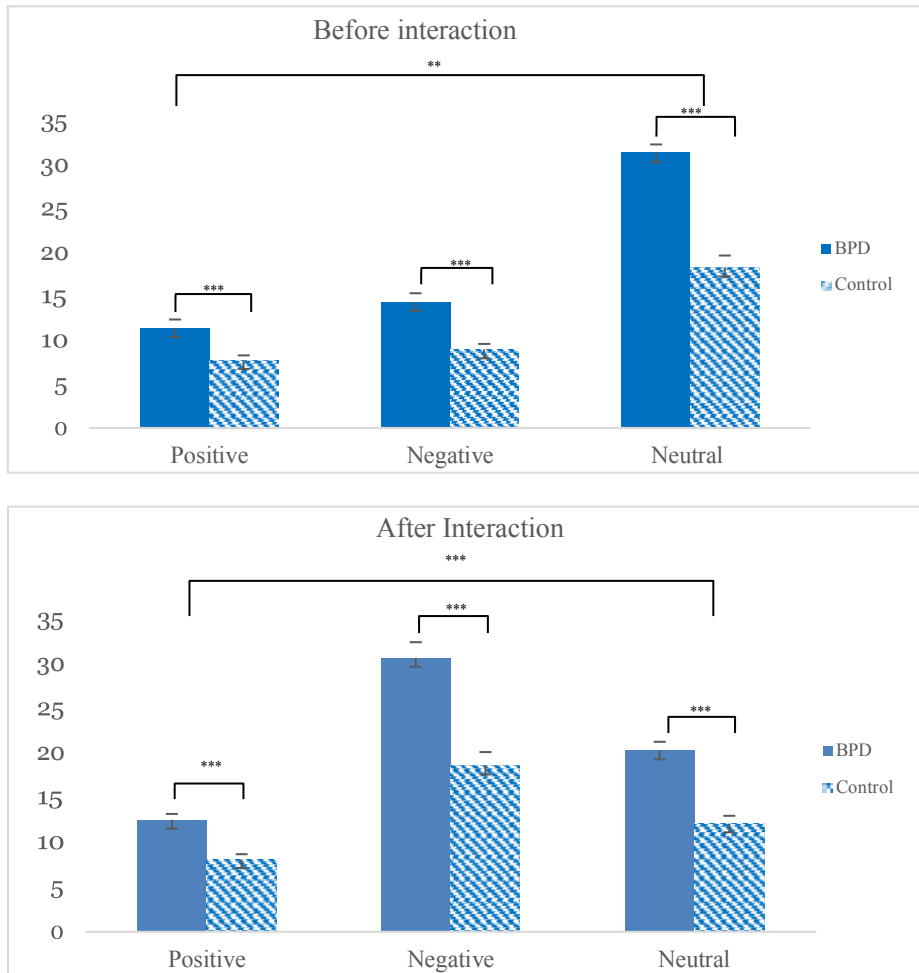
In addition, a significant main effect of time ($F(1, 46) = 5.93, p = .02, \eta_p^2 = .11$, observed power = .66), and diagnosis ($F(1,46) = 15.52, p < .001, \eta_p^2 = .25$, observed power = .97) were also found. This suggests that the accuracy of estimating emotional states of others improved after social interactions ($M = 4.24, SD = .14, CI [3.95, 4.52]$) compared to the baseline ($M = 3.91, SD = .15, CI [3.62, 4.21]$). BPD patients ($M = 4.58, SD = .19, CI [4.19, 4.96]$) were also more accurate on the RMET compared to healthy individuals ($M = 3.57, SD = .17, CI [3.23, 3.91]$).

The modified RMET total

A four-way ANCOVA found a significant time by valence interaction ($F(1,45) = 30.87, p < .001, \eta_p^2 = .41$, observed power = 1.00), and time by valence by diagnosis interaction ($F(1,45) = 16.42, p < .001, \eta_p^2 = .27$, observed power = .98) (Fig 24). Before the social interactions, participants, particularly BPD patients, significantly overanalysed neutral facial stimuli. However, they

showed this tendency only for negative and neutral facial expressions after the social interactions. Hence, they did not overanalyze positive facial expressions.

Figure 24. Interaction between time, valence and diagnosis on the RMET total number of words selected.

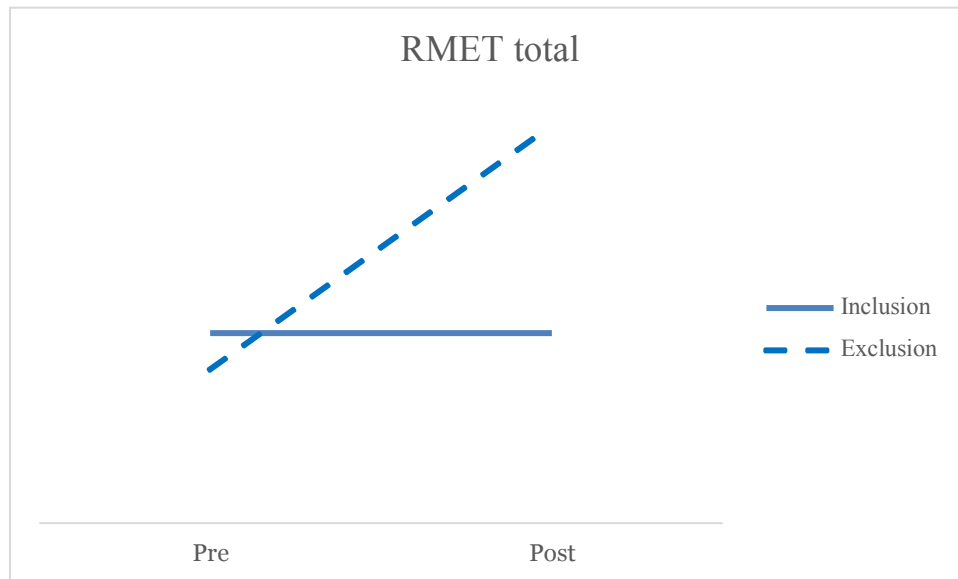


Note. BPD = Borderline Personality Disorder.

* $p < .05$, ** $p < .01$, *** $p < .001$.

In addition, a significant time by condition interaction ($F(1, 45) = 5.30$, $p = .03$, $\eta_p^2 = .11$, observed power = .62) was found where participants became overanalyzing facial stimuli especially after exclusive social interactions compared to inclusive social interactions (Fig 25).

Figure 25. Interaction between time and condition on the RMET total.



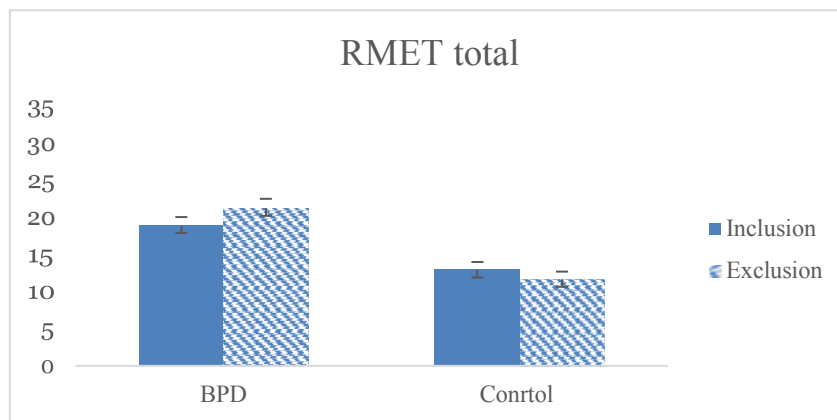
Further, results found a significant main effect of time ($F(1,45) = 6.34, p = .02, \eta_p^2 = .12$, observed power = .69), diagnosis ($F(1,45) = 37.03, p < .001, \eta_p^2 = .45$, observed power = .1.00), and valence ($F(1,45) = 4.35, p = .04, \eta_p^2 = .09$, observed power = .53).

Participants showed a tendency to overanalyze facial stimuli after interactions ($M = 17.06, SE = .62$) compared to the baseline ($M = 15.34, SE = .55$) and BPD patients hypermentalized ($M = 20.10, SE = .91$) compared to healthy individuals ($M = 12.30, SE = .78$) regardless of interactions types. Participants showed a tendency to overanalyze neutral facial stimuli ($M = 20.51, SE = .74$) compared to negative facial stimuli ($M = 18.15, SE = .71$) or positive facial stimuli ($M = 9.94, SE = .34$). Hence, the sensitivity to ambiguous social stimuli was not limited to BPD patients.

Although it was not statistically significant, there was a trend for a condition by diagnosis interaction ($F(1,45) = 2.25, p = .14, \eta_p^2 = .05$, observed

power = .31). BPD patients showed a tendency to associate more emotional words following exclusive social interactions ($M = 21.25, SD = 1.32$) than inclusive interactions ($M = 18.95, SD = 1.15$). However, healthy individuals associated less emotional words after exclusive social interactions ($M = 11.67, SD = 1.06$) compared to inclusive social interactions ($M = 12.94, SD = 1.08$). The direction of the effect of conditions, diagnosis, and valence was same as the one in the RMET accuracy (Fig 26).

Figure 26. Interaction between condition and diagnosis on the RMET total number of words selected.



Note. BPD = Borderline Personality Disorder.

6.3.6. Expectation Violation

It was found a significant main effect of condition ($F(1,46) = 43.91, p < .001, \eta_p^2 = .49$, observed power = 1.00). The difference between what they expected to receive and what they actually received was significantly larger in the exclusion condition ($M = 26.21, SE = 2.19$) than the inclusion condition ($M = 6.23, SE = 2.08$). This indicates that participants' expectations have been significantly violated in the exclusion condition. Although it was not statistically significant, BPD patients expected to receive more ball-tosses than what they

received ($M = 18.68$, $SE = 2.26$) compared to healthy individuals ($M = 13.77$, $SE = 2.00$). BPD patients expected to receive more than a fair amount of ball-tosses ($M = 36.14$, $SD = 10.04$), whereas healthy individuals expected to receive a fair distribution ($M = 33.71$, $SD = 8.66$). Although the effect size of BPD was small to medium, this preliminary finding indicated that BPD patients might have a tendency to expect to be over-involved. The effect size of BPD was small to medium, which may be due to the small statistical power. However, as there was no statistical difference, the level of expectations or perception of ball-tosses did not significantly differ between BPD patients and healthy individuals.

6.4. Discussion

The present study investigated the effect of interpersonal interactions on social mentalizing in BPD patients compared to healthy controls. Results suggest that social cognitive capacities to accurately estimate other's emotional states vary depending on a number of factors including the type of social stimuli (i.e., neutral facial expressions), the type of social interactions (inclusion/exclusion), and BPD symptoms.

Although many previous studies have found the impaired mentalizing capacities in BPD patients assessed by the RMET (Levine, Marziali & Hood, 1997; Richman & Unoka, 2015), the current research found significantly enhanced (more accurate) mentalizing capacities in BPD patients, which was consistent with other studies (Fertuck et al., 2009; Frick et al., 2012; Scott et al., 2011). Also, BPD patients were found to over-analyse facial cues compared to healthy individuals, even without social interactions. This suggests that BPD patients have a constant tendency to hypermentalize even without a presence of

the interpersonal threat. Results suggest that BPD patients' threat detection mechanism may be constantly active as their default mode assumes that there is a threat even when there is no threat in reality. This view is consistent with the recent findings that BPD patients tend to experience negative affect and feel that they are disconnected from others even in the objectively included social situations (De Panfilis et al., 2015).

Prior to social interactions, BPD patients showed an enhanced accuracy in estimating the emotional state of ambiguous facial expressions. This may be because ambiguous stimuli were perceived as threatening; hence they focused on neutral facial stimuli, which led to an enhanced accuracy. This hypersensitivity to ambiguous social stimuli in BPD patients found in the present study is consistent with the previous study (Lobbestael & McNally, 2016).

However, after social interactions, BPD patients became more accurate in interpreting negative facial expressions, and the difference in response to neutral and negative facial stimuli was reduced. This suggests that social interactions may have been perceived as a threat and have activated their attachment system, which elevated emotional arousal. Consequently, even neutral facial stimuli were perceived as negative facial expressions due to their negative cognitive biases. This view is consistent with the past research which found the BPD patients' tendency to perceive ambiguous faces more negatively (Domes et al., 2008).

The accuracy to estimate the emotional states was found to be the lowest on the positive facial expressions. This may be because positive faces were least threatening; hence, the attention may have been compromised on less threatening stimuli. This was supported by the number of emotional words selected to

describe the emotional states of the others' faces. BPD patients may have paid more attention to threatening cues (ambiguous & negative facial expressions), which resulted in the tendency to overanalyse those facial expressions.

Following the social interactions, the accuracy of mentalizing improved among all participants. This suggested that social interactions had activated the attachment system, which resulted in improved social cognition. There was also another possibility that the accuracy of the RMET improved after the social interactions due to a practice effect. However, the results were not simply due to a practice effect as the change in the RMET accuracy differed depending on the type of stimuli (facial expressions and interactions).

When participants had social interactions, they showed a tendency to overanalyze other people's facial expressions particularly when they are ambiguous. This over-interpretation of facial expressions improves the accuracy in detecting the emotional states of others. Given that a tendency to over-analyze facial stimuli in healthy individuals was associated with an enhanced accuracy in detecting the emotional states of others, a certain level of over-interpretation of social stimuli may function as a coping strategy to increase the chance to correctly understand others' emotional states. As a result, over-analyzing social stimuli can enable successful and healthy interactions. However, the opposite effect of over-interpretation of facial stimuli was found in BPD patients. Those BPD patients with a higher tendency to overanalyze facial stimuli were less accurate in estimating others' emotional states. This maladaptive strategy to over-analyze social stimuli leads to hypermentalizing. Hence, hypermentalizing in BPD patients results in more misunderstanding, which hinders successful interpersonal

interactions. This suggests that a certain level of over-interpretation of social stimuli is adaptive to enable successful interpersonal interactions. However, BPD patients may exceed this healthy level, and their coping mechanism becomes rather maladaptive.

The impact of social interactions on the accuracy in mental decoding capacities among BPD patients was distinct to the impact among healthy participants. Although exclusive social interactions impaired the accuracy on the RMET among healthy individuals, BPD patients did not show any impairment in the accuracy of detecting the emotional states of others following exclusive interactions. Thus, social rejection suppressed social cognition in healthy individuals. However, social rejection did not hinder the capacity to detect emotional states of others in BPD patients. This may suggest that healthy individuals have perceived only exclusive interactions as a threat, which elevated emotional arousal. Consequently, the emotional arousal may have impaired the social cognition. However, BPD patients may have perceived even inclusive interactions as threatening as social rejection. This view is consistent with the findings in the recent pilot study (Euler et al., 2018), which suggested that BPD patients perceived even social inclusion as threatening.

However, the current findings were somewhat inconsistent with another recent study (Savage & Lenzenweger, 2018). This study investigated the effect of social exclusion manipulated the Cyberball paradigm on the RMET among non-clinical participants. In this study, individuals with BPD features showed the impaired accuracy in estimating neutral facial stimuli after exclusive social interactions. The inconsistent findings may be due to the difference in the

methodology. The previous research (Savage & Lenzenweger, 2018) did not have an inclusion condition; whereas, the present study used both inclusion and exclusion condition. Further, there were only non-clinical participants in the previous study; hence, the severity of BPD symptoms captured in the previous study may differ from the current study.

Further, social interactions enhanced the tendency to overanalyze social stimuli in general. Social interactions may have activated the attachment system, which led them to pay more attention to perceived social stimuli. As a result, people tend to overanalyze social cues to enable a better understanding of the given social context. Although the effect was not statistically significant, BPD patients showed a tendency to hypermentalize following the exclusive social interactions compared to inclusive social interactions. On the other hand, healthy participants showed a tendency to hypomentalize after social rejection compared to inclusive social interactions. This finding is consistent with findings in the last study among non-clinical participants described in the previous chapter.

As explained in the previous chapter, exclusive social interactions suppressed the tendency to overanalyze facial stimuli in participants with low BPD features. On the other hand, social rejection elevated the tendency to overanalyze in those with high BPD features. The current study also found a heightened sensitivity to ambiguous social stimuli, which was not limited to BPD patients. At last, although it was not statistically significant, there was a small to medium trend of BPD patients' expectation to be over-included. This is consistent with the previous finding (De Panfilis et al., 2015) which suggests that BPD patients have an idealized expectation of social inclusion.

Limitations

However, before drawing any implications and conclusion from the current findings, a number of limitations need to be addressed. First, the current study aimed to investigate the effect of social interactions on mentalizing; however, the modified RMET assessed only one aspect of mentalizing capacities. Although the RMET was used in the previous research to assess mentalizing, the stimuli used in the task was assessing only external (facial expressions) and affective (emotional states) aspects of mentalizing. In reality, people need to consider various aspects of social situations (i.e., behaviours, verbal expressions, a tone of the voices, past interactions etc) to speculate others' mental states. Hence, the current findings are limited to one aspect of mentalizing. Future research should employ different tasks to assess other aspects of social cognition.

Second, the current study modified the RMET to capture hypermentalizing. However, this methodology was not validated yet. The reliability test was assessed and showed a high internal consistency in the current study as well as previous studies. However, the external validity was not examined. Hence, the conceptualization of hypermentalizing and hypomentalizing using the modified RMET needs to be further tested for consistency with other validated methodologies in the future study.

Third, the current study did not find a negative impact of social rejection on social cognition among BPD patients. As described in the previous section, BPD patients may have perceived the “normal” level of inclusive social interactions as threatening as exclusive interactions. Previous research (De Panfilis, et al., 2015) using the Cyberball paradigm found that BPD patients felt

they were excluded in the standard inclusion condition, and their negative affect was only reduced by “extreme” inclusion. Hence, it is plausible that BPD patients felt negative affect following the inclusive interactions because the current inclusive condition was not inclusive enough for BPD patients. However, the current study did not include any measurements to assess subjective response, particularly negative emotional reactions (i.e., anxiety, anger) following the interactions. Hence, it is not clear whether the manipulation using the Cyberball paradigm was successful in inducing negative emotional arousal. Future research should assess affective states before and after the social interactions to capture the emotional arousal, particularly rejection-related emotions.

Overall Conclusions

This study investigated the effect of social interactions on the perceptions of affective facial cues among BPD patients compared to healthy individuals. Both positive and negative interactions were found to activate social cognition which increased the tendency to overanalyze facial cues. Healthy individuals with a higher tendency of overinterpretation were more likely to accurately interpret facial emotional cues. On the other hand, when BPD patients overanalyzed social cues, they were more likely to be inaccurate in understanding the mental state of others. Hence, the more they try to understand others’ mental state, BPD patients were more likely to misunderstand others. Hypermentalizing in BPD patients can be seen as a maladaptive coping strategy in response to social interactions, which may explain their interpersonal difficulties.

Although only negative social interactions (rejection) impaired the social cognition in healthy individuals, even objectively positive interactions had the

same effect as negative interactions in BPD patients. The current findings suggest that BPD patients are constantly alerted and react intensely to social stimuli regardless of the presence of the actual social threat. Therefore, BPD patients tend to overanalyze even objectively non-threatening social cues. Overinterpretation of social cues can be an adaptive function to enable healthy interpersonal interactions by increasing the chance to accurately interpret social cues. However, BPD patients tend to exceed this healthy level of over-interpretation. Hypermentalizing is a maladaptive coping strategy, which may explain their difficulties in interpersonal relationships.

CHAPTER III

DISCUSSION AND CONCLUSION

Overview

Borderline personality disorder (BPD) is a severe mental illness characterized by affect instabilities, impulsivity, identity disturbance, self-harm behaviours, and interpersonal problems. The interpersonal hypersensitivity has been described as a core characteristic of BPD patients (Gunderson & Lyons-Ruth, 2008), where most of their difficulties are captured in interpersonal contexts (Baer, Peters, Eisenlohr-Moul, Geiger & Sauer, 2012; Lieb, Zanarini, Schmahl, Linehan, & Bohus, 2004; Sanislow & McGlashan, 1998; Skodol et al., 2002). Within interpersonal contexts, BPD patients exhibit an intense fear of rejection, which suggests that BPD patients have the heightened rejection sensitivity (Ayduk et al., 2008; Butler et al., 2002; Boldero et al., 2009; Fertuck et al., 2013; Meyer et al., 2005; Ruocco et al., 2010; Staebler et al., 2011).

The current study supported the hypothesis that the association between rejection sensitivity and BPD features was mediated by individual's level of need to belong, and this indirect association was influenced by their adult attachment style and self-critical traits. Further, the attachment styles were differently associated with the need to belong. Among those individuals with high BPD features who are more likely to present attachment anxiety, the desire to be accepted by others may be the motivations to be self-critical. In addition, the association between rejection sensitivity and BPD features was also mediated by the intolerance of ambiguity and effortful control. Highly rejection-sensitive individuals were more likely to have BPD features when they were less able to

tolerate the ambiguity and regulate their cognitive disturbance. These cognitive impairments were found to be prominent in response to interpersonal threats. Social rejection impaired effortful control and mentalizing capacities among individuals with high BPD features. Further, the activation of the attachment system also impaired learning capacities among those with high BPD features. Finally, BPD patients were found to have a fundamental tendency to hypermentalize facial cues. Having an inclusive social interaction had the same effect as social rejection on mentalizing in BPD patients where they presented a constant tendency to hypermentalize. On the other hand, social rejection impaired the accuracy of mentalizing among healthy individuals.

Empirical Findings

Study 1 and 2 examined the mediating and moderating roles of developmental and cognitive factors, which explain the association between rejection sensitivity and BPD features. Anxiously attached individuals have been found to present more BPD features, which is consistent with previous research (Mikulincer & Shaver, 2007). On the other hand, avoidant attachment has been found to be unrelated to BPD features, which contradicts to previous findings (Clitchfield, Levy, Clarkin, & Kernberg, 2008).

Although the need to belong to others is an evolutionary fundamental need, this need was found to be suppressed depending on the individuals' attachment strategy. People with attachment anxiety have been found to hold a stronger desire to belong to others; whereas, those with the avoidant attachment style hold less desire for intimacy. Given that BPD patients have an intense desire for bonding (Ayduk et al., 2008), BPD patients should be more associated with

attachment anxiety. Hence, the current findings regarding the attachment anxiety being associated with BPD features, not attachment avoidance, are justified theoretically and empirically despite the contradicting findings in the previous study (Clitchfield, Levy, Clarkin, & Kernberg, 2008). Although past studies have suggested that the self-criticism is related to attachment avoidance (Sibley & Overall, 2008, 2010), the present study has found that the attachment anxiety is more strongly associated with self-criticism compared to attachment avoidance. These findings suggest that individuals with heightened rejection sensitivity are more likely to seek intimacy due to attachment anxiety and be over-critical of themselves to achieve acceptance from others. This finding is consistent with the view that self-critical perfectionism may function as a self-improvement strategy (Hewitt & Flett, 1995). On the other hand, avoidant individuals were more likely to suppress the need to belong to others, but still more likely to be self-critical. This is consistent with the view that self-criticism may function as a self-punishment strategy (Whelton & Greenberg, 2005). This maladaptive coping strategy is more likely to increase BPD features as a result, which is consistent with previous findings where BPD patients often have maladaptive coping strategies (Berenson et al., 2011; Dixon-Gordon et al., 2011).

In addition, intolerance of ambiguity and effortful control have been found to account for the association between rejection sensitivity and BPD features. People with heightened rejection sensitivity are more likely to present intolerance of ambiguity and effortful control impairments. The role of intolerance of ambiguity in BPD features found in the current study is consistent with BPD patients' cognitive biases presented in the study by Veen and Arntz (2000). As

BPD patients frequently present dichotomous thinking, the tendency to evaluate experiences in black or white (Napolitano & McKay, 2007; Veen & Arntz, 2000), they are less able to evaluate the experiences that are grey (i.e. ambiguity). Further, inconsistent with the previous findings, the heightened rejection sensitivity has been associated with less effortful control capacities (De Panfilis et al., 2015), which is associated with higher BPD features (Ayduk et al., 2008; De Panfilis et al., 2015). This suggests that highly rejection-sensitive individuals are more likely to have BPD features partially due to their cognitive disturbance.

Study 3 has investigated that the role of attachment systems in learning among healthy individuals with BPD features. Results have indicated that the presence of the mother's photo impairs the learning capacities of participants with affective instabilities (BPD features) when they had to inhibit actions. However, such disturbances were not found in the other condition where participants had to activate actions. Given that BPD patients have been found to experience difficulties with inhibiting actions due to affect dysregulations (Mathews & MacLeod, 2005; Wilson, MacLeod & Campbell, 2007), the current findings showing the difficulties in inhibition are consistent with the previous findings among BPD patients (Layton et al., 2001; Nigg et al., 2005). Further, the attachment disturbance has been shown to have a negative impact on learning and short-term recall (Minzenberg, Poole, & Vinogradov, 2008), which supports the current findings of the learning disturbance in response to the stimuli associated with the attachment figures. This finding suggests that the activation of the attachment system may have impaired the learning capacity of individuals with affective instabilities under the cognitively challenging situations.

Study 4 has investigated the effects of ambiguous social interactions on effortful control and mentalizing capacities among healthy individuals with BPD features. Results have revealed the significantly faster and less accurate response in individuals with BPD features compared to those with low BPD features on the emotional Stroop task, which indicates that people with BPD features are more impulsive. This finding is consistent with the impulsivities found in BPD patients (Layton et al., 2001; Nigg et al., 2005). Following the social interactions, people with self-harm tendencies (BPD features) have shown the tendency to over-analyse facial expressions compared to those with low self-harm tendencies. Therefore, this preliminary finding suggests that the social interaction can lead to over-interpretation of facial stimuli among those with BPD features.

Study 5 replicated the findings of Study 4 regarding the impulsivities and the tendency to over-analyse social cues among individuals with BPD features. Results revealed that individuals with higher BPD features had more impulsive reactions following both inclusive and exclusive social interactions, but made more errors on the task only following the exclusive interactions. This suggests that rejection interfered with effortful control capacities among individuals with BPD features. Having social interactions improved mentalizing capacities to accurately estimate others' emotional states in individuals with BPD features more than those with low BPD features. Rejection led to over-interpretation of social cues only among those with higher BPD features, not among those with low BPD features. This suggests that people with BPD features may over-focus on the social cues in response to threats to increase the chance to accurately interpret social cues, which leads to an over-interpretation of the cues.

Study 6 has revealed that BPD patients are significantly more accurate in interpreting facial cues, which is consistent with previous findings (Fertuck et al., 2009; Frick et al., 2012; Scott et al., 2011). Results also have revealed that BPD patients have a fundamental tendency to overanalyse facial cues, particularly when they see ambiguous facial expressions, regardless of the experience or the type of social interactions. Although BPD patients were generally more accurate in interpreting facial expressions, there was no difference in the mentalizing accuracy on the positive facial expressions after the social interactions compared to healthy individuals. This may suggest that BPD patients' mentalizing capacities were compromised to focus on more threatening social cues. Rejection impaired the mentalizing capacities to interpret facial expressions among healthy individuals. However, BPD patients did not differ when they were rejected compared to the inclusive interactions. This suggests that BPD patients perceive even objectively positive interactions as threatening as exclusive interactions. In addition, BPD patients expected to receive more than a fair amount of ball-tosses in the social interactions. These findings are consistent with the previous studies showing that BPD patients' unrealistic expectations of social inclusion and negative perceptions towards positive social situations (De Panfilis et al., 2015; Renneberg et al., 2012; Staebler et al., 2011).

Limitations

As described in Chapter II, a number of limitations have been addressed in the discussion sections of each empirical study. Hence, this section summarises the limitations throughout the thesis.

Sample Biases

As participants in all studies, except Study 6, were recruited from the UCL SONA system, the majority of participants were young students. The convenience sample of healthy adults has limited generalizability to the actual clinical populations with BPD. Although the previous study has shown that the dimension approach is appropriate to capture substantial impairments of BPD features in the non-clinical population (Clifton & Pilkonis, 2007), the clinical level of BPD features (the PAI-BOR > 38) were captured in a small number of current subjects. This may explain the results not showing the large effect of BPD features. However, a number of studies have been conducted and found substantial impairments related to BPD symptoms among non-clinical participants (Bagge et al., 2004; Clifton & Pilkonis, 2007; Daley et al., 2000; Frank & Hoffman, 1986; Meyer et al., 2005; Miano et al., 2013; Trull, 2001; Rosenthal, Cheavens, Lejuez, & Lynch, 2005; Sauer & Baer, 2010) and university students (Gardner, Qualter, Stylianou, & Robinson, 2010; Nickell, Waudby, Trull, 2002). Therefore, the subjects recruited from the non-clinical population in the current study appropriate to investigate the cognitive impairments associated with BPD features.

Methodological Issues

Study 1 and Study 2 conducted the mediation analysis using the cross-sectional data. As the mediation analysis is suitable for testing a causal model that assumes the directionality among constructs (Hayes, Montoya, & Rockwood, 2017), the current methodology has a critical issue that cannot be ignored. To address this limitation, multiple mediation models and moderated mediation

model were analysed. The strength of the association between rejection sensitivity and BPD features differ depending on the model, which supports the directionality of the proposed model.

Also, as Study 1 and Study 2 used only self-report measurements collected at the same point in time, there is a possible common-method variance among all constructs. However, Study 1 showed the discriminant validity as attachment avoidance was not associated with BPD features, unlike attachment anxiety. In addition, a number of previous studies have used the self-report measurements to capture effortful control impairments in relation to BPD features (Clarkin, & Posner, 2005; De Panfilis et al., 2013; Gardner & Qualter, 2009; Posner & Rothbart, 2009), Therefore, using self-report measurements to capture cognitive functions is well justified.

In addition, effortful control was assessed using a computer paradigm (emotional Stroop task) in Study 4 and 5. Results also have suggested that the impairments in effortful control are associated with BPD features. Therefore, the current findings using the behavioural paradigm also have supported the findings based on the self-report measurements.

Social interactions in Study 4 were manipulated by the interactions with a number of confederates. Although the researcher aimed to keep each interaction as consistent as possible by using a script, confederates were using their own words and change the dialogue depending on the interactions they had with participants. This may have made the interactions more realistic and natural; hence, it may have enhanced the ecological validity of the task. However, there was no consistency in the interactions that each participant had. This may explain

why the results did not find any difference in the emotional Stroop task and the RMET between different conditions (inclusion/ambiguous/rejection). However, the performance of the emotional Stroop task and the RMET differed after the behavioural interactions compared to the baseline, which indicated that the interactions had an impact on effortful control and mentalizing. Therefore, the behavioural paradigm was effective in inducing the affective arousal, which had an effect on cognitive functions. In addition, behavioural interactions using confederates were found to be effective to manipulate the social experience and induce rejection stress (Stroud, Salovey, & Epel, 2002). The manipulation introduced in the current study was very similar to the one used in the study conducted by DeWall and colleagues (2009), which was successful in inducing rejection stress. Therefore, the current methodology would have been more effective if the confederates were more trained.

Also, Study 5 aimed to examine the effect of unexpected social interactions on effortful control and mentalizing. However, participants' pre-existing expectations of social interactions could not be manipulated by the instructions. Although participants were aware of the instructions (i.e., to receive 2 ball-tosses out of 30 ball-tosses), participants still expected to receive a fair amount of ball-tosses. Hence the current study could not examine the difference between the expected inclusive interactions and the unexpected inclusive interactions and between the expected exclusive interactions and the unexpected exclusive interactions. However, the exclusion condition was successful in violating the participants' expectations of ball-tosses as all participants expected to receive a fair amount of ball-tosses.

The current research presented the new way to capture hypermentalizing in BPD patients with the preliminary data. Given that there were no other measurements to assess mentalizing capacities, it was not possible to validate the current methodology. However, the internal consistency was calculated in the present study. In addition, another study using the MASC and the modified RMET is currently conducted. Therefore, there is a plan to validate the modified RMET with the MASC.

The current research has utilized only one methodology to capture mentalizing capacities. The RMET assessing only one aspect of Mentalizing/social cognition: as mentioned earlier, mentalizing is a complex mechanism which takes into account a number of factors. The present research using the modified RMET is only able to capture one aspect of mentalizing. The stimuli used in the RMET contain only facial cues around eyes. In reality, people need to consider many other aspects of the interactions such as the tone of the voice, body language, facial expressions, the previous interactions, and the contents of the conversations. In addition, one's own behaviours will impact on others' behaviours; hence, people also need to consider their own mental states and behaviours in order to speculate on others' mental states and behaviours. Hence, human interactions are far more complicated than a picture of facial expressions. However, a large number of studies have investigated the social cognition in the BPD population using the RMET (Fertuck et al., 2009; Frick et al., 2012; Harkness et al., 2005; Richman & Unoka, 2015; Schilling *et al.*, 2012; Scott et al., 2011). Those studies have found similar results as other studies using

the MASC (Preißler et al., 2010). Therefore, the RMET is a well-validated and appropriate method to examine social cognition.

Affective Components

Consistent with the Linehan's model (1993), the current thesis has proposed that the elevated negative emotional arousal in response to interpersonal threats might explain the disturbed cognitive functions in BPD patients. However, the emotional states of the participants have not been assessed prior to the interactions as well as after the interactions. Hence, it is not clear whether the cognitive disturbance in effortful control and mentalizing following the interpersonal stimuli (i.e., interactions) was due to the emotional arousal. This can be a critical limitation of the current research. However, emotional instabilities and intense emotional arousals in BPD patients have been well observed and reported in a large number of studies (Ayduk, Zaya, Downey, Cole, Shoda & Mischel, 2007; Gross, 2002; Kröger, Vonau, Kliem, & Kosfelder, 2011; Linehan, 1993; Paris 2002). In addition, a large number of neuroimaging and experimental studies have found that the Cyberball paradigm is effective in activating the emotional arousal (Bernstein & Claypool, 2012; De Panfilis et al., 2015; Domsalla et al., 2014; Eisenberger, 2015; Eisenberger & Lieberman, 2004; Renneberg et al., 2012; Staebler et al., 2011). Therefore, it is well justified to assume that affective components play a role in the cognitive disturbance in the BPD population.

Research Implications

One of the most significant contributions of the current research is the findings of hypermentalizing in BPD patients. Although the current methodology

still has limitations, the results have revealed the BPD patients' fundamental tendency to hypermentalize. The tendency to over-analyse social cues was seen in healthy individuals and found to be an effective strategy to increase the accuracy in assessing the emotional states of others. However, BPD patients were found to exceed this healthy level, which led to the misunderstanding of social cues. When BPD patients hypermentalize social cues, they may end up being more confused and overwhelmed with all possible scenarios, which may lead to poor decision-making. To support this idea, BPD patients are indeed found to present poor decision-making (LeGris, Links, van Reekum, Tannock, & Toplak, 2012). This suggests that over-analysing interpersonal cues may negatively impact on higher cognitive function such as decision-making. Further, over-interpretation of social cues may also influence how people view their interpersonal relationships. Wilson and colleagues (1984) conducted a series of experiments to investigate the effects of analysing the reasons on subsequent attitudes and behaviours. In this experiment, half of the couples were asked to list all the possible reasons for why their romantic relationships were the way they were. The other half of the couples were asked to indicate their relationship satisfaction without listing reasons. Then all the couples were followed up after eight months to see if they were still in the relationship. The results revealed that the satisfaction predicted the relationship status after eight months among those couples who did not analyse their relationships. Those more satisfied couples were less likely to break up after eight months. On the other hand, the relationship satisfaction did not predict whether they would break up after eight months among those couples who analysed their relationships. Authors concluded that over-analysing their relationship led to

confusion about assessing their relationship. Therefore, these findings suggest that BPD patients may become confused when they hypermentalize, which leads to a misunderstanding of the social cues and further leads to poor decision making.

Another possible negative consequence of hypermentalizing is that the tendency to overthink social stimuli may increase suicide risk, which may explain Study 4 findings where individuals with suicide tendencies (BPD features) have overanalysed facial cues following social interactions. A recent meta-analysis (Rogers, & Joiner, 2017) has suggested that rethinking the situations, focusing on negative feelings, over-analyzing them, and speculating about the problems are the risk factor for suicidal ideation and attempts. Therefore, hypermentalizing can lead to further cognitive disturbances and increase suicidal tendencies in BPD patients.

Given that stress/arousal can affect the balance of mentalizing (Fonagy & Bateman, 2006), BPD patients' fundamental tendency to hypermentalize, even in non-threatening social situations, suggests that BPD patients may be constantly under distress due to their heightened interpersonal sensitivity (i.e. rejection sensitivity). As found in the current research, individuals with high BPD features were more intolerant of ambiguity. In addition, BPD patients have shown hypermentalizing in ambiguous facial cues. This suggests that individuals with BPD features perceive ambiguous cues as threats due to their interpersonal hypersensitivity. This hypersensitivity to ambiguous cues found in the current study is consistent with BPD patients' negative biases toward ambiguous and neutral social stimuli (Arntz et al., 2001; Baer et al., 2012; Domes et al., 2008; Donegan et al., 2003; Dyck et al., 2009; Fertuck et al., 2013; Miano et al., 2013;

Lobbestael & McNelly, 2016; Minzenberg et al., 2007; Mitchell et al., 2014; Wagner & Linehan, 1999).

Given that BPD patients have shown hypermentalizing following inclusive social interactions, BPD patients even perceive objectively fair social interactions as threats. This finding is consistent with previous research showing that BPD patients have felt as if they are excluded even when they are included in the social interaction (Renneberg et al., 2012; Staebler et al., 2011). This suggests that BPD patients are hypersensitive to perceive rejection, but insensitive to perceive acceptance from others. Their sensitivity to detect possible negative cues may compensate the capacity to detect positive cues in the social situations.

In addition, when the fundamental needs of security, affection, support, and acceptance from significant others are constantly ignored or unfulfilled, some individuals may feel hopeless (Gibb et al., 2001) and suppress the needs of affection and acceptance, which leads to the avoidance of intimacy. However, the current study has suggested that BPD patients tend to intensify this needs and be over-critical of themselves to achieve the acceptance from others. As BPD patients often have low self-esteem (Santangelo et al., 2017), they may try to criticise their own flaws and be “good enough” to be liked or accepted by others. Therefore, BPD patients may use maladaptive coping strategies to satisfy the need to belong to others through being overly self-critical. Hewitt and Flett (1991) have suggested that self-oriented perfectionism (similar to self-criticism) may function as a self-improving strategy. More recent research has suggested that self-criticism is used as a self-punishment strategy (Whelton & Greenberg, 2005). However, either way, being extremely self-critical is not an effective or healthy

coping strategy. Given that self-critical perfectionism is a risk and maintaining factor (Campos, Besser, & Blatt 2013; Flett & Hewitt, 2002; Hewitt & Flett, 2002) for a number of psychological problems (e.g. depression, eating disorder, suicidal behaviours), BPD patients may elevate their interpersonal problems due to this maladaptive coping strategy instead of satisfying their needs or improving their relationships with others.

Therefore, the current findings have suggested that individuals who have multiple risk factors including biological and social factors during the developmental process may expect to experience further negative events (e.g. rejection). In order to prevent further negative social experience and satisfy their basic need for acceptance, BPD patients may use maladaptive coping strategies, which may increase further affective, cognitive, and behavioural disturbance. As a result, they experience more interpersonal problems, and their anxious expectations of future rejection may become stronger. Then, their priority is to detect any hazard which indicates the potential threat. As a result, they may over-focus on the negative aspects, which hinders the capacity to consider the positive aspects of the social situations. Therefore, BPD patients may be threatened when they encounter uncertain social cues or inclusive social interactions. Given that social situations often contain some uncertainty, BPD patients may have interpersonal difficulties due to the enhanced affective arousal which suppresses higher cognitive functions to regulate the maladaptive affective-cognitive process. Due to the limited effortful control capacities, they cannot suppress the elevated emotional arousal and cannot shift their attention away from the threatening social cues. Focusing on the social cues they perceive as threats may lead to

hypermentalizing. As a consequence, they may become overwhelmed and confused, which further increases misunderstandings of the social situation and interpersonal problems.

Clinical Implications

As described earlier, BPD patients require intensive care and attention, which often leads to a burden in healthcare professionals and carers. Although the treatment such as psychotherapies is found to be effective in reducing BPD symptoms, BPD patients have a high rate of early dropout. Hence, it is crucial to understand the affective-cognitive mechanisms which explain the maladaptive behaviours of BPD patients. To understand the disturbance in BPD patients' cognition and behaviours, it is important to capture what is going on in their mind during the distressing interpersonal situations. This thesis proposes the potential triggers and causes of distress, coping strategies, maladaptive cognitive reactions in response to the perceived threats among BPD patients. The research findings have suggested that BPD patients' interpersonal sensitivity becomes so hypersensitive that even non-threatening social stimuli such as neutral facial expressions and inclusive interactions are perceived as threats. Further, the activation of the attachment system influences on learning. Hence, the findings highlight that it is clinically important to consider that objectively non-threatening interpersonal stimuli can activate the attachment system and result in cognitive impairments, which may be responsible for the treatment efficacy. Further, the current findings suggest that BPD patients' maladaptive tendency to over-interpret and misinterpret social cues, which may explain the interpersonal difficulties they experience. Effortful control is crucial to correct the maladaptive

reactions by inhibiting impulsive actions and shifting attention away from the threatening cues.

Future Directions

Given that there are many limitations in the present research, future research should replicate the current findings in a larger and diverse population using a more robust methodology.

As mentioned in the limitation, future research may use other more validated assessment tools to capture hypermentalizing and compare the results with the modified RMET to validate the proposed methodology. Given that the RMET assesses the only one aspect of mentalizing, a more comprehensive paradigm such as the MASC may be appropriate to be utilized to investigate hypermentalizing in BPD patients. The MASC is a 15-minutes film where four characters (two males and two females) are having a dinner together. The film is a more realistic scenario of a day-to-day conversation. Unlike the RMET, the MASC allows capturing social cognition in more complicated interpersonal situations, which has better ecological validity. In each scene, participants are asked to indicate what each character is feeling or thinking from four answer choices in which the only one of them is a correct answer. This allows capturing not only affective mentalizing but also cognitive mentalizing. In addition, the MASC allows capturing hypermentalizing, hypomentalizing, no mentalizing and accurate mentalizing. Hence, the MASC can assess different levels and aspects of mentalizing. The present research also has considered the possibility of using the MASC. However, the RMET was chosen instead because of the Cyberball. As the social interactions manipulated by the Cyberball took only less than five minutes,

the effect of social interactions was suspected to last only a short amount of time. Hence, the RMET was considered to be more appropriate as it took only 10 to 15 minutes, whereas the MASC would take 30 to 45 minutes.

There are a number of paradigms which induce the emotional state of social inclusion and exclusion other than the Cyberball. For instance, numerous studies employed a recall-memory task (Knowles, 2014; Maner, DeWall, Baumeister, & Schaller, 2007) where participants were asked to write an essay about the time they felt they were rejected. This recall task was found to be effective in inducing rejection stress. Also, manipulations introduced by social feedback is also effective in inducing the social rejection (Baumeister, DeWall, Ciarocco, & Twenge, 2005). In this study, participants complete a questionnaire regarding their personality trait. In the “*future alone*” condition, researchers give feedback on the questionnaire and inform participants that they will end up alone later in life. Therefore, future studies may employ other manipulation tasks to induce rejection stress and assess the effect of interpersonal distress on mentalizing using the MASC.

Final Conclusion

As described in the literature review, interpersonal difficulties are the core dysfunction found in people with BPD features (Gunderson et al., 2018). BPD patients often have genetic and environmental vulnerabilities (Gunderson et al., 2018; Gunderson & Lyons-Ruth, 2008) with less protective factors (Fonagy et al., 2017). Based on the developmental perspective, BPD patients frequently experience negative interpersonal experiences during childhood (i.e., abuse, neglect) and become insecurely attached to primary caregivers (Afiti et al., 2011;

Fonagy et al., 2002; Lorenzini & Fonagy, 2013). As a result, they develop dysfunctional maltreatment-related cognitions (De Haan et al., 2017) and expect negative interpersonal consequences (i.e., rejection) will happen in the future (Rosenbech & Renneberg, 2011). In order to prevent the negative interpersonal events from happening, the alarm system develops associations to detect potential hazards, which leads to a heightened alarm system (Eisenberger, 2015). As a result, the alarm system perceives even non-threatening social cues (i.e., ambiguity, expectation violation) as threatening (Lobbestael & McNally, 2016; Mortensen et al., 2016). Heightened rejection sensitivity may over-focus on negative aspects and may compensate for the capacity to perceive positive aspects of social interactions. This may explain why BPD patients perceived even objectively inclusive interactions as threats. Hence, BPD patients experience constant distress because the alarm system keeps inducing negative affective arousal in response to any stimuli they perceive as threats. To reduce the elevated emotional arousal, BPD patients may develop maladaptive coping strategies including attachment anxiety, self-critical perfectionism, and physical pain induced by self-harm behaviours (Grats, 2003; Gunderson et al., 2018; Niedtfeld et al., 2010). As these coping strategies are rather maladaptive, BPD patients may experience further disturbances in the affective-cognitive process.

In response to the maladaptive reactions due to an elevated emotional arousal induced by perceived threats, BPD patients' self-control needs to suppress and modulate their disrupted emotions, cognition, and behaviours. However, BPD patients may lack effortful controls, particularly attention control, which leads to the excessive focus on the negative aspects of interpersonal situations. As a result,

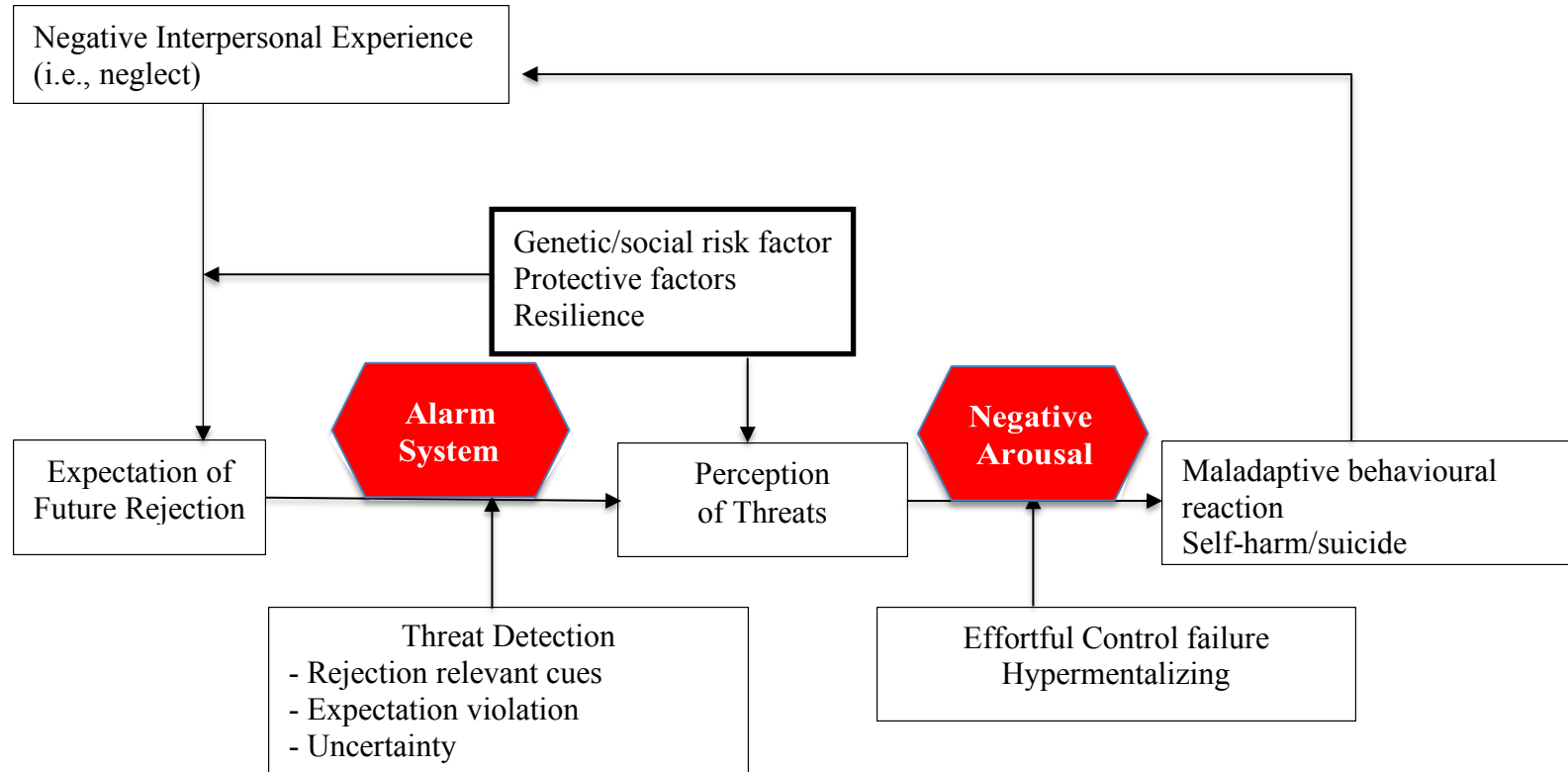
BPD patients may hypermentalize others' mental states, which may lead to further cognitive and behavioural problems as increased rates of rumination can lead to catastrophizing and increase the risk of suicidal ideation (Rogert & Joine, 2017).

Due to their intense and unstable interpersonal relationship styles (Gunderson et al., 2018), BPD patients are more likely to experience actual social rejection. BPD patients are indeed found to experience more difficulties in forming and maintaining healthy interpersonal relationships in adolescence (Wolke et al., 2012) and adulthood (Sansone et al., 2010). Therefore, BPD patients' intense fear of imagined rejection and anxious expectations of future interpersonal problems lead to actual rejection in a self-fulfilling prophecy (Ayduk et al., 2008; Downey et al., 1998).

Given that the current research found some consistent and inconsistent results regarding hypermentalizing between non-clinical and clinical participants, both categorical and dimensional approaches may be appropriate to conceptualize BPD. Therefore, the present research supports the hybrid model of BPD (Conway et al., 2018; Hypertz et al., 2017; McGlashan et al., 2005; Zanarini et al., 2007).

Although there are a number of limitations in the methodology used, the current thesis highlights the importance of developmental and cognitive factors in understanding interpersonal hypersensitivity and difficulties in BPD patients. The findings suggest

Figure 27. Theoretical Model of the development of BPD.



Appendix A: Informed Consent Form

Informed Consent Form for participants in dissertation research

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Project Title: *Interpersonal cognition and perception study*

This study has been approved by the UCL Research Ethics Committee (Project ID Number): 8547/001

Researcher: Momoko Sato

Contact Details:

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Thank you for your interest in taking part in this research. Before you agree to take part, the person organising the research must explain the project to you.

If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you to decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

Details of Study: You should only participate if you want to. Before you decide whether you want to take part, it is important for you to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. This study is being conducted by researchers from the Research Department of Clinical, Educational and Health Psychology at UCL.

If you agree to participate in this study you will be asked to complete several questionnaires on how you see yourself and also will be asked to perform some tasks on a laptop and a behavioural interaction task. Before the computer task, we will ask to take a picture of you, which will be deleted immediately after the study. These tasks aim to assess the effects of practising mental visualization on task performance. Also, they are to do with how you perceive and memorize in social situations. These tasks can be thought as a very simple computer games and an interaction task. There are two of these tasks in total with breaks in between and you should let us know at any stage if you do not want to continue or start with any of them. Completion of the tasks will take approximately 40-60 minutes.

Who are we recruiting?

We are recruiting healthy English-speaking adults, aged 18-60 years old. We aim to explore pre-clinical levels of interpersonal impairments and how these impact upon task performance.

What are the potential risks?

There are no major risks in participating. Some people may find some of the questions asked in the questionnaires upsetting or stress-inducing. If this was the case, we recommend to review this with your GP or to seek help (e.g. via Mind, a mental health charity, <http://www.mind.org.uk>) and to inform the research team.

Possible benefits

There are no direct benefits to you as the participant. However we will inform you of the overall outcome and impact of our experiments if you would like to know. Your participation will help to advance science in the field of individual differences in how people engage with and sustain relationships and learning in social contexts. However, you will be compensated for your time with £10 per hour. This compensation scheme reflects a common approach used at UCL and psychology department.

Arrangements for ensuring anonymity and confidentiality

All information which is collected about you during the course of the research (including questionnaires and your task data) will be kept strictly confidential and will be securely stored electronically, using a numbered code so that you cannot be identified. Only researchers directly involved in the study will have access to the data. All data will be stored in accordance with the Data Protection Act 1998. The data will be used only for informing the research question in this study and the results of the research will be disseminated in peer-reviewed scientific journals, but you will in no way be identifiable from such publications.

It is completely voluntary. If you decide to take part, you are still free to withdraw at any time and without giving a reason. Choosing not to take part will not disadvantage you in any way.

Please discuss the information above with others if you wish or ask us if there is anything that is not clear or if you would like more information.

All data will be collected and stored in accordance with the Data Protection Act 1998.

Participant's Statement

I agree that:

- I have read the notes written above and the Information Sheet, and understand what the study involves.
- I understand that if I decide at any time that I no longer wish to take part in this project, I can notify the researchers involved and withdraw immediately.
- I consent to the processing of my personal information for the purposes of this research study.
- I understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.
- I agree that the research project named above has been explained to me to my satisfaction and I agree to take part in this study.
- I agree to be contacted in the future by UCL researchers who would like to invite me to participate in follow-up studies.

Signature:

Date:

Appendix B: Information Sheet

Information Sheet for *Participant* in Research Studies

You will be given a copy of this information sheet.

Title of Project: **Relational neuroscience - behavioural battery and psychopathology**

This study has been approved by the UCL Research Ethics Committee (Project ID Number): 6129/002

Name, Work Address, Tobias Nolte

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We would like to invite you to participate in this research project.

Details of Study: You should only participate if you want to. Before you decide whether you want to take part, it is important for you to read the following information carefully and discuss it with others if you wish. Ask us if there is anything that is not clear or if you would like more information. This study is being conducted by researchers from the Research Department of Clinical, Educational and Health Psychology at UCL in collaboration with The Anna Freud Centre where the study will take place.

Who are we recruiting?

We are recruiting healthy English-speaking adults, aged 18-60 with no history of mental disorder.

What will happen if you agree to take part

If you agree to participate in this study you will be asked to complete several questionnaires on how you see yourself and also will be asked to perform some tasks on a laptop. These are to do with how you make decisions in social situations and with how you learn about the stimuli we will be presenting you with. These tasks can be thought of as very simple computer games. For most of them, we would like you to perform as best as you can as this will be rewarded with additional remuneration. There are five of these tasks in total – with breaks in

Informed Consent Form for *Participant* in Research Studies

Please complete this form after you have read the Information Sheet and/or listened to an explanation about the research.

Title of Project: **Relational neuroscience - behavioural battery and psychopathology**

This study has been approved by the UCL Research Ethics Committee (Project ID Number): 6129/002

Thank you for your interest in taking part in this research. Before you agree to take part, the person organising the research must explain the project to you.

If you have any questions arising from the Information Sheet or explanation already given to you, please ask the researcher before you to decide whether to join in. You will be given a copy of this Consent Form to keep and refer to at any time.

Participant's Statement

I

- have read the notes written above and the Information Sheet, and understand what the study involves.
- understand that if I decide at any time that I no longer wish to take part in this project, I can notify the researchers involved and withdraw immediately.
- consent to the processing of my personal information for the purposes of this research study.
- understand that such information will be treated as strictly confidential and handled in accordance with the provisions of the Data Protection Act 1998.
- agree that the research project named above has been explained to me to my satisfaction and I agree to take part in this study.
- I agree that my non-personal research data may be used by others for future research. I am assured that the confidentiality of my personal data will be upheld through the removal of identifiers.
- I understand that my participation will be recorded and I consent to the anonymous use of this material as part of the project.
- I agree to be contacted in the future by UCL researchers who would like to invite me to participate in follow-up studies.
- I understand that the information I have submitted will be published as a report and I will be sent a copy if requested. Confidentiality and anonymity will be maintained and it will not be possible to identify me from any publications.

Signed:

Date:

Appendix C: Information Sheet

Version 1.6 - 17/07/2017

[Information Sheet; Clinical/Probation Service]

PD - CPA

Personality Disorders - a Computational
Psychiatry Approach

Understanding the Social Brain in Healthy Volunteers and People with Psychological Difficulties.

This study has been approved by the Research Ethics Committee for Wales (Project ID Number): 12/WA/0283.

We would like to invite you to participate in this research project.

You are being invited to take part in a research study. You should only participate if you want to. Before you decide whether to take part, this sheet will give you some more information about why the study is being carried out, what you would be asked to do if you decide to take part, and how the study will be conducted. Please take some time to read this sheet, and to discuss it with other people if you wish. You are also very welcome to ask any further questions about the study, or if you find anything on this sheet unclear.

Why is this study being done?

With the proposed project we plan to investigate the brain activation patterns of people suffering from personality disorders or similar traits and compare them with healthy control participants. Only little is known about the neurobiology of Borderline and Antisocial Personality Disorders. Our study design will address some of these. This will hopefully allow us to gain a better understanding of the disorders and to develop more informed and effective treatments from which clients will benefit.

Why have you been invited to take part?

You have been invited to take part in the study because you have recently been assessed by a clinician at one of the clinical or probation services currently collaborating with the research team.

Do I have to take part?

No. Taking part in the study is entirely voluntary. It is your choice whether or not you would like to participate. Deciding not to take part in the study will not affect the care you receive from services either now or in the future. If you do decide to participate, you will be given this information sheet to keep, and you will later be asked to sign a consent form stating that you wish to take part. If you do give consent to take part in the study, you are still free to leave the study at any point, without giving a reason. This will not affect the care you are currently receiving, or will receive in the future. If you leave, any information that we have already collected from you will be destroyed.

What will happen if I decide to take part?

If you wish to take part in the study, then you can get in touch with the research team or provide your contact details so that we can arrange a time to discuss the study in more detail and to book in the assessments if consent is obtained. We can then contact you to arrange a convenient time to meet. At this meeting you will meet a member of the research team and you can ask any other questions you may have. You will then be asked to sign a consent form to say that you wish to take part in the study. You will also be asked about your eligibility for brain scans as not every person can undergo these.



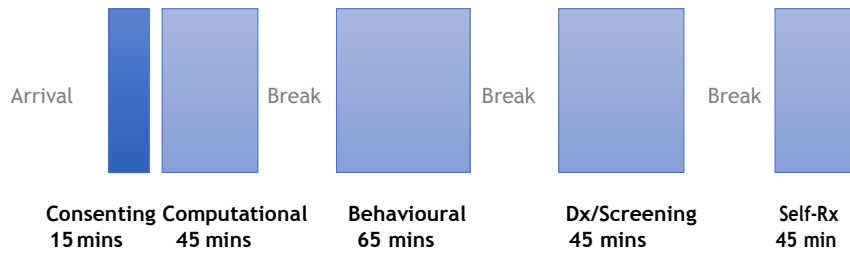

Caring for young minds
Anna Freud
Centre



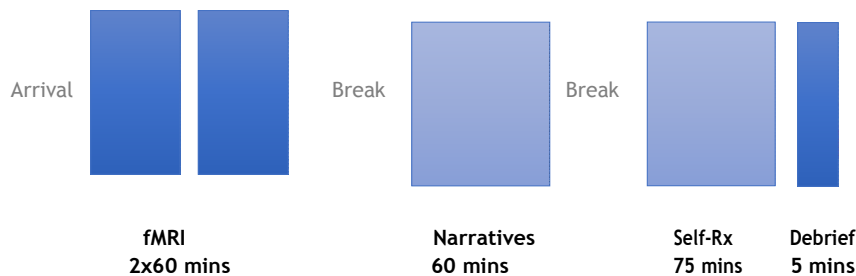
Central and North West London 
NHS Foundation Trust

Study overview:

Visit 1 (4-5 hrs) at clinical site or WTCN



Visit 2 (4-5 hrs) at clinical site or WTCN



There will be two or three assessments with approximately 8-10 hours in total duration. In the first assessment, which will be held at the Wellcome Trust Centre for Neuroimaging or your clinical site/probation service, you will be asked to fill in questionnaires on personality functioning, developmental history, symptomatology etc. You will then perform some computer-based cognitive tasks and have a SCID II which is a psychiatric interview that takes approximately 30 to 60 minutes to complete. Any of these measures that have already been routinely obtained at your service will not be repeated if you are happy for your service to share the data with us (your consent provided).

The second assessment will consist of 5 computerised tasks (which you will do whilst lying in a magnetic resonance imaging (MRI) brain scanner at the Wellcome Trust Centre for Neuroimaging or on a laptop either at the Wellcome Trust Centre for Neuroimaging or your clinical site/probation service. In the tasks you will have to perform some tasks such as responding to written cues using different buttons to estimate or compare different events or conditions (similar to simple computer games). In some of them you will play another person who is being scanned at a different laboratory at the Principal Investigator's second laboratory at Virginia Tech University. This phase will last roughly 2-3 hours but it is broken down into 2 sections of approx. 60 minutes maximum with lots of breaks. After each hour you will have a longer break and leave the scanner. Most \

Appendix

people find the tests quite straightforward and interesting to do. After the scanning, or on a third assessment day, we will ask you to fill out several questionnaires and you will be administered an interview regarding experiences in your childhood which usually takes another 45 minutes and which will be audio-recorded and transcribed before being coded for attachment by a reliable and experienced member of the research team. Before coding, all identifiable information will be removed from the audio file for anonymity.

If you have a tattoo, we will ask you to participate in a study that investigates any adverse effects which may occur as a result of MRI, such as heating or pulling on the tattoo.

No part of the study is compulsory and there will be separate consent sections for each part of the study.

What is functional magnetic resonance (fMRI) and what are the potential risks?

An MRI scanner takes pictures of your brain and measures the activity of different parts of it. The MRI scan procedure is painless and safe - these procedures are done hundreds of times a day all over the world. However, the MRI scanner makes loud noises while it is operating; we will provide you with headphones or earplugs to reduce the noise to safe levels. Some people find being in an MRI scanner makes them feel anxious and/or claustrophobic, even if they have not experienced claustrophobia before. A member of staff will be in constant contact with you via the intercom, and if you feel uncomfortable in anyway the scanning can be stopped. Before you get into the MRI scanner the person who operates the scanner will explain the procedure to you and answer your questions. There is no radiation involved. MRI scans work using very strong magnetic fields. Therefore it would be dangerous for anyone with any magnetic metal in their body to go near the scanner, since that metal might move towards the magnet. You will not be able to participate in the MRI scan if you do have such metal in your body. Examples include: pace-makers; piercings; certain tattoos (which are sometime made with metallic inks) and screws from surgery. Fillings are not magnetic and are therefore not a problem. **If you are not sure whether you are able to participate in the MRI scan due to the presence metal in your body, please ask a researcher.**

What are the possible disadvantages and risks of taking part?

We will support you if you become upset. A specific Risk and Safety protocol for this study has been developed. You will be given time at the end of the study to be fully debriefed with a member of the research team and provided with a handout on emotional regulation skills, and crisis phone numbers and details of clinical services to contact. Your personal therapist or probation officer will also be aware of your participation in the study and able to support you should you find discussing your experiences difficult. Should you feel overwhelmed or acutely distressed during or at the end of the assessments, we you will be appropriately looked after by an experienced clinician.

Some people find the experience of being in the brain scanner uncomfortable or distressing as it is very noisy in you will have to lie still for a long time in a narrow tube.

Should any abnormalities be found during the scan a qualified Neurologist will be asked to review the image and if necessary contact your GP regarding any concerns.

What are the possible benefits of taking part?

You may find it interesting to complete these tasks and the information gathered during this study will also help to inform our understanding of treatment for Personality Disorders, which will hopefully be a step towards helping improve interventions in the future.

Will I be paid for taking part in the study?

As an acknowledgement of your time, we will be offering you a flat rate of £10 per hour for your participation with additional compensation depending on your performance on some of the tasks. If you agree to give a saliva and blood sample, we will be offering you an additional £30.

Who will know you are taking part in the study?

We will inform your personal therapist or probation officer if you have been recruited via these services. We will inform your GP of your participation in this study, but information collected during all stages of the study will be kept strictly confidential. All information will only be viewed by members of the research teams at University College London and Virginia Tech University in the US. However, if through the course of the study it was found that you are at immediate risk of harm to yourself or others, this information will be shared with your therapist or GP and, if necessary, emergency services.

Your consent form will be kept in a separate location from all your other data, ensuring that this remains anonymous. All data will be stored in secure locations whereby a participant ID will be assigned to your data, not identifiable personal information and the results of your tasks will be recorded on computers or flash drives which are password protected. Any published data will also be entirely anonymous meaning individuals cannot be identified.

Some of the MRI data will be transferred for analysis to the Principal Investigator's second laboratory at Virginia Tech University in the US. Those data will be anonymised and no identifiable personal information will be shared or transferred.

The data from this study will be stored in accordance with the UCL and NHS Data Protection and Records Management policies.

All data will be collected and stored in accordance with the Data Protection Act 1998.

What will happen to the results of the research study?

The results will be written up in the form of reports to be submitted to scientific journals or presented at conferences. As mentioned, you will not be identifiable from these results. On completion and if you request it you will be sent a report of the study.

What if there is a problem?

Every care will be taken in the course of this study. However, in the unlikely event that you are injured by taking part, compensation may be available.

If you suspect that the injury is the result of the Sponsor's (University College London) negligence then you may be able to claim compensation. After discussing with your research doctor, please make the claim in writing to Dr. Janet Feigenbaum or Dr Tobias Nolte on behalf of the Chief Investigators (Profs Read Montague and Peter Fonagy) who are based at University College

If you suspect that the injury is the result of the Sponsor's (University College London) negligence then you may be able to claim compensation. After discussing with your research doctor, please make the claim in writing to Dr. Janet Feigenbaum or Dr Tobias Nolte on behalf of the Chief Investigators (Profs Read Montague and Peter Fonagy) who are based at University College London. The Chief Investigator will then pass the claim to the Sponsor's Insurers, via the Sponsor's office. You may have to bear the costs of the legal action initially, and you should consult a lawyer about this.

If you wish to complain, or have any concerns about any aspect of the way you have been approached or treated by members of staff you may have experienced due to your participation in the research, National Health Service or UCL complaints mechanisms are available to you. Please ask your research doctor if you would like more information on this. In the unlikely event that you are harmed by taking part in this study, compensation may be available to you. If you suspect that the harm is the result of the Sponsor's (University College London) or the hospital's negligence then you may be able to claim compensation. After discussing with your research doctor, please make the claim in writing to the Prof Fonagy who is the Chief Investigator for the research and is based at UCL, Research Department of Clinical, Educational and Health Psychology, 1-19 Torrington Place, London, WC1E 7HB. The Chief Investigator will then pass the claim to the Sponsor's Insurers, via the Sponsor's office. You may have to bear the costs of the legal action initially, and you should consult a lawyer about this

Who has reviewed this study?

This study has been reviewed by the REC for Wales 12/WA/0283

Contact Details

If you wish to contact the research team to discuss any of the information further or any concerns you have about the study, then please do so by getting in touch with the members of the research team listed below:

If you feel that we have not addressed your questions adequately or if you have any concerns about the conduct of the research team, then please contact my supervisor Dr. Janet Feigenbaum (Strategic and Clinical Lead for Personality Disorder Services, North East London NHS Foundation Trust and Senior Lecturer, Research Department of Clinical, Educational and Health Psychology, UCL) on 07957 919 9610r by email at janet.feigenbaum@nhs.net.

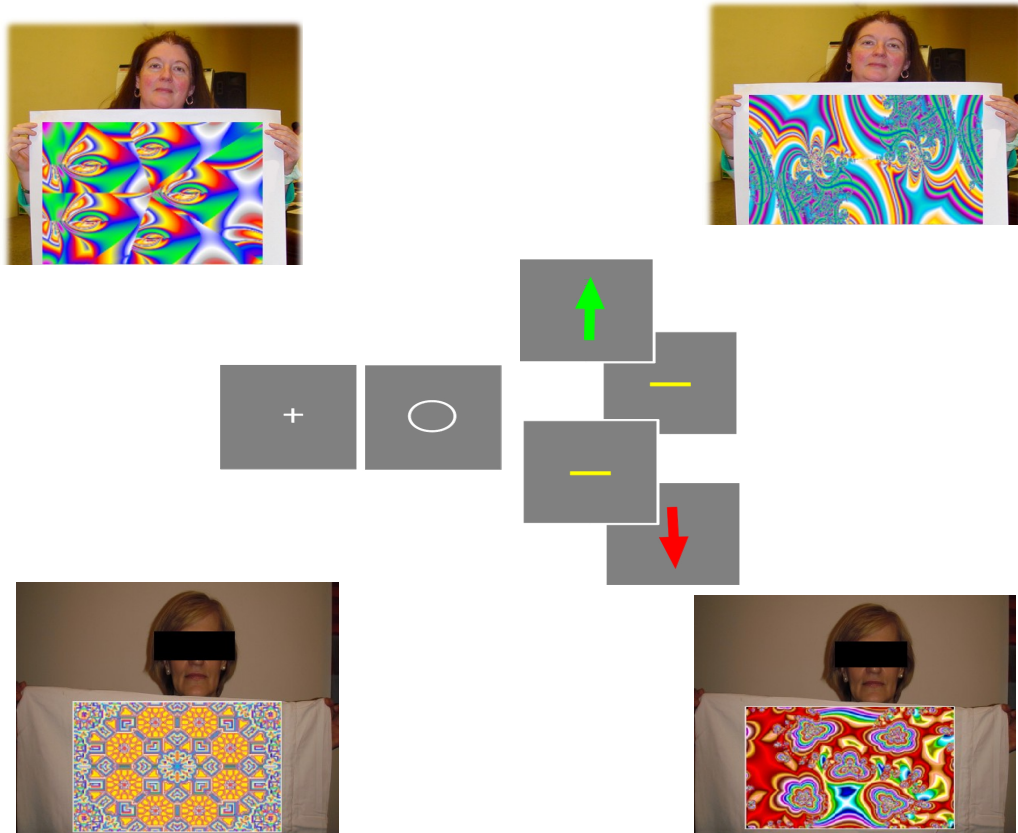
Janet Feigenbaum, PhD
Research Department of Clinical, Educational and Health Psychology
General Office, Room 436, 4th Floor
1-19 Torrington Place, London, WC1E 7HB

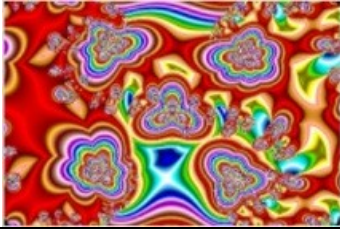

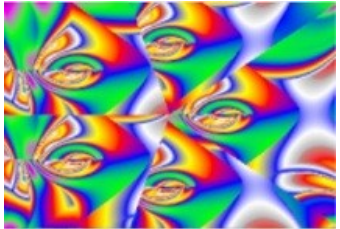
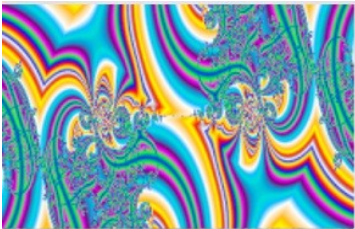
Tobias Nolte MD

Wellcome Trust Centre for Neuroimaging & Research Department of Clinical, Educational and Health Psychology
12 Queen Square
London
WC1N 3BG
Tobias.nolte@annafreud.org

Thank you very much for taking the time to read this information sheet.

Appendix D: Stimuli presented in the GNG paradigm



	Punishment	Reward
Go	Go to Avoid Punishment 	Go to Win 
No-go	No-go to Avoid Punishment 	No-go to Win 

Appendix E: A list of discussion topics for interactions

Positive personal	
	What is your achievement that you feel most proud of in life?
	What is the happiest memory from childhood?
	What do you want to achieve in next 5 years?
Positive non-personal	
	What is your favourite cuisine?
	What is your favourite mode of transportation?
	What is your favourite animal?
Negative personal	
	What was your scary experience?
	What was your sad experience?
	What was your most disappointing in the past?
Negative non-personal	
	What is your least favourite type of food?
	What is the sport that you enjoy the least?
	What is your least favourite subject at school?

Appendix F: Interaction scripts

Behavioral interaction

Now we move on to the next task. In this task, I will ask ____ (confederate) and _____ (participant) to discuss about given topics. There are two interactions in total. The selection of topics you will discuss is listed in the sheet (the experimenter hand over the sheet). You are free to choose any topic you like from the list. I will pick the name of the person who starts the discussion. (The experimenter opens the envelope and picks the name of the confederate). Okay, _____ (confederate) will start the discussion and _____ (participant) will be the next. The selection of the topic can be different or same as the other person, and you can take turns to talk. Please try to talk about each topic for a few minutes. You can respond to what the other person talks about, but try not to talk too long about only one topic. If you want to take notes, please feel free to do so. I will come back to the room after 15 minutes, so please continue the discussion until I come back. Each person should talk about minimum 3 topics in given time. Please indicate which topic you chose and the order of your choice in the sheet, so that you won't talk about the same topic.

Appendix G: Manipulations introduced in the behavioural interactions

- a) Inclusion: Now we will move on to the second part of the interaction task as both of you are happy to continue this task. At the end of the study, I will ask you about the second interaction between the two of you.

- b) Exclusion: We were supposed to start the second interaction task, but unfortunately the other participant does not want to do this any longer with you. So I will need you to complete the computer tasks that we had scheduled for after the second interaction task now, and then the study is over.

- c) Uncertainty: We were supposed to start the second interaction, but unfortunately the other participant left the study without giving me any reasons, this is his/her good right of course, but I'm not sure why this was, whether it perhaps had anything to do with what happened in the previous interaction task, or had to do with something else. So I will need you to complete the computer tasks that we had scheduled for after the second interaction task now, and then the study is over.

Appendix H: The modified RMET

2



Please choose one from Group 1 and choose as many words from Group 2 that best describe what the person in the picture is thinking or feeling.

Group 1

- Playful
- Comforting
- Irritated
- Bored

Group 2

- Playful
- Comforting
- Irritated
- Bored
- Sarcastic
- Uneasy
- Annoyed
- Shy
- Curious
- Alarmed
- Anxious
- Confused

Appendix I: Stimuli presented in the Cyberball paradigm

You can throw the ball by clicking on the name or picture of another player



Mariana



Kevin



Felicia

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