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Too Good to Be True?

Unpacking the Processing of Positive Social Information in Borderline Personality Disorder and Social Anxiety Disorder

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Anna Weinbrecht, M.Sc.

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Gutachter:in

Erstgutachterin: Prof. Dr. Babette Renneberg

Zweitgutachter: Prof. Dr. Stefan Röpke

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Summary

A hallmark feature of individuals with borderline personality disorder (BPD) and social anxiety disorder (SAD) are severe interpersonal problems. According to cognitive theories, interpersonal problems are caused by biases in the processing of social information. Indeed, previous research has shown that individuals with BPD and SAD tend to process social information in a biased manner. For example, compared to individuals without a mental disorder, individuals with BPD evaluate facial expressions more negatively, and individuals with SAD direct their attention faster towards negative facial expressions. However, little is known about the processing of *positive* social information in BPD and SAD, and no study has compared the processing of positive social information between both disorders so far. The aim of this thesis is to unpack biases in the processing of positive social information in BPD and SAD in order to understand the nature of their interpersonal problems in more detail. To this end, the three studies presented in this thesis compared the processing of two specific types of positive social information – *inclusive social situations* and *positive social feedback* – between individuals with BPD and SAD. In the long term, these insights on *shared* as well as *disorder-specific biases* will help to treat interpersonal problems in BPD and SAD more effectively.

Study 1 and study 2 examined whether individuals with BPD and SAD process inclusive social situations in a biased manner. Inclusive situations were operationalized as social inclusion (being equally included into a group) and social overinclusion (being overly included into a group). Structured clinical interviews were conducted to compare the processing of social inclusion and overinclusion among three groups: Participants with BPD (n = 29), participants with SAD (n = 28) and healthy controls (HCs; n = 28). All 85 participants played two rounds of the well-established Cyberball paradigm, an online ball-tossing game. In the first round, participants received the ball as often as their virtual co-players did (social inclusion); in the second round, participants received the ball more often than the co-players did (social

overinclusion). In addition to self-report data, electroencephalography data was assessed. This enabled the examination of event-related potentials associated with the processing of inclusive social situations. Event-related potentials of interest were the P2 amplitude, an indicator for reward processing, and the P3 amplitude, an indicator for expectancy violation.

Results of study 1 showed an enhanced P3 amplitude in participants with BPD and SAD irrespective of the condition (inclusion and overinclusion). This indicates that individuals with BPD and SAD tend to expect exclusion even if they find themselves in inclusive social situations. Self-report data revealed that participants with BPD and SAD emotionally responded more negatively to social inclusion, while their emotional response to social overinclusion mostly did not differ from HCs.

Results of study 2 showed that the transition from social inclusion to social overinclusion was accompanied by an enhanced P2 amplitude in participants with BPD and HCs, but not in participants with SAD. This indicates that an increase in the level of social inclusion is perceived as rewarding by individuals with BPD and individuals without a mental disorder, but not by individuals with SAD. However, the increase in the level of social inclusion did not affect self-reported positive emotions and it is necessary to further clarify the association between the P2 amplitude and reward processing.

Study 3 examined whether individuals with BPD and SAD fear positive social feedback. One hundred participants (three groups: 36 participants with BPD, 29 participants with SAD, 35 HCs) took part in an online assessment. Results of the Fear of Positive Evaluation Scale showed that individuals with BPD and individuals with SAD highly fear positive feedback. A hierarchical regression analysis further indicated that social anxiety explains high fear of positive feedback in BPD and SAD.

In summary, the findings of this thesis point towards *shared* as well as *disorder-specific* biases in the processing of positive social information in BPD and SAD. On the one hand,

individuals with BPD and individuals with SAD seem to process inclusive social situations in a biased manner. That is, they expect to be excluded even in inclusive social situations and emotionally respond to social inclusion more negatively. Furthermore, individuals with SAD and individuals with BPD seem to be afraid of positive social feedback. On the other hand, findings indicate that specifically individuals with SAD might not benefit from an increase in the level of social inclusion.

On a general level, the findings of this thesis indicate that both disorders are characterized by *negative social expectations* (i.e., the expectation to be excluded) and *maladaptive emotions* (i.e., fear of positive feedback) even in the processing of positive social information. This knowledge is important for clinical practice. For a start, therapists should be aware that their patients tend to process positive social information in a biased manner, which might contribute to their interpersonal problems.

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List of abbreviations

BDI-II	Beck Depression Inventory II
BFNE-R	Brief Fear of Negative Evaluation Scale–Revised
BPD	Borderline personality disorder
Cz	Central
DSM-IV	Diagnostic and Statistical Manual of Mental Disorders IV
DSM-5	Diagnostic and Statistical Manual of Mental Disorders 5
EEG	Electroencephalogram
EOG	Electrooculogram
ERP	Event-related potentials
fMRI	Functional magnetic resonance imaging
FPES	Fear of Positive Evaluation Scale
Fz	Frontal
HC	Healthy controls
NTQ	Need Threat Questionnaire
Pz	Parietal
QTF	Questionnaire of Thoughts and Feelings
RSQ	Rejection Sensitivity Questionnaire
SAD	Social anxiety disorder
SCID	Structured Clinical Interview (for DSM)
SPIN	Social Phobia Inventory

Chapter 1: Theoretical Background

1.1 Introduction

When thinking of borderline personality disorder (BPD), one might typically imagine someone who is impulsive and dramatic. Someone whose behavior is hard to predict because he or she switches from being charming and loving in one moment to being angry in the next. One might also think of self-harm and suicide attempts. Individuals suffering from BPD might describe the thought of being unacceptable and the constant fear of being abandoned by others. They might also describe the hazard of intense, shifting emotions that dictate daily life and, of course, their helplessness in handling these intense emotions.

When thinking of social anxiety disorder (SAD), one might imagine an extremely shy person, who seems a little off. One might also think of someone blushing or shaking when addressed by others or maybe someone who does not show up to a meeting or a get-together. Individuals suffering from SAD might describe the constant fear of embarrassing oneself in front of others and the persistent belief to be inferior to others. They might also describe the intense discomfort felt in many social situations, and, of course, the strong desire to avoid the next social encounter.

These stereotypical descriptions have to be treated with caution as both disorders, BPD and SAD, are heterogeneous disorders and can occur in many facets (e.g., Binelli et al., 2015; Hallquist & Pilkonis, 2012). However, the descriptions above illustrate an important issue: although both disorders appear to be quite different, both disorders are characterized by *intense interpersonal problems* which cause suffering.

What might cause these interpersonal problems? Most individuals tend to see the world through “rose-colored glasses”, which promotes well-being and prosocial behavior (e.g., Catalino & Fredrickson, 2011; Korn et al., 2012; Korn et al., 2014; McKay & Dennett, 2009; Nelson & Crick, 1999; Raila et al., 2015). For example, most people tend to be overly

optimistic: they underestimate the chances of getting a divorce, but overestimate the number of positive events they will encounter in an upcoming month (Sharot, 2011; Weinstein, 1980). Moreover, people direct their attention more easily to positive than to negative or neutral information (Pool et al., 2016) and can detect a happy face in the crowd faster than an angry one (Becker et al., 2011).

Individuals with BPD and SAD lack these “rose-colored glasses” and often put on “tinted glasses”. This means that individuals with BPD and SAD tend to process social information in a negative manner. For example, individuals with BPD tend to evaluate facial expressions negatively and seem to remember negative social information better than individuals without a mental disorder (Dyck et al., 2009; Niedtfeld et al., 2020). Individuals with SAD tend to interpret social scenarios in a negative manner (e.g., Everaert et al., 2018) and seem to direct their attention faster and more easily to negative facial expressions than individuals without a mental disorder (e.g., Grafton & MacLeod, 2016). These biases in the processing of negative social information contribute to interpersonal problems in BPD and SAD (Beck et al., 2015; Clark & Wells, 1995).

But do individuals with BPD and SAD also process *positive* social information in a biased manner? For example, do they overlook or misinterpret information like a compliment or a subtle smile? Simply put, do individuals with BPD and SAD experience positive social information as “too good to be true”? So far, most research has focused on the processing of negative social information and little is known about the processing of positive social information in BPD and SAD. This thesis tries to unpack biases in the processing of positive social information in BPD and SAD to improve our understanding of the nature of interpersonal problems of these disorders. To this end, this thesis is the first to compare the processing of positive social information between individuals with BPD and individuals with SAD. Hence, this thesis provides knowledge on *shared biases* as well as on *disorder-specific biases* in the

processing of positive social information. These insights can help tailor intervention for interpersonal problems in BPD and SAD more precisely and effectively.

This thesis focuses on two different types of positive social information*: inclusive social situations* as well as *positive social feedback.* In the next sub-chapter (1.2), I will describe BPD and SAD in more detail. Afterwards, I will summarize existing literature on the processing of social information in BPD and SAD (chapter 1.3) as well as literature on the processing of inclusive social situations (chapter 1.4) and positive social feedback (chapter 1.5) in BPD and SAD. Finally, in sub-chapter 1.6, I will present how each of the three studies of this thesis contributes to the overall research aim.

1.2 Borderline personality disorder and social anxiety disorder

The diagnostic criteria of BPD and SAD reflect that interpersonal problems are a hallmark feature of both disorders. According to the Diagnostic and Statistical Manual of Mental Disorders 5 (DSM-5)[1], BPD is characterized by "a pattern of unstable and intense interpersonal relationships characterized by extremes between idealization and devaluation" and by "frantic efforts to avoid real or imagined abandonment" (American Psychiatric Association, 2013, p. 663). SAD is characterized by a "marked fear or anxiety about one or more social situations in which the individual is exposed to possible scrutiny by others" so that social situations are avoided or endured with intense fear" (American Psychiatric Association, 2013, p. 202). Table 1 displays all diagnostic criteria of BPD and SAD.

[1] In the European health system, mental disorders are currently diagnosed according to the International Classification of Diseases for Mortality and Morbidity Statistics 10 (ICD-10; World Health Organization, 2004). Diagnostic criteria for BPD and SAD strongly overlap in both manuals, ICD-10 and DSM-5. In this thesis, the clinical samples were diagnosed according to DSM-5 criteria. Therefore, I only present DSM-5 criteria.

Table 1

Diagnostic criteria of borderline personality disorder and social anxiety disorder according to DSM-5

Borderline personality disorder	Social anxiety disorder
BPD is a pervasive pattern of instability in interpersonal relationships, self-image, and emotion, as well as marked impulsivity beginning by early adulthood and present in a variety of contexts, as indicated by five (or more) of the following: • Frantic efforts to avoid real or imagined abandonment. • A pattern of unstable and intense interpersonal relationships characterized by extremes between idealization and devaluation (also known as "splitting"). • Identity disturbance: Markedly or persistently unstable self-image or sense of self. • Impulsive behavior in at least two areas that are potentially self-damaging (e.g., spending, sex, substance abuse, reckless driving, binge eating). • Recurrent suicidal behavior, gestures, or threats, or self-harming behavior. • Emotional instability in reaction to day-to-day events (e.g., intense episodic sadness, irritability, or anxiety usually lasting a few hours and only rarely more than a few days). • Chronic feelings of emptiness. • Inappropriate, intense anger or difficulty controlling anger (e.g., frequent displays of temper, constant anger, recurrent physical fights). • Transient, stress-related paranoid ideation or severe dissociative symptoms.	A: Marked fear or anxiety about one or more social situations in which the individual is exposed to possible scrutiny by others. B: The individual fears that he or she will act in a way or show anxiety symptoms that will be negatively evaluated. C: The social situations almost always provoke fear or anxiety. D: The social situations are avoided or endured with intense fear. E: The fear or anxiety is out of proportion to the actual threat posed by the social situation and to the sociocultural context. F: The fear, anxiety, or avoidance is persistent, typically lasting for 6 months or more. G: The fear, anxiety, or avoidance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Note. This table does not display all notes that are presented in the DSM-5. Moreover, this table does not list diagnostic criteria H, I and J for social anxiety disorder (e.g., symptoms are not attributable to the physiological effects of a substance or another medical condition and are not better explained by another mental disorder).

The interpersonal problems have detrimental consequences in both disorders. In BPD, interpersonal problems are reflected in small social networks, which are characterized by high rates of conflict and criticism among partners (Lazarus & Cheavens, 2017). Moreover, interpersonal problems are mirrored in a lack of positive relationships in the social network, which would be characterized by trust and social support (Clifton et al., 2007). In SAD, interpersonal problems are also reflected in small social networks with little social support (Cramer et al., 2005). Moreover, interpersonal problems are mirrored in the fact that individuals with SAD are less likely to get married and have children (Wittchen et al., 2000). Interpersonal problems might also contribute to other impairments in BPD and SAD. For example, BPD is associated with personal suffering, lower quality of life, impaired occupational and social functioning as well as high usage of healthcare services (Gunderson et al., 2011; IsHak et al., 2013; Soeteman et al., 2008; Zanarini et al., 2009). Likewise, SAD is associated with lower quality of life as well as impairments in social and occupational functioning (National Collaborating Centre for Mental Health, 2013). For example, individuals with SAD are more likely to leave school early and obtain poor job qualifications (Van Ameringen et al., 2003).

How many people are affected by BPD and SAD and can symptoms be treated effectively? BPD affects 1.6% of the general population (median population lifetime prevalence; American Psychiatric Association, 2013) and 10-22% of the clinical population (Ellison et al., 2018). SAD has higher prevalence rates than BPD. It was estimated that 13% of US citizens (Kessler et al., 2012) and 7% of European citizens will suffer from SAD at some point during their life (Lecrubier et al., 2000). Psychological interventions for SAD have been shown to be effective (Acarturk et al., 2009; Barkowski et al., 2016; Powers et al., 2008) with effect sizes varying between d = 0.70 to 1.19 (see Boettcher et al., 2019). Psychological interventions for BPD have also been found to be effective (Choi-Kain et al., 2017; Stoffers et al., 2012), but effect sizes might be smaller (Cristea et al., 2017). Despite these effective

interventions, interpersonal problems in BPD and SAD seem to be a central and persistent feature of both disorders (e.g., Alden & Taylor, 2010; Choi-Kain et al., 2010; Southward & Cheavens, 2018; Videler et al., 2019). This is especially devastating as interpersonal problems also impede the improvement of other symptoms in BPD and SAD (Powers et al., 2013; Wiltink et al., 2016).

To sum up, BPD and SAD are debilitating mental disorders that are associated with severe interpersonal problems. There are effective psychological interventions available, but interpersonal problems remain a central and persistent feature of the disorders. To improve interventions and effectively treat interpersonal problems in BPD and SAD, we need to understand the nature of these interpersonal problems in more detail. In this context, researchers examined how individuals with BPD and SAD process social information.

1.3 Processing of social information in BPD and SAD

The way individuals perceive and interpret social information in their environment crucially influences the way they behave in social situations. Accordingly, cognitive theories state that biases in the processing of social information contribute to interpersonal problems in BPD and SAD (Beck et al., 2015; Clark & Wells, 1995). In this context, researchers revealed that individuals with BPD and SAD process *negative, ambiguous or neutral* social information in a more negative manner than individuals without a mental disorder do (e.g., Daros et al., 2013; Dyck et al., 2009; Vestergaard et al., 2019). How individuals with BPD and SAD process *positive* social information has been studied less extensively. Yet it is crucial to understand how individuals with SAD and BPD process positive social information, because this will help understand the nature of their interpersonal problems in more detail. To this end, the aim of the thesis is to extend our knowledge on the processing of positive social information in BPD and SAD. The following sub-chapters introduce the model I use for conceptualizing social

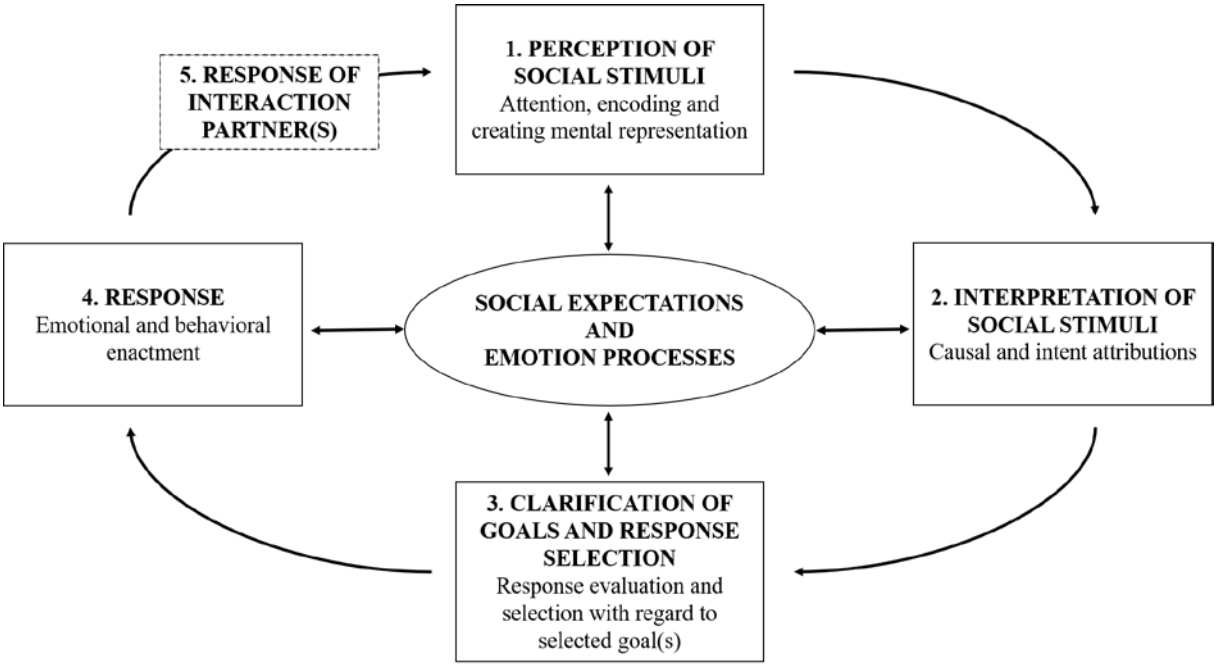
information processing in general (chapter 1.3.1) before turning to a review of the literature on the processing of positive social information in BPD and SAD (chapter 1.3.2).

1.3.1 Social information processing model

According to the social information processing model by Crick and Dodge (1994), social information processing starts when an individual perceives and interprets social information (step 1 and 2 in the model, see Figure 1). That is, an individual attends to specific social information (e.g., an individual enters a party and sees a person with raised corners of the mouth) and then encodes and interprets this social information in a specific way (e.g., "this person is smiling at me and wants to welcome me"). In a third and fourth step, the individual reflects specific goals for the social situation (e.g., having a conversation partner during the evening) before selecting a behavioral response (e.g., smiling back).

Figure 1

Simplified version of the social information processing model by Crick and Dodge (1994)



Note. Model was adapted in reference to Lemerise and Arsenio (2000) as well as Gutz (2016).

All these steps are influenced by the individual's core beliefs and social expectations (e.g., the expectation to be welcome). Importantly, Lemerise and Arsenio (2000) extended the model by highlighting that emotion processes also influence each of these steps. That is, the emotion[2] we are in, for example, being anxious or happy, before and during a social situation crucially influences the way we perceive, interpret and respond to social information (e.g., Everaert et al., 2018; Van Kleef, 2009). Figure 1 displays a simplified version of the information processing model, which integrates the influence of emotion processes. It is important to note that Crick and Dodge (1994) assumed that the information processing steps occur rapidly, often simultaneously and include feedback loops.

1.3.2 Processing of positive social information in BPD and SAD

In this sub-chapter, I will summarize findings of previous studies on the processing of positive social information in BPD and SAD in reference to the social information processing model by Crick and Dodge (1994).

Previous studies on the processing of positive social information indicated that individuals with BPD and SAD *perceive*, *interpret* and *respond* to positive social information in a biased manner (step 1, 2 and 4 in the social information processing model). For example, participants with BPD recognized less self-relevant positive words and interpreted positive self-relevant words more negatively than healthy controls (HCs; Auerbach et al., 2016; Winter et al., 2015). Moreover, participants with BPD recognized fewer positive facial expressions than HCs (Fenske et al., 2015). For participants with SAD, it was shown that they turn their attention away from positive information such as friendly facial expressions or positive social-evaluative words (Pishyar et al., 2004; Taylor et al., 2011). Moreover, participants with SAD devalued

[2] Note that the distinction between emotion and affect is discussed controversially. In this thesis, affect refers to a neurophysiological state, which can be described by valence and arousal, while emotion refers to the classification of this neurophysiological state such as feeling anxious or happy (Russell, 2009).

positive experiences in a post-event process (e.g., Cody & Teachman, 2010; Laposa et al., 2010). Previous research also showed that individuals with BPD and SAD experience less positive affect in their daily life compared to HCs (e.g., Ebner-Priemer et al., 2007; Harp et al., 2019; Kashdan et al., 2013) and report to down-regulate positive emotions (Beblo et al., 2013; Eisner et al., 2009; Farmer & Kashdan, 2012). This is in line with findings that individuals with BPD and SAD respond with less positive emotions to positive social information (Budnick et al., 2015; Pfaltz et al., 2015; Reichenberger et al., 2017; Reichenberger et al., 2019). For example, compared to HCs, participants with BPD and SAD responded with less positive emotions to appreciating sentences like “one can really count on you!” (Reichenberger et al., 2017; Reichenberger et al., 2019).

Previous studies also showed that individuals with BPD and individuals with SAD are characterized by *negative social expectations* (Arntz et al., 2011; Heimberg et al., 2010; Roepke et al., 2012). For example, individuals with BPD and SAD are characterized by the expectation to be socially rejected (Cavicchioli & Maffei, 2019; Gu et al., 2020; Staebler, Helbing, et al., 2011). Available evidence supports the notion that these negative social expectations influence the processing of positive social information. An experimental study showed that being included into a group violated the expectations of individuals with BPD (Gutz et al., 2015) and signs of social acceptance violated the expectations of individuals with SAD (Harrewijn et al., 2018). However, little is known about *maladaptive emotion processes* which might influence the processing of positive social information in BPD and SAD.

To sum up, previous evidence indicates that individuals with BPD and SAD share biases in the processing of positive social information. That is, individuals with BPD and SAD *perceive*, *interpret* and *respond* to positive social information in a negative manner. Moreover, individuals with BPD and SAD are characterized by the expectation to be excluded, which seems to influence how individuals with BPD and SAD process positive social information

(e.g., signs of affiliation). However, available evidence resembles a hotchpotch and no comprehensive model for the processing of specific types of positive information (e.g., positive facial expressions, signs of affiliation) or processes (e.g., perception, expectation) is available. Moreover, little is known about maladaptive emotion processes, which might influence the processing of positive social information. Also, and most importantly, no study so far has directly compared the processing of positive social information between individuals with BPD and SAD.

This thesis aims at closing these gaps to extend our knowledge on how individuals with BPD and SAD process positive social information. To this end, this thesis directly compares the processing of positive social information between individuals with BPD and SAD. This comparison will help clarify which biases are shared between both disorders and which biases occur disorder-specific. In the long term, this knowledge can help tailor interventions for interpersonal problems more effectively. Two different types of positive social information will be focused on. These will be introduced in the following sub-chapters: *inclusive social situations* (chapter 1.4) and *positive social feedback* (chapter 1.5).

1.4 Processing of inclusive social situations in BPD and SAD

Given the importance of the human need to affiliate with others (Baumeister & Leary, 1995; Hill, 1987), processing of affiliative signals might be especially relevant for the development and maintenance of interpersonal problems in BPD and SAD. Therefore, this thesis examines the processing of *inclusive social situations* – that is being included and overincluded into a group.

Next, I will present research on the processing of inclusive social situations and its neural correlates in healthy participants as well as the method used to examine this

phenomenon: the cyberball paradigm (chapter 1.4.1). Afterwards, I will present available research on biased processing of inclusive social situations in BPD and SAD (chapter 1.4.2).

1.4.1 Studying inclusive social situations and its neural correlates in HCs

Cyberball is an experimental paradigm which offers the possibility to study the processing of inclusive social situations (Williams & Jarvis, 2006). Cyberball is a virtual ball-tossing game (see Figure 2, left column), in which participants believe they are tossing the ball back and forth with two other co-players. These co-players are in fact computer-generated players (Williams et al., 2000; Williams & Jarvis, 2006). Researchers can manipulate the percentage of ball tosses a participant receives and thereby induce different levels of social inclusion[3]. That is, *social exclusion* (participant gets the ball almost never from the co-players), *social inclusion* (participant gets the ball as often as the co-players) or *social overinclusion* (participant gets the ball almost all the time from the co-players).

Cyberball was developed on the basis of Williams`s Need Threat Model (1997). According to this model, social exclusion immediately threatens fundamental social needs and leads to negative emotions and feelings of ostracism (Williams, 2007). This immediate, painful reaction to social exclusion was observed in many Cyberball studies (for a meta-analysis see Hartgerink et al., 2015). In contrast, inclusive situations – that is social inclusion and social overinclusion - did not threaten fundamental social needs or induce negative emotions and ostracism in healthy participants (e.g., Niedeggen et al., 2014; Sacco et al., 2014; Simard & Dandeneau, 2018; Williams et al., 2000). Social overinclusion even led to a *positive emotional response*. For example, healthy participants reported enhanced enjoyment as well as reduced threat to social needs and reduced negative emotions in the overinclusion condition (Kawamichi et al., 2016; Niedeggen et al., 2014). Interestingly, this positive emotional response was

[3] Please note that, in study 1, I refer to the level of social participation. Both, level of social participation and level of social inclusion, can be used interchangeably.

observed when HCs experienced an increase in the level of social inclusion: they were first included and afterwards overincluded (Kawamichi et al., 2016; Niedeggen et al., 2014). The mere experience of social overinclusion did not lead to a positive emotional response in HCs (Kawamoto et al., 2012; van Beest & Williams, 2006).

Hence, self-report data of previous Cyberball studies indicated that an increase in the level of social inclusion leads to a positive emotional response in individuals without a mental disorder. However, self-report data can be biased by response tendencies, recall effects or social desirability (Althubaiti, 2016). The combination of Cyberball with neuoscientific techniques bypasses these problems and allows to examine the processing of inclusive social situations in an "objective manner". Neural correlates of inclusive situations have been mostly examined with functional magnetic resonance imaging (fMRI) or electroencephalogram (EEG; Wang et al., 2017). EEG enables the assessment of event-related potentials (ERPs). ERPs are electrical potentials of the brain that are generated by a specific event, for example, ball reception during the Cyberball game (Luck, 2012). ERPs[4] have been used fruitfully in clinical psychology to get a direct measure of brain activity in mental disorders and examine cognitive and affective processes with a very high temporal solution (Hajcak et al., 2019).

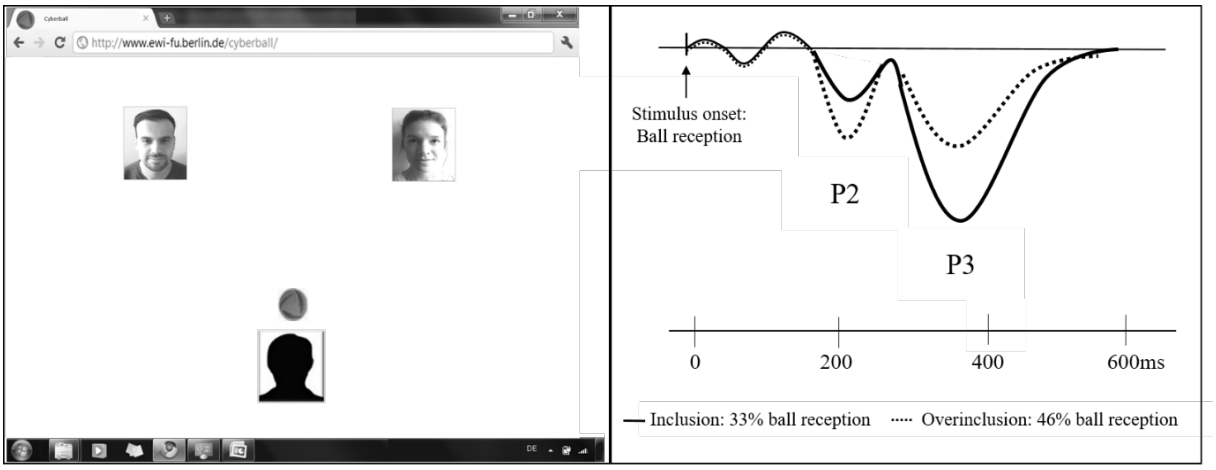
Which ERP components are associated with the processing of inclusive social situations? Most EEG studies compared social inclusion to social exclusion (for a review see Wang et al., 2017). Only one EEG study compared the processing of social inclusion to the processing of social overinclusion (Niedeggen et al., 2014). This study showed that the

[4] ERPs are characterized by a distinct waveform, which is either a positive (P) or a negative (N) voltage deflection, which reaches a peak at a specific time point after stimulus onset. The nomenclature of most ERPs describes this waveform (Luck, 2012). For instance, a positive deflection with a peak around 200ms after stimulus onset is called P200 or P2. It is also important to define the location of the highest peak of the scalp-recoded ERP: frontal, central or parietal.

transition from social inclusion to overinclusion is associated with a larger P2 amplitude and a reduced P3 amplitude (see Figure 2, right column).

Figure 2

Display of the Cyberball paradigm (left column) and ERP correlates of the inclusion and overinclusion condition (right column)



Note. The left column shows the display seen by the participant for the situation that the participant received the ball during the Cyberball game. The right column represents an example of grand-averaged ERPs for the inclusion condition (solid line) and the overinclusion condition (dotted line). Note that this figure does not differentiate between frontal, central and parietal position.

What do these changes in the P3 and P2 amplitude indicate? The P3 amplitude is well examined in the context of the Cyberall game and correlates reversely with the frequency of the ball reception (Duncan-Johnson & Donchin, 1977; Polich, 2007). Numerous Cyberball studies provided evidence that the P3 component is an indicator for expectancy violation (e.g., Gutz et al., 2011; Gutz et al., 2015; Kiat et al., 2017; Schuck et al., 2018; Weschke & Niedeggen, 2015). This means that the P3 component indicates whether or not reveiving the ball is a violation of the individual's expectations. A theoretical interpretation for this is provided by the context-updating model (Donchin & Coles, 1988; Polich, 2007). According to the context-updating model, players have a mental representation of their inclusionary status. The P3 amplitude indicates the comparison of the current stimulus to this mental representation. If the current stimulus (e.g., ball reception) is inconsistent with this mental representation (e.g., expectation

to be excluded), the representation needs to be updated. This update of the own mental representation induces a larger P3 amplitude (P3 effect). Weschke and Niedeggen (2015) directly examined the idea that expectancy violation induces the P3 effect. Half of the participants played an inclusion and afterwards an exclusion condition. The other half of the participants played an inclusion and afterwards a modified inclusion condition, in which the number of co-players was increased. Thus, the authors were able to separate the probability to receive the ball from the expectancy to receive the ball. Results confirmed that the expectancy, not the probability, to receive the ball predicted changes in the P3 amplitude (Weschke & Niedeggen, 2015). Hence, the P3 amplitude offers the possibility to measure violations of social expectations regarding one's own inclusionary status in the context of the Cyberball paradigm.

The P2 component, on the other hand, seems to reflect attentional (e.g., McPartland et al., 2011) or reward processes (e.g., Weschke & Niedeggen, 2013), but interpretations vary among studies (e.g., Sreekrishnan et al., 2014). Interestingly, in the study by Niedeggen et al. (2014), changes in the P2 component depended on the order of conditions: only the transition from social inclusion to overinclusion induced a larger P2 amplitude (P2 effect), not the transition from social overinclusion to inclusion. Such an order effect was not observed for the P3 amplitude. The authors interpreted this as evidence that the P2 component is related to social reward processing, because only an increase in the level of social inclusion is associated with a larger P2 amplitude, not a decrease. Further support for this notion stems from an fMRI study (Kawamichi et al., 2016). In this study, the transition from social inclusion to overinclusion was associated with an activation of the ventral striatum, which is part of the reward system (Delgado, 2007).

To sum up, the EEG compatible version of the Cyberball paradigm provides the opportunity to study the processing of inclusive social situations and its neural correlates. In this context, the P3 component indicates the violation of expectations regarding the own

inclusionary status and the P2 component indicates reward processing. Importantly, existing research showed that healthy participants report a positive emotional response due to an increase in the level of social inclusion and process this increase as rewarding.

1.4.2 Biases in the processing of inclusive social situations in BPD and SAD

I now turn to previous Cyberball research on biases in the processing of inclusive social situations in BPD and SAD. I will summarize this research in the context of the social information processing model by Crick and Dodge (1994). As most research compared the processing of social inclusion to social exclusion, I will also discuss the processing of social exclusion.

What do we know about the processing of inclusive social situations in BPD? A recent review summarized 14 Cyberball studies on social inclusion and exclusion (Cavicchioli & Maffei, 2019). Results indicated that individuals with BPD *perceive* social inclusion and exclusion in a biased manner and show a more negative *emotional response* to social inclusion and exclusion (step 1 and 4 in the information processing model). Interestingly, these biases seem to be more pronounced in the inclusion than in the exclusion condition (Cavicchioli & Maffei, 2019). In line with this, participants with BPD felt more excluded (Domsalla et al., 2014; Gutz et al., 2015) and estimated to have received the ball less frequently (Gutz et al., 2015; Staebler, Renneberg, et al., 2011) than HCs only in the inclusion condition, but not in the exclusion condition. One Cyberball study examined biases in the *expectancy* to be excluded relying on the P3 component (Gutz et al., 2015). In this study, participants with BPD, compared to HCs, had a larger P3 amplitude in the inclusion, but not in the exclusion condition. The authors concluded that individuals with BPD expect to be excluded, and social inclusion violates this expectation. Only one Cyberball study examined biases in the processing of individuals with BPD to social overinclusion (De Panfilis et al., 2015). This between-subject study examined the emotional response of participants with BPD to social ex-, in- and

overinclusion. Results revealed that biases in the emotional response to social overinclusion are less pronounced than to social inclusion (De Panfilis et al., 2015).

What do we know about biases in the processing of inclusive social situations in SAD? Previous research indicated that individuals with SAD do not differ in their processing of social inclusion from HCs (Gutz et al., 2015; Heeren et al., 2017; Zadro et al., 2006). However, highly socially anxious participants differed in their *prolonged reaction to social exclusion* from low socially anxious participants (Gilboa-Schechtman et al., 2014; Oaten et al., 2008; Zadro et al., 2006). For example, highly socially anxious participants needed longer to recover from exclusion and had problems regulating themselves after having been excluded (Oaten et al., 2008; Zadro et al., 2006). Moreover, highly socially anxious participants reacted to social exclusion with less prosocial behavior than HCs, which might lead to a reduced chance to reconnect after having been socially excluded (Mallott et al., 2009). One Cyberball study examined the reaction of highly socially anxious individuals to social overinclusion (Gilboa-Schechtman et al., 2014). In this between-subject study, women high in social anxiety reported more negative emotions and threat to their self-esteem in the overinclusion compared to the inclusion condition. However, these differences were not found for men and did not affect all outcomes (Gilboa-Schechtman et al., 2014).

To sum up, previous research on the processing of inclusive social situations in BPD and SAD focused on the processing of social inclusion. Results indicated that individuals with BPD *perceive*, *expect* and *emotionally respond* to social inclusion in a biased manner (see Cavicchioli & Maffei, 2019 for a review), while individuals with SAD do not process social inclusion in a biased manner. Little is known about the processing of social overinclusion and no study has combined the assessment of self-report with neuroscientific techniques to examine the processing of inclusive social situations in BPD and SAD. The first two studies of this thesis

aim at closing these gaps. I now turn to a further form of positive social information: positive social feedback.

1.5 Processing of positive social feedback in BPD and SAD

Next to the need to affiliate with others, humans need recognition and appreciation (Grawe, 1998; Maslow, 1943). Hence, the processing of positive social feedback might also be important for the development and maintenance of interpersonal problems in BPD and SAD. Therefore, this thesis examines how individuals with BPD and SAD process *positive social feedback*. Positive social feedback can be defined as a favorable evaluation of oneself, which is expressed by another person (Lundgren, 2004). This means positive feedback refers to all kinds of positive statements a person receives about oneself such as a compliment.

What do we know about biases in the processing of positive social feedback in BPD and SAD? There is growing evidence that individuals with SAD and individuals with BPD process positive social feedback in a biased manner. For example, several studies suggested that individuals with BPD and SAD are impaired in the ability to integrate positive social feedback: Individuals with SAD (Koban et al., 2017) and individuals with BPD (Korn et al., 2016) integrated negative social feedback to a greater extent than positive social feedback[5]. Also, individuals with BPD and SAD seem to *respond* with less positive emotions to positive social feedback compared to HCs (see 1.3.2; Reichenberger et al., 2017; Reichenberger et al., 2019). Moreover, in SAD, biases in the processing of positive social feedback might also apply to the memory of this information: individuals with SAD remembered a positive social feedback to be less positive than it had been one week after they had received it (Glazier & Alden, 2019).

[5] HCs showed the opposite updating bias: They integrated positive self-relevant social feedback to a greater extent than negative self-relevant social feedback (Korn et al., 2012). This is in line with the tendency of individuals without a mental disorder to see the world through “rose-colored glasses” (see introduction).

One experimental study examined the interplay between the processing of positive social feedback and social expectations in BPD (Liebke et al., 2018). Results showed that participants with BPD did not change their *negative expectation* even after repeated positive feedback.

All in all, previous evidence indicates that individuals with BPD *and* SAD process positive social feedback in a biased manner. For example, persistent negative expectations and a negative emotional response seem to characterize individuals with BPD and SAD in the processing of positive feedback. However, little is known about *emotion processes* which might influence how individuals with BPD and SAD process positive social feedback. Therefore, study 3 focused on maladaptive emotions associated with the processing of positive social feedback – using the example of fear of positive evaluation.

There is robust evidence that individuals with SAD fear positive evaluation. More precisely, individuals with SAD seem to be characterized not only by fear of negative but also fear of positive evaluation (Reichenberger & Blechert, 2018; Weeks, Heimberg, Rodebaugh, et al., 2008). Fear of positive evaluation can be defined as fearing others' favorable social feedback. The research group of Weeks and colleagues (e.g., 2008; 2012) conducted most research on fear of positive evaluation in SAD. Weeks (2015) argued that individuals with SAD try to avoid positive evaluation because this might lead to competition of social attention with others or pressure to perform well in the future. For example, an individual with SAD might not only be afraid of performing poorly, but also of performing very well at a presentation, because performing very well might make other students jealous or set high expectations for the next semester. Importantly, fear of positive evaluation seems to be associated with interpersonal problems, such as avoidance tendencies and social isolation (Dryman et al., 2016). This is in line with findings that fear of positive evaluation is specifically correlated with social interaction anxiety (Kocijan & Harris, 2016). All in all, after over ten years of research on fear of positive evaluation, it has become clear that fear of positive evaluation is an important

component of social anxiety and some researchers even suggested including fear of positive evaluation as a diagnostic criteria for SAD (Skocic et al., 2015). However, it is not known whether individuals with BPD also fear positive evaluation and how fear of positive evaluation influences the processing of positive social feedback.

To sum up, there is growing evidence that individuals with BPD and SAD process positive social feedback in a biased manner. Fear of a positive evaluation is characteristic of individuals with SAD and might influence biased processing of positive social information as a *maladaptive emotion process*. Despite the importance of fear of positive evaluation for SAD and the association of fear of positive evaluation with interpersonal problems, research on fear of positive evaluation in BPD is lacking. The third study of this thesis aims at closing this gap.

1.6 Research Aims

The overall aim of this thesis is to unpack biases in the processing of positive social information in BPD and SAD. To this end, this thesis comprises three studies which examined how individuals with BPD and SAD process inclusive social situations as well as positive social feedback. In this sub-chapter, I will discuss the overall research aim in more detail, before presenting all three studies and each of their research aims.

A hallmark feature of individuals with BPD and SAD are severe interpersonal problems (chapter 1.2). According to cognitive theories, biases in the processing of social information contribute to interpersonal problems in both disorders (Beck et al., 2015; Clark & Wells, 1995). Until now, most research has focused on the processing of *negative* social information and little is known about the processing of *positive* social information in BPD and SAD (chapter 1.3). Importantly, no study so far has systematically compared how individuals with BPD and SAD process positive social information, although both disorders are characterized by interpersonal problems. This thesis aims at providing knowledge on *shared* as well as *disorder-specific biases*

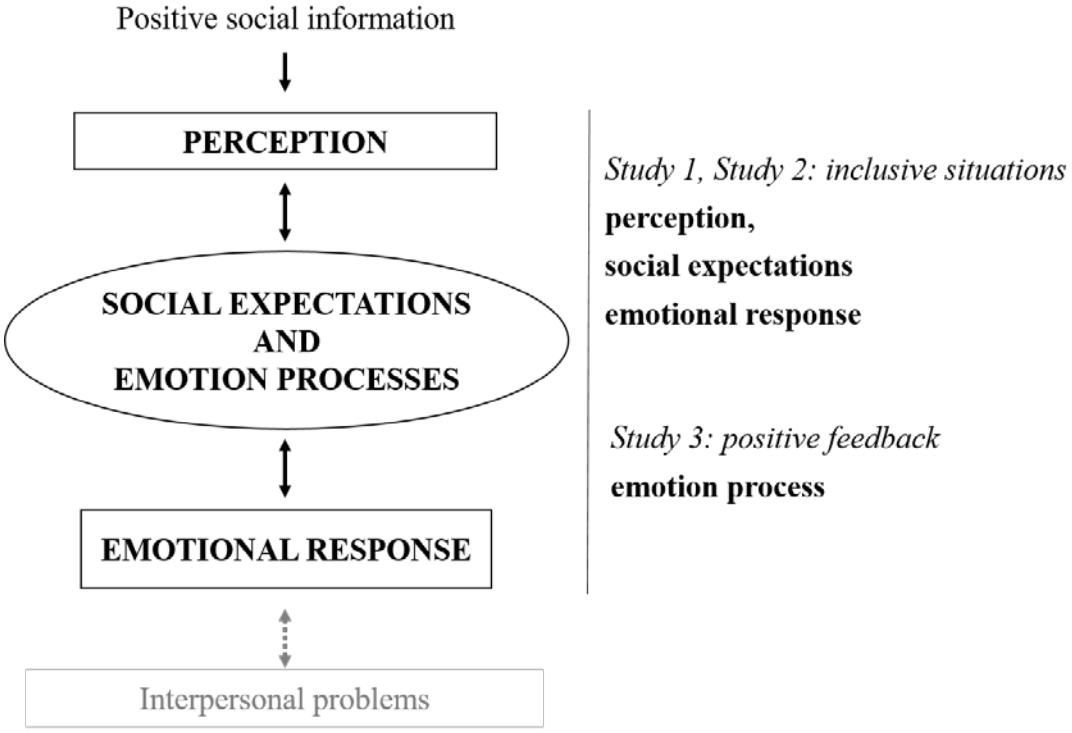
in the processing of positive social information in BPD and SAD. This knowledge will help to understand the nature of interpersonal problems in BPD and SAD in more detail. In the long term, this will help tailor interventions for interpersonal problems in BPD and SAD more precisely and effectively.

The three studies at the core of this dissertation examined the processing of two different types of positive social information: *inclusive social situations* and *positive social feedback*. To examine the processing of these two types of positive social information in BPD and SAD, I use a framework based on an integrated version of the social information processing model (Crick & Dodge, 1994; Lemerise & Arsenio, 2000). Figure 3 illustrates this framework as well as the processes this thesis focuses on. Study 1 and study 2 examined the *perception* of and *emotional response* to inclusive social situations as well as associated *expectancy processes*. Study 3 examined maladaptive *emotion processes* in the context of positive social feedback.

Next, I will present these three studies in more detail. All three studies build on data, which was collected in an online assessment and at an EEG lab of Freie Universität Berlin from June 2015 to January 2017. Participants underwent a structural clinical interview and were grouped according to their diagnoses (BPD, SAD, HCs).

Figure 3

Framework of this thesis for examining the processing of positive social information in social anxiety disorder and borderline personality disorder



Note. This framework is based on the social information processing model by Crick and Dodge (1994). The left column displays the framework of this thesis in general. The right column specifies which type of positive social information (in italics) and which processes (bold) the studies focused on.

STUDY 1 and STUDY 2: Given that affiliation with other people is a central human need (Baumeister & Leary, 1995; Hill, 1987; Leary, 2010), study 1 and study 2 focused on the processing of affiliative signals. More precisely, study 1 and 2 examined the processing of inclusive situations – social inclusion and overinclusion – in BPD and SAD. Previous research showed that individuals with BPD, but not individuals with SAD, processed social inclusion in a biased manner (e.g., Gutz et al., 2015). Moreover, previous research showed that healthy participants responded with more positive and less negative emotions to an increase in the level of social inclusion and that healthy participants processed this transition from social inclusion to social overinclusion as rewarding (Kawamichi et al., 2016; Niedeggen et al., 2014). However, previous research focused on the comparision of social inclusion to social exlusion and mostly

relied on self-report data which can be biased (Althubaiti, 2016). No study so far has examined the processing of social overinclusion in BPD and SAD as well as its neural correlates. Study 1 and 2 aimed at closing these gaps. Study 1 focused on the *perception* of and *emotional response* to inclusive social situations as well as *expectancy processes,* while study 2 focused on effects of an *increase in the level of social inclusion*. To examine research question 1 and 2, participants took part in a laboratory EEG assessment and played the online ball-tossing game Cyberball (see Which ERP components are associated with the processing of inclusive social situations? Most EEG studies compared social inclusion to social exclusion (for a review see Wang et al., 2017). Only one EEG study compared the processing of social inclusion to the processing of social overinclusion (Niedeggen et al., 2014). This study showed that the transition from social inclusion to overinclusion is associated with a larger P2 amplitude and a reduced P3 amplitude (see Figure 2, left column). All 85 participants played the inclusion before they played the overinclusion condition. Perception was operationalized by the estimated ball reception and emotional response was operationalized by self-reported negative and positive emotions as well as by threat to social needs and ostracism. The main outcome variables of study 1 and 2 were the P3 amplitude and P2 amplitude. While the P3 amplitude was used as an indicator for expectancy processes concerning the level of social inclusion, the P2 amplitude was used as an indicator for reward processing.

STUDY 3: Previous research indicated that individuals with SAD and individuals with BPD process positive social feedback in a biased manner (Budnick et al., 2015; Cody & Teachman, 2010; Glazier & Alden, 2019; Korn et al., 2016; Liebke et al., 2018; Reichenberger et al., 2017; Reichenberger et al., 2019; Reichenberger et al., 2015). In this context, study 3 focused on *emotion processes* which might play a role in the processing of positive social feedback: fear of positive evaluation. Fear of positive evaluation seems to be a hallmark feature of SAD and seems to be associated with interpersonal problems (Reichenberger & Blechert,

2018)1.3. However, fear of positive evaluation has not been examined in BPD yet, although fear of positive evaluation might be important for interpersonal problems in BPD as well (Reichenberger & Blechert, 2018). To examine whether individuals with BPD fear positive evaluation and which factors are associated with fear of positive evaluation in BPD, 100 participants took part in an online assessment and completed the Fear of Positive Evaluation Scale (Weeks, Heimberg, & Rodebaugh, 2008).

The three studies will be presented in the following three chapters:

- Study 1 and study 2 examined whether individuals with BPD and individuals with SAD process inclusive social situations in a biased manner.

  Study 1 focused on biases in the e*xpectation, perception of* and *emotional response to* social in- and overinclusion (chapter 2). Study 2 focused on biases in the processing of an increase in the level of social inclusion (chapter 3).
- Study 3 examined whether individuals with BPD fear positive evaluation and which factors are associated with fear of positive evaluation in BPD (chapter 4). Hence, study 3 focused on *emotion processes* which might influence the processing of positive social feedback.

Chapter 2: Study 1

FEELING EXCLUDED NO MATTER WHAT? BIAS IN THE PROCESSING OF SOCIAL PARTICIPATION IN BORDERLINE PERSONALITY DISORDER

The following paper was published in NeuroImage: Clinical

Weinbrecht, A., Niedeggen, M., Roepke, S., & Renneberg, B. (2018). Feeling excluded no matter what? Bias in the processing of social participation in borderline personality disorder. *NeuroImage: Clinical*, *19*, 343-350. https://doi.org/10.1016/j.nicl.2018.04.031

Note that the formatting was adjusted to be consistent throughout the thesis.

Abstract

Background: Patients with borderline personality disorder (BPD) feel ostracized even when they are included. This might be due to a biased processing of social participation in BPD. We examined if patients with BPD also process social overinclusion in a biased manner, i.e., if they feel ostracized even when the degree of social participation is increased. *Methods*: An EEG-compatible version of Cyberball was used to investigate the effects of inclusion and overinclusion (33% vs. 45% ball reception) on perceived ostracism, need threat and P3 amplitude, an EEG indicator for expectancy violation. Twenty-nine patients with BPD, 28 patients with Social Anxiety Disorder (SAD) and 28 healthy controls (HC) participated. *Results*: The P3 amplitude was enhanced for patients with BPD and SAD compared to HCs independent of condition. Both patient groups reported more perceived ostracism relative to HCs in the inclusion but not in the overinclusion condition. Only patients with BPD reported stronger need threat in both conditions. *Conclusions:* The EEG results imply that being socially included violates the expectations of patients with BPD, irrespective of the actual degree of social participation. However, when overincluded, patients with BPD no longer feel ostracized. Except for need threat, patients with SAD might show a comparable bias in the processing of social participation as patients with BPD.

Keywords: borderline personality disorder, social anxiety disorder, social cognition, social participation, overinclusion, event-related brain potentials

2.1 Introduction

Long-lasting interpersonal problems are a hallmark feature of borderline personality disorder (BPD) (American Psychiatric Association, 2013). The Cognitive Theory of Personality Disorders postulates that these interpersonal problems are related to maladaptive schemas, which lead to biases in the processing of social information (Beck et al., 2015). For example, an individual with BPD typically thinks, “I am unacceptable and others will abandon me” (Arntz, 2004; Renneberg et al., 2005). Due to this maladaptive schema and the associated processing bias, the individual may incorrectly interpret that he/she is being excluded from a group. This, in turn, may lead to interpersonal problems, for example., impulsively insulting others, which might foster actual exclusion from social groups.

Previous research showed a characteristic bias of social information processing in BPD (e.g., Chechko et al., 2016; Niedtfeld et al., 2016) and supported the idea that the biases are related to interpersonal problems in BPD (e.g., Herbort et al., 2016; Whalley et al., 2015). Examples for the characteristic bias are that patients tend to perceive ambiguous facial expressions in a negative way (see Domes et al., 2009 for a review) and quickly feel rejected (e.g., Arntz et al., 2011; Staebler et al., 2011a). In this study, we focused on a possible bias in the processing of social participation. Most research examining social participation has relied on the Cyberball paradigm (Williams and Jarvis, 2006). Cyberball is a virtual ball-tossing game, in which the participant believes that he/she is tossing the ball with two other co-players, which are, in fact, computer-generated. Cyberball can be reliably used to induce different degrees of social participation depending on the percentage of ball tosses received (Hartgerink et al., 2015); that is, social exclusion, inclusion, and overinclusion.

According to the Cognitive Theory of Personality Disorders (Beck et al., 2015), the aforementioned biases in the processing of social information should be most prominent in ambiguous social situations. Being included is an ambiguous situation and leaves space for

biased interpretations. Being excluded and being overincluded, by contrast, mean getting the ball almost never or almost all of the time during the Cyberball game, and cannot be seen as ambiguous. Following this line of thought, we argue that individuals with BPD should process social inclusion in a biased manner, but should show no bias in the processing of social exclusion and overinclusion.

2.1.1 Bias in the processing of social inclusion in BPD

Results of previous Cyberball studies indicated that patients with BPD process social inclusion in a biased manner: Compared to healthy controls, they estimated that the co-players tossed the ball less often to them than to the other player (Gutz et al., 2015; Renneberg et al., 2012; Staebler et al., 2011b), and they reported feeling more ostracized (Domsalla et al., 2014; Gutz et al., 2015).

Gutz and colleagues (2015) used an EEG-compatible version of the Cyberball game to examine an EEG correlate associated with the processing of social participation, the event-related potential P3. The P3 amplitude has mostly been studied in the oddball paradigm and peaks parietally approximately 350 ms after stimulus onset. It is inversely related to the subjective target probability (see Polich, 2007 for a review). In the social context of the Cyberball paradigm, the P3 amplitude additionally depends on the participant's prior expectation of her/ his social involvement: The P3 amplitude increases if the participant's expectation of her/ his degree of social participation is violated (Gutz et al., 2011; Weschke and Niedeggen, 2015). Consequently, in healthy participants, the P3 amplitude is reduced when they are included compared to when they are excluded (Gutz et al., 2011). Moreover, Niedeggen and colleagues (2014) showed that the P3 amplitude is enhanced when healthy participants are included compared to overincluded, indicating that overinclusion does not violate the expectations of healthy controls. The expectancy-based effect on the P3 amplitude has been confirmed in numerous Cyberball studies (Hajcak et al., 2005; Kiat et al., 2017; Niedeggen et

al., 2017). For example, individuals who expected to be excluded because of a stereotyped cue (Kiat et al., 2017) or an inferior position (Niedeggen et al., 2017) showed a reduced P3 amplitude when they got the ball.

The study by Gutz and colleagues (2015) provided a clinical validation of the expectancy-based account: BPD patients showed an increased P3 amplitude compared to healthy controls in the inclusion condition. This suggests that patients with BPD expect to be excluded, and being socially included violates this expectation. Interestingly, patients with Social Anxiety Disorder (SAD) did not show an increased P3 amplitude compared to healthy controls. This might indicate that specifically patients with BPD experience social inclusion as an expectancy violation. However, this non-significant finding has to be interpreted with caution, because the lack of a statistically significant difference between BPD and SAD patients might also be due to low statistical power.

2.1.2 Bias in the processing of social exclusion and overinclusion in BPD

Gutz and colleagues (2015) compared the processing of social inclusion to the processing of social exclusion in BPD in a within-subject design: All participants were first included and then excluded. Interestingly, differences between BPD patients and healthy controls were mostly found for the processing of inclusion, and not for the processing of exclusion. This is in line with previous Cyberball studies (Domsalla et al., 2014; Staebler et al., 2011b) and supports the assumption that biases in the processing of social participation are most prominent in ambiguous social situations.

To our knowledge, only one study has looked at overinclusion in patients with BPD (De Panfilis et al., 2015). De Panfilis and colleagues (2015) compared self-reported reactions of patients with BPD to overinclusion, inclusion and exclusion in a between-subject design. The results indicated that patients with BPD and healthy controls do not differ in their emotional reaction to overinclusion: Patients with BPD did not report greater levels of rejection-related

negative emotions than healthy controls when overincluded. Again, however, the lack of a difference between BPD patients and HCs might also be due to low statistical power. In contrast to the assumption that differences between patients with BPD and HCs should be most prominent in the ambiguous situation of social inclusion, patients with BPD felt less connected to their co-players in all three conditions (irrespective of the degree of social participation).

To summarize, there is sound evidence that patients with BPD process social participation in a biased manner. However, most previous studies focused on social inclusion and exclusion (Domsalla et al., 2014; Gutz et al., 2015; Renneberg et al., 2012; Staebler et al., 2011b). To our knowledge, this is the first study that applies not only self-report measures but also EEG correlates to assess the processing of social inclusion and overinclusion in BPD. More precisely, we examined the effects of inclusion and overinclusion on the P3 complex. The P3 offers an objective and continuous assessment of social expectancy violation. Moreover, EEG data present the possibility to gain a high temporal resolution, and enable a distinction between specific stages of social information processing (Bartholow and Dickter, 2007).

The primary aim was to examine whether the biased processing in BPD is specific to the ambiguous situation of social inclusion or whether patients with BPD also process overinclusion in a biased manner. Relying on the Cognitive Theory of Personality Disorders (Beck et al., 2015), we hypothesized that the P3 complex, our main outcome variable, would be enhanced for patients with BPD in the inclusion condition but not in the overinclusion condition (interaction effect) compared to HCs. A further aim of this study was to replicate the findings of Gutz and colleagues (2015) that patients with BPD process social inclusion in a biased manner. We hypothesized that the P3 complex would be enhanced in patients with BPD compared to HCs in the inclusion condition. In line with the study by Gutz and colleagues (2015), we included SAD patients as a clinical control group in order to examine whether the bias is disorder-specific.

2.2 Material and methods

2.2.1 Participants

Overall, 85 participants took part in the study: 28 healthy controls (HCs), 28 SAD patients and 29 BPD patients. All HCs, 11 BPD patients and 12 SAD patients were recruited via media advertisements. The remaining 18 BPD patients were recruited at the Department of Psychiatry (Charité Berlin) and the remaining 16 SAD patients were recruited at two university outpatient departments in Berlin. Outpatients and HCs were reimbursed for their participation (30 €). The 18 BPD inpatients from the Department of Psychiatry did not receive financial compensation for their participation. The study was approved by the ethics committee of the Freie Universität Berlin (ID 97 II /2016). Participation was voluntary.

Table 2 displays sociodemographic data of the sample as well as comorbid diagnoses of the BPD and SAD groups. All three groups were matched according to age, IQ and gender (all $p < 0.6$). Inclusion criteria for all participants were age between 18 and 40 years and the absence of mental retardation, epilepsy or organic brain disease. Exclusion criteria for the patients were any psychotic disorder, current substance abuse / dependency and intake of psychotropic medication within the last 4 weeks (intake of an antidepressant without any changes in dosage in the last 4 weeks was allowed).

Table 2

Sociodemographic characteristics and comorbid DSM-IV diagnoses

	Descriptive statistics	HC (n = 28)	SAD (n = 28)	BPD (n = 29)
Gender: female	*n* (%)	24 (85)	22 (79)	25 (86)
Family status: in a relationship	*n* (%)	15 (54)	18 (64)	11 (38)
Antidepressant medication	*n* (%)	0	7 (25)	10 (35)
Age	*M* (*SD*)	28.21 (5.81)	28.86 (6.21)	27.86 (5)
IQ	*M* (*SD*)	113.71 (11.47)	114.79 (13.54)	111.47 (12.68)
Number comorbid diagnoses	*M* (*SD*)	0	1.21 (1.17)	1.69 (1.17)
MDE current (mild)	*n* (%)	0	6 (21)	2 (7)
MDE lifetime	*n* (%)	0	8 (29)	14 (48)
Any anxiety disorder except SAD	*n* (%)	0	5 (18)	16 (55)
SAD	*n* (%)	0	28 (100)	1 (4)
AVPD	*n* (%)	0	7 (25)	0
BPD	*n* (%)	0	0	29 (100)
Any other PD	*n* (%)	0	1 (4)	2 (7)

Note. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder; MDE = major depressive episode, AVPD = avoidant personality disorder, PD = personality disorder.

We confirmed DSM-IV diagnoses using the German versions (Wittchen et al., 1997) of the SCID I and SCID II (First *et al.*, 1997). All interviewers were clinical psychologists, who were trained and supervised in the application of the SCID I and SCID II. Participants recruited via media advertisements were initially screened by telephone, before undergoing the clinical interview in the lab directly before the experiment. Participants recruited at the Department of Psychiatry or the university outpatient departments were interviewed at the respective treatment site.

2.2.2 Material

Experimental Manipulation of Social Inclusion and Overinclusion: Cyberball

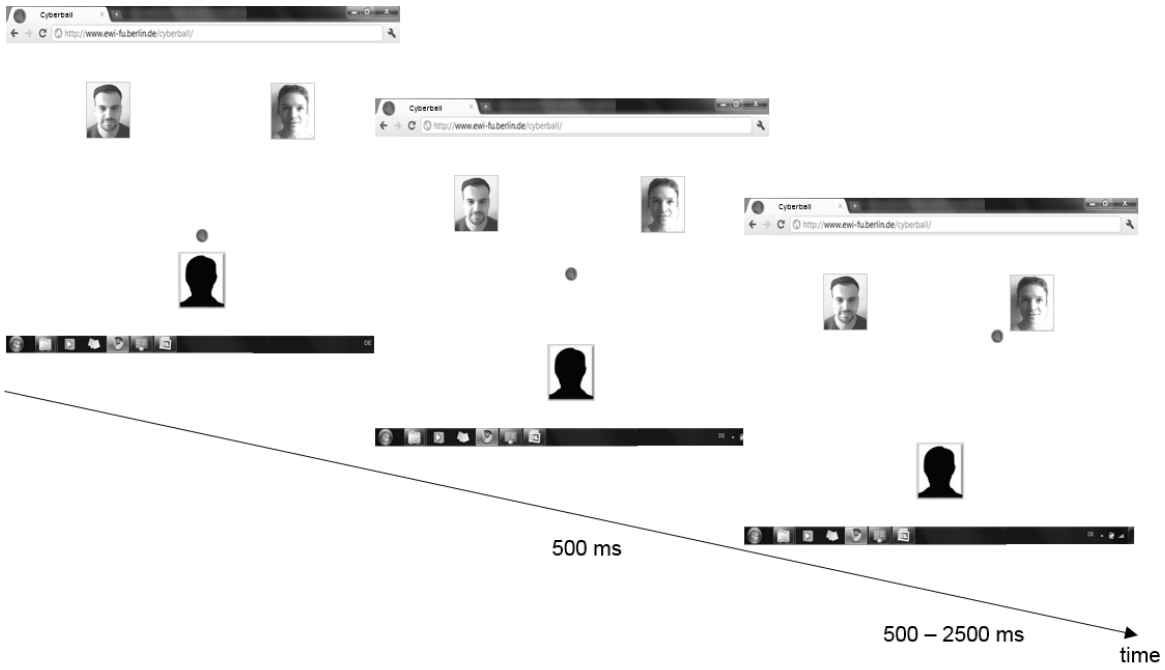
To manipulate social inclusion and overinclusion, we used the EEG-compatible version (Gutz et al., 2011) of Cyberball (Williams and Jarvis, 2006). The participants believed that they were tossing a ball with two other co-players via an Internet connection (see Figure 4). However, their co-players were computer-generated. After the experiment, participants had to rate the extent to which they believed in the cover story ("I played with the co-players via the Internet"; 1 = *not at all* to 5 = *very much*). Results indicated that participants tended to believe the cover story (M = 2.67, SD = 1.16).

To induce inclusion, each player received the ball equally often (i.e. the participant got the ball in 33% of the throws). To induce overinclusion, the participant received the ball in 45% of all throws (i.e. the co-players rarely passed the ball to each other). The participants were told a cover story that the study was aiming to examine visual mentalization capabilities, and were thus instructed to mentally visualize the ball-tossing procedure throughout the Cyberball game. After completing the experiment, all participants were debriefed.

The participant sat in front of a computer screen (7° x 7° at a viewing distance of 140cm) on which the participant and the putatively connected co-players were displayed. Figure 4 depicts, by way of example, the sequence of a participant passing the ball to the co-player on the top right. The Cyberball game was programmed in MATLAB (R2012a, The MathWorks, Inc.).

Figure 4

Display and sequence of the Cyberball game



Note. The display imitated an Internet screen including the photos of two putatively human co-players. A sequence of the participant passing the ball to the right co-player is shown by way of example. To indicate the participant's ball possession, the ball appeared in front of the avatar. The participant decided to pass the ball to the right co-player by pressing a corresponding button. The ball was then displayed at a central position for 500 ms. To indicate the co-player's ball possession, the ball appeared next to the co-player for 500–2500 ms (to support the cover story of playing with humans).

Self-Report Measures: Need Threat Questionnaire (NTQ; Williams et al., 2000)

We assessed need threat via the German version of the NTQ (Grzyb, 2005). The NTQ assesses four fundamental social needs that are threatened by social exclusion (Williams, 2007): belonging (e.g., "I felt disconnected"), self-esteem (e.g., "I felt good about myself"), meaningful existence (e.g., "I felt invisible"), and control (e.g., "I felt powerful"). For all four fundamental needs, three items have to be answered on a 5-point Likert scale (ranging from 1 = *not at all* to 5 = *very much*). Like Gutz and colleagues (2015), we used the sum score of all four subscales as a measure of total need threat (range 4 - 20). Higher values indicate more need threat (items were reverse-coded if necessary).

Moreover, the NTQ also assesses ostracism intensity, negative mood (e.g., “I felt sad”; range 1 - 4) and the estimated percentage of ball tosses received (“Assuming that the ball should be thrown to each person equally (33%), what percentage of the throws was directed to you?”). Ostracism intensity was measured by creating the sum score of two items (“I was ignored” and “I was excluded”), which were answered on the 5-point Likert scale described above (range 2 - 10).

2.2.3 Procedure

Prior to the lab session, participants completed a web-based battery of questionnaires. At the lab, electrodes were attached and participants completed further questionnaires, specifically the LPS-4 to measure IQ (Horn, 1962) and the Vividness of Visual Imagery Questionnaire to support the cover story (Marks, 1973). Before the EEG recording started, participants received instructions on the Cyberball game and completed a training trial. The Cyberball game consisted of two blocks: First, all participants were included (33% ball possession) and then all participants were overincluded (45% ball possession). Each block consisted of 200 throws and lasted for about 7 min. At the end of the Cyberball game, participants completed the NTQ for both conditions and were debriefed. At the beginning and end of the lab session, participants signed informed consent forms.

This study was part of a larger project. Here, we only report the part relevant to a bias in the processing of social participation. Results referring to the hypothesis of impaired positivity in SAD will be reported elsewhere.

2.2.4 EEG recording and data preparation

We recorded EEG data at frontal, central and parietal positions with Ag/AgCl electrodes. We embedded the electrodes in an electrode cap (EASYCAP, Herrsching, Germany) and filled them with electrode cream (Abralyt 2000, EASYCAP). Electrodes attached at the earlobes served as the reference (impedance for all EEG electrodes: < 10 kOhm). In addition, vertical

and horizontal electrooculogram were recorded to control for ocular artifacts (impedance < 20 kOhm). EEG data were band-pass filtered online (0.1 – 200 Hz) and sampled at 500 Hz.

"Brain Vision Analyzer" was used to analyze EEG data offline (Version 2, Brain Products GmbH, Gilching, Germany). Two discrete events on the screen were of interest: (1) participant receives the ball ("self"), (2) co-player receives the ball from the other co-player ("others"). For each ball reception event, a trigger was provided and EEG was segmented accordingly (-200 to 600 ms epoch length). These EEG segments were baseline corrected (-150 to 50 ms) and filtered (0.3 – 30 Hz and 50 Hz). Subsequently, EEG segments with muscular or ocular artifacts as well as high Alpha activity were removed manually. A minimum number of 15 segments per event "self inclusion" and per event "self overinclusion" was defined to ensure the stable averaging of noise. Ten participants (4 BPD, 1 SAD, 5 HC) had to be excluded due to an insufficient number of segments, leading to the sample of 85 participants described above. We were not able to consider the events "others" in the analysis because of the reduced number of EEG segments in the overinclusion condition (co-players rarely passed the ball to each other in this condition). We matched the number of segments for the event "self overinclusion" to the number of segments for the event "self inclusion" to obtain comparable signal-to-noise ratios.

Averages for each participant were calculated, separately for condition (inclusion, overinclusion), ball possession (self, others) and electrode position (frontal, central, parietal). Subsequently, grand averages were calculated for the three groups (HC, SAD, BPD) and the P3 time window (310 - 390 ms). The time window was determined based on the grand averages of the event-related potentials.

2.2.5 Statistical analysis

We used mixed ANOVAs to examine group differences in the processing of social inclusion and overinclusion. Dependent variables were a) need threat, b) ostracism intensity, c) estimated percentage of ball tosses received and d) P3 amplitudes. Independent variables were

group (between-subject factor with 3 levels: HC, SAD, BPD) and *condition* (within-subject factor with 2 levels: inclusion, overinclusion). Significant effects of the ANOVA were further examined in Bonferroni-corrected post-hoc analyses. Pearson`s *r* was used as a measure of effect size (small effect: $r = 0.10$; medium effect: $r = 0.30$; large effect: $r = 0.50$).

Analyses were conducted using R version 3.4.0 (R Core Team, 2014) and an alpha level of 0.05 was applied. To calculate the ANOVAs, we relied on a multi-level approach using the nlme package of R (Pinheiro et al., 2017). This enabled us to consider dependency in the data resulting from the repeated measurement (Field et al., 2012).

2.3 Results

Table 3 depicts means and standard deviations for all outcome variables as well as the results of the mixed ANOVAs.

2.3.1 EEG data: P3 complex

In a pre-analysis, we checked the effect of the electrode position on the P3 amplitude ($\chi^2(2) = 199.58$, $p < 0.001$). A contrast analysis revealed that, as expected, the P3 amplitude was more pronounced at the parietal compared to the frontal / central position ($t(338) = 13.82$ $p < 0.001$, $r = 0.60$). Means and *SDs* of the P3 amplitude at all electrode positions can be found in Table A.1 in the appendix.

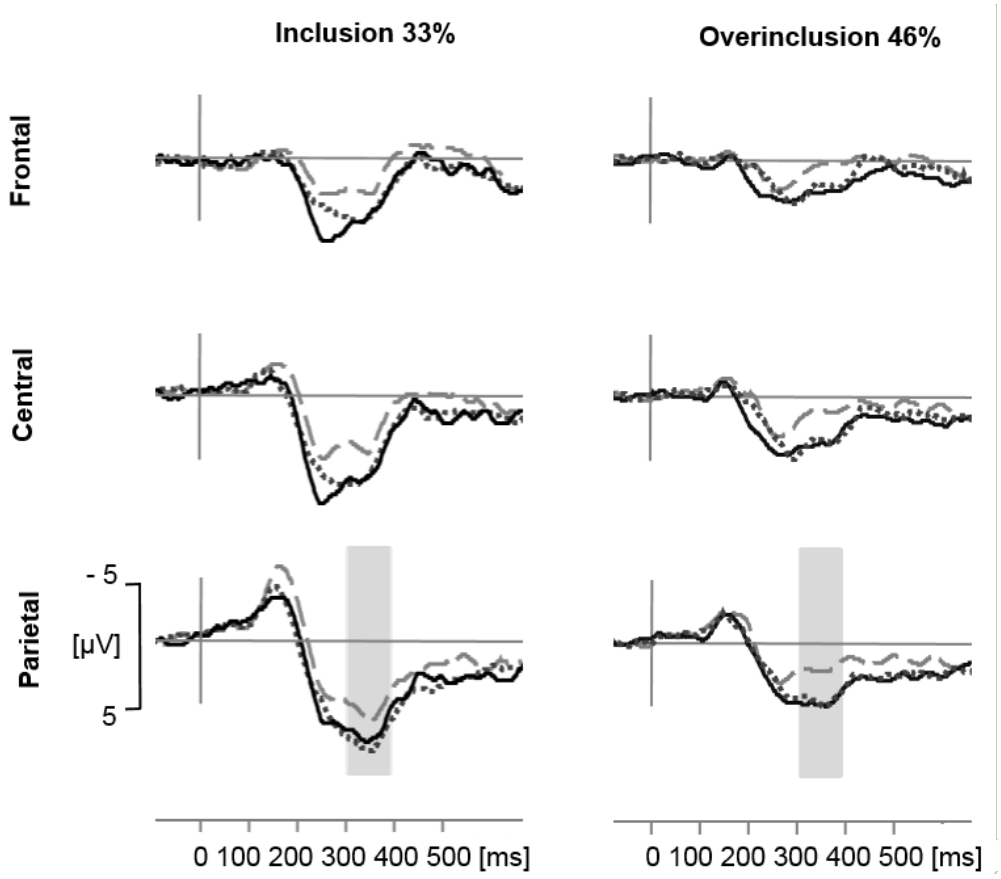
Mean amplitudes of the parietal position indicated that the P3 was more pronounced in the inclusion compared to the overinclusion condition and that SAD patients and BPD patients showed a more pronounced P3 amplitude than HCs (see Figure 5). Both main effects were confirmed in the statistical analysis (see Table 3). The interaction effect between condition and group on the P3 amplitude was not significant (see Table 3). Post-hoc analyses for the main effect of group revealed that the P3 was more pronounced in both clinical groups compared to

healthy controls (HC vs. SAD: p = 0.009, r = 0.32; HC vs. BPD: p = 0.001, r = 0.37). The clinical groups did not differ in their P3 amplitude (SAD vs. BPD: p = 1, r = 0.06).

Figure 5 depicts grand-averaged event-related potentials for each group at each position in both conditions.

Figure 5

Grand averages of event-related potentials for both conditions (inclusion with 33% ball possession and overinclusion with 45% ball possession) and each group at three electrode positions (frontal, central, parietal)



Note. Dashed grey line = healthy controls, solid line = borderline personality disorder, dotted line = social anxiety disorder. Amplitude differences between the conditions and groups were examined for the P3 complex (310 – 390ms) at parietal position.

2.3.2 Self-report data

The interaction effect of condition and group on ostracism intensity was significant (see Table 3). Bonferroni-corrected post-hoc analyses revealed that both clinical groups reported

stronger feelings of ostracism than HCs in the inclusion condition (HC vs. SAD: $p = 0.001$, $r = 0.38$; HC vs. BPD: $p = 0.006$, $r = 0.33$). SAD patients and BPD patients did not differ in ostracism intensity in the inclusion condition (SAD vs. BPD: $p = 1$, $r = 0.05$). In the overinclusion condition, the three groups did not differ in their reported ostracism intensity (all $p = 1$).

The interaction effect of condition and group on negative mood was significant (see Table 3). The Bonferroni-corrected post-hoc analyses revealed that both clinical groups reported more negative mood than HCs in the inclusion condition, while the clinical groups did not differ (HC vs. SAD: $p = 0.01$, $r = 0.32$; HC vs. BPD: $p = 0.04$, $r = 0.27$; SAD vs. BPD: $p = 1$, $r = 0.06$). In the overinclusion condition, the groups did not differ in terms of negative mood (all $p < 0.15$).

The interaction effect of condition and group on need threat was significant (see Table 3). Post-hoc analyses revealed that both clinical groups reported higher need threat than HCs in the inclusion condition (HC vs. SAD: $p < 0.001$, $r = 0.47$; HC vs. BPD: $p < 0.001$, $r = 0.45$; SAD vs. BPD: $p = 1$, $r = 0.03$). In the overinclusion condition, only BPD patients reported higher need threat than HCs (HC vs. SAD: $p = 0.80$, $r = 0.12$; HC vs. BPD: $p = 0.005$, $r = 0.34$; SAD vs. BPD: $p = 0.10$, $r = 0.23$).

Participants estimated having received the ball more often in the overinclusion than in the inclusion condition (see Table 3). Thus, our experimental manipulation was successful. There was no significant effect of group and no significant interaction effect between group and condition on the estimated percentage of received ball tosses (all $p > 0.17$).

Table 3

Means / SDs of the outcome variables and results of the mixed ANOVAs

					Mixed ANOVAs						
		HC	SAD	BPD	Condition			Group		Condition x Group	
		M (*SD*)	*M* (*SD*)	*M* (*SD*)	$\chi^2(1)$	*p*	*r*	$\chi^2(2)$	*p*	$\chi^2(2)$	*p*
P3 Pz	Inclusion	5.78 (3.53)	7.62 (3.19)	8.40 (4.39)	**41.03**	**< 0.001**	**0.62**	**14.56**	**< 0.001**	2.03	0.36
	Overinclusion	2.48 (2.79)	5.60 (3.17)	5.68 (3.47)							
Throws % [b]	Inclusion	31.25 (12.15)	29.43 (12.42)	26.61 (6.90)	**46.04**	**< 0.001**	**0.65**	3.50	0.17	0.45	0.80
	Overinclusion	46.11 (16.98)	46.43 (20.92)	40.46 (13.09)							
Ostracism [a]	Inclusion	2.93 (1.36)	4.54 (2.47)	4.33 (2.17)	32.92	< 0.001	0.59	6.64	0.04	**9.56**	**0.008**
	Overinclusion	2.39 (1.37)	2.32 (0.72)	2.48 (1.12)							
Neg. Mood	Inclusion	1.20 (0.46)	1.93 (1.18)	1.81 (0.97)	1.90	0.17	0.16	8.22	0.02	**6.33**	**0.04**
	Overinclusion	1.30 (0.86)	1.38 (0.78)	1.78 (0.97)							
Need Threat	Inclusion	9.33 (1.64)	12.7 (2.97)	12.5 (2.53)	26.91	< 0.001	0.54	27.24	< 0.001	**8.38**	**0.02**
	Overinclusion	8.3 (2.5)	9.07 (2.93)	10.55 (2.8)							

Note. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder. Throws % = estimated percentage of ball tosses received, Neg. Mood = negative mood. Fz = frontal, Cz = central, Pz = parietal. Significant interaction effects are indicated in bold; if there was no significant interaction effect, significant main effects are indicated in bold instead.

[a] two persons with BPD with missing data: *n*(BPD) = 27

[b] one person with BPD with missing data: *n*(BPD) = 28

2.3.3 Further analysis of the inclusion condition

Finally, we examined whether we can replicate the results of Gutz et al. (2015) that patients with BPD process social inclusion in a biased manner. To test our hypothesis that the P3 complex would be enhanced in patients with BPD compared to HCs in the inclusion condition, we performed a one-way ANOVA with the independent variable *group* (3 levels: HC, SAD, BPD).

First, we checked the effect of the electrode position on the P3 amplitude in the inclusion condition ($\chi^2(2) = 116.65$, $p < 0.001$). As expected, the contrast analysis revealed that the P3 was more pronounced at the parietal compared to the frontal / central position ($t(168) = 10.48$, $p < 0.001$, $r = 0.63$).

In the inclusion condition, the P3 amplitude was more pronounced in BPD patients compared to HCs (see Table 3 for means and *SD*). The one-way ANOVA showed that group had a significant effect on the P3 amplitude in the inclusion condition ($\chi^2(2) = 7.25$, $p = 0.03$). Bonferroni-corrected post-hoc analyses revealed that the P3 amplitude was only significantly more pronounced in BPD patients compared to HCs ($p = 0.03$, $r = 0.28$). Differences in the P3 amplitude between SAD patients and HC and differences between SAD patients and BPD patients were not significant (all $p > 0.21$).

2.4 Discussion

The current study confirmed, with an EEG correlate, that individuals with BPD show a bias in the processing of social inclusion: Relative to healthy controls, individuals with BPD showed an enhanced P3 complex when included. Our results further imply that this bias is not specific to the situation of social inclusion: Even when overincluded, patients with BPD showed

an enhanced P3 complex and felt a threat to their fundamental social needs relative to healthy controls.

The primary aim of this study was to examine whether patients with BPD show a biased processing only in the ambiguous situation of social inclusion or also when overincluded. When overincluded, BPD patients reported as much negative mood and ostracism as did healthy controls. However, the threat to social needs and the P3 amplitude were generally higher in BPD patients relative to HCs. These results are in line with the only previous study that looked at overinclusion in BPD (De Panfilis et al., 2015), which found that BPD patients experienced comparable levels of negative mood to HCs when overincluded, but felt less connected to the co-player irrespective of their current degree of social participation.

As part of the study, we replicated the finding of Gutz and colleagues (2015) that patients with BPD process social inclusion in a biased manner: When included, the P3 complex was enhanced in BPD patients compared to the non-clinical control group. This indicates that individuals with BPD expect to be excluded a priori, and social inclusion violates this expectation. Accordingly, this also specifies that the bias is already present in an initial stage of social information processing (Bartholow and Dickter, 2007). We also found evidence that patients with BPD *experience* (subjectively report) social inclusion in a biased manner. When included, patients with BPD reported more negative mood as well as ostracism and experienced more need threat compared to healthy controls.

It is necessary to specify our hypothesis that the bias in BPD is most prominent in the more ambiguous situation of social inclusion (Beck et al., 2015). On the one hand, our results imply that patients with BPD are able to recognize when they are extremely included, and consequently no longer feel excluded or sad / angry (which is in line with our hypothesis). On the other hand, in BPD, underlying constructs such as the need to belong might always be threatened in social interactions and social inclusion might always be unexpected (indicated by

the enhanced P3 amplitude), irrespective of the current degree of social participation. This also fits with the finding of Gutz and colleagues (2015) that patients with BPD experienced more negative mood and ostracism than healthy controls only when included, but reported higher threat to their social needs when included *and* when excluded. Moreover, this finding corresponds with the negative thinking patterns in BPD (Roepke et al., 2012; Staebler et al., 2011a).

The generally enhanced P3 amplitude could be interpreted in the light of difficulties of BPD patients to adjust their prior expectations (e.g., “I will always be excluded”) to the current situation (e.g., being included). Hence, the P3 amplitude might be a possibility to measure the persistence of expectation, which seems to be a core feature of mental disorders (Rief et al., 2015). It should be noted that besides the violation of a priori social expectation, other mechanisms might have led to the generally enhanced P3 complex in BPD. For example, using a social feedback task, van der Veen and colleagues (2014) showed that the P3 amplitude is larger in response to positive outcomes. This is in line with studies linking the P3 amplitude to the motivational significance of stimuli (see Nieuwenhuis et al., 2005 for a review). Hence, the P3 amplitude might have been elevated in both patient groups, because social stimuli might be more significant to them. However, this cannot explain why the P3 amplitude is less increased in the overinclusion compared to the inclusion condition.

In contrast to the results of Gutz and colleagues (2015), all groups were quite accurate in their estimation of received ball tosses. This is in line with other studies reporting that BPD patients showed no difficulties to accurately estimate how often they received the ball (e.g., Domsalla et al., 2014). However, in some Cyberball studies, BPD patients generally underestimated how often they received the ball (Renneberg et al., 2012) or underestimated it only in the inclusion condition (Staebler et al., 2011b). Future research should target this

heterogeneity of findings by identifying possible moderator variables (e.g., arousal, study design).

Patients with SAD reported more need threat, ostracism intensity and negative mood compared to HCs in the inclusion but not in the overinclusion condition. Moreover, patients with SAD showed a generally enhanced P3 amplitude compared to HCs. Thus, our results further imply that individuals with SAD show deviations in the processing of social participation as well. This extends previous findings that individuals high in social anxiety need longer to recover from social exclusion than individuals low in social anxiety (Heeren et al., 2017; Oaten et al., 2008); and that women high in social anxiety benefit less from social overinclusion than women low in social anxiety (Gilboa-Schechtman et al., 2014). However, when focusing on the inclusion condition (one-way ANOVA) differences between patients with SAD and HCs were non-significant. Thus, results have to be interpreted with caution. Moreover, in the inclusion condition, the P3 complex was not elevated in SAD compared to BPD patients. This contrasts with the results of Gutz and colleagues (2015). One possible explanation is that our SAD sample was more clinically impaired on the Social Phobia Inventory (Connor et al., 2000) than the SAD sample in the study by Gutz et al. (2015). Indeed, an exploratory analysis (see appendix Table A.2) revealed that our SAD sample had a significantly higher symptom load than SAD patients in the study by Gutz et al. (2015).

2.4.1 Limitations

Several limitations of the study design need to be mentioned: First, we had no exclusion condition and were thus only able to confirm the results of Gutz and colleagues (2015) for the inclusion condition. Second, we did not control for possible order effects (all participants were first included and then overincluded). However, in a previous study, the order of conditions had no effect on the P3 amplitude (Niedeggen et al., 2014). Third, in order to preserve the cover story, self-report questionnaires were applied after both conditions had been completed (and not

directly after each condition). The slightly divergent results between self-report and EEG data might be explained by the different timing of assessments, as the EEG data were assessed continuously during the Cyberball game.

2.4.2 Conclusion

This is the first study to examine the processing of social inclusion and overinclusion in BPD and in SAD relying on EEG data. Our study replicated previous findings that individuals with BPD process and experience social inclusion in a biased manner. Moreover, we provided evidence that individuals with BPD are well able to recognize when they are extremely included, and consequently no longer feel ostracized. However, they seem to expect to be excluded and feel a threat to their social needs irrespective of their current degree of social participation.

In BPD, these deviations in the processing of social participation may decrease the probability of positive social interactions and may explain interpersonal problems of individuals with this disorder. These results have implications for clinical practice. Psychoeducation is needed to inform BPD patients about the possibility that they may feel excluded even though they are part of a group. BPD patients could be advised to behave in social situations as if they are included, even if they feel rejected (e.g., in group therapy). This might enable them to interrupt the vicious cycle of interpersonal problems related to perceived ostracism. Future research should target adaptive processes in social interactive situations that influence the modification of social expectation in individuals with BPD

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2.6 Appendices

Table A.1

Means and SDs of the P3 amplitude at central, frontal and parietal position

		HC (n = 28)	SAD (n = 28)	BPD (n = 29)
		M (*SD*)	*M* (*SD*)	*M* (*SD*)
P3 Fz	Inclusion	1.79 (2.94)	3.97 (4.13)	3.94 (3.57)
	Overinclusion	0.30 (2.14)	2.35 (3.18)	2.81 (2.34)
P3 Cz	Inclusion	3.93 (3.28)	6.42 (3.70)	6.41 (4.39)
	Overinclusion	1.23 (2.40)	4.05 (3.18)	4.18 (2.88)
P3 Pz	Inclusion	5.78 (3.53)	7.62 (3.19)	8.40 (4.39)
	Overinclusion	2.48 (2.79)	5.60 (3.17)	5.68 (3.47)

Note. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder. Fz = frontal, Cz = central, Pz = parietal.

Table A.2

Means and SDs of the SPIN scores

	HC	SAD	BPD	*t*–test for SAD groups	
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*t(51)*	*p*
SPIN (this study)	12.82 (10.99)	41.07 (10.99)	35.93 (13.48)	2.55	0.01
SPIN (Gutz et al., 2015)[a]	13.76 (7.10)	32.60 (13.16)	34.40 (12.87)		

Note. SPIN = Social Phobia Inventory; HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder.

[a] *n* = 25 per group.

Chapter 3: Study 2

THE MORE INCLUSION THE BETTER? PROCESSING OF INCREASED FREQUENCY OF SOCIAL INTERACTION IN SOCIAL ANXIETY DISORDER AND BORDERLINE PERSONALITY DISORDER

The following paper was prepared for publication:

Weinbrecht, A., Niedeggen, M., Roepke, S., & Renneberg, B. (under review). Processing of increased frequency of social interaction in social anxiety disorder and borderline personality disorder. *Scientific Reports.*

Data availability: https://osf.io/sqgbr/?view_only=917a4a545f144ddd948c4ae6a3bcb2e5

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Note that the formatting was adjusted to be consistent throughout the thesis.

Abstract

Background: We investigated how patients with social anxiety disorder (SAD) and patients with borderline personality disorder (BPD) process an increase in the frequency of social interaction. *Methods:* We used an EEG-compatible version of the online ball-tossing game Cyberball to induce an increase in the frequency of social interaction. In the first condition, each player received the ball equally often (inclusion: 33% ball reception). In the following condition, the frequency of the ball reception was increased (overinclusion: 45% ball reception). The main outcome variable was the event-related potential P2, an indicator for social reward processing. Moreover, positive emotions were assessed. Twenty-eight patients with SAD, 29 patients with BPD and 28 healthy controls (HCs) participated. *Results:* As expected, HCs and patients with BPD, but not patients with SAD, showed an increase in the P2 amplitude from the inclusion to the overinclusion condition. Contrary to our expectations, positive emotions did not change from the inclusion to the overinclusion condition. *Conclusion:* EEG results provide preliminary evidence that patients with BPD and HCs, but not patients with SAD, process an increase in the frequency of social interaction as rewarding.

*Keywords***:** Social anxiety disorder, borderline personality disorder, EEG, social interaction, overinclusion, Cyberball, social reward

3.1 Introduction

To belong to a group is a central human need, which explains why interacting frequently with other individuals and feeling included into a group is important for our well-being[1,2]. In line with this, many studies have shown that being excluded from a group has detrimental effects on our well-being[3-5]. In this context, we were interested in the effects of changes in the quantity of social interaction: Are there benefits when the frequency of social interaction is increased? This question is particularly interesting for individuals with social anxiety disorder (SAD), because individuals with SAD are afraid of embarrassing themselves in front of others and often try to avoid social interaction[6].

This study investigates how individuals with SAD process increased frequency of social interaction compared to individuals with borderline personality disorder (BPD) and healthy controls (HCs).

A possibility to investigate effects of increased frequency of social interaction provides the well-established virtual ball-tossing paradigm Cyberball[7]. During the Cyberball game, participants believe that they are tossing the ball with two other co-players. However, the game is preprogrammed, so that it is possible to manipulate the frequency of ball reception. This allows to test the effect of inclusion (participant gets the ball as often as the co-player), exclusion (participant gets the ball less frequently), and overinclusion (participant gets the ball more frequently).

The effects of social exclusion on HCs have been examined in numerous Cyberball studies, for reviews see [8,9], while the effects of social overinclusion have been less extensively examined[10-17]. In contrast to the negative effects of a transition to social exclusion[18-20], a transition to overinclusion induces positive effects, like greater than anticipated enjoyment[17]

and a decrease in threat to fundamental social needs[13]. Notably, these effects were only reported when participants experienced a transition from inclusion to overinclusion[13,17]. The immediate onset of an overinclusion condition in the Cyberball game – not preceded by an inclusion condition – does not result in a beneficial effect for HCs[12,15]. Hence, exclusively the experience of an increase in the frequency of social interaction results in positive effects.

This study examines positive effects of the transition from social inclusion to social overinclusion. Self-report data can be biased by, for example, response tendencies, recall effects or social desirability[21]. To overcome these biases and to assess cognitive processes not covered by self-report data[22], we recorded event-related brain potentials (ERPs) using an EEG-compatible version of the Cyberball game[18].

To the best of our knowledge, only one Cyberball study examined the effects of the transition from social inclusion to social overinclusion relying on EEG data[13]. In this study, the transition from inclusion to overinclusion was associated with an increase in the frontal P2 amplitude[13]. The P2 amplitude is an ERP component, which has been related to the processing of rewarding stimuli[23-25]. For example, students showed a larger P2 amplitude when receiving positive compared to negative social feedback[26]. More precisely, the P2 amplitude has been related to the emotional evaluation of rewards[27,28]. This has been confirmed in recent studies across different experimental paradigms[29-31]. The P2 amplitude has also been related to other processes such as feature detection and allocation of attentional resources[32-34] as well as emotional evaluation of stimuli[35,36]. However, we argue that in the context of the Cyberball paradigm the P2 amplitude is an indicator for reward processing, because none of these other processes can explain that the transition from inclusion to the overinclusion is associated with an increase in the P2 amplitude. For example, processes such as feature detection are not differently activated in the inclusion and the overinclusion condition. Moreover, attentional

demands decrease in the overinclusion condition (the event of interest occurs more often) which should lead to a decrease in the P2 amplitude.

Importantly, next to the study by Niedeggen and colleagues[13], another Cyberball study supported the notion that an increase in the frequency of social interaction is processed as socially rewarding with fMRI data: the transition from social inclusion to social overinclusion was associated with an activation of the ventral striatum, a region closely related to social reward processing[17]. Hence, previous Cyberball studies indicated that an increase in the frequency of social interaction serves as a social reward signal.

Which effect does an increase in the frequency of social interaction have on individuals with BPD and SAD? Research revealed that individuals with SAD are characterized by positivity impairments: They tend to process positive social information in a more negative way and tend to disqualify positive social information in a post-event process[37,38]. Hence, individuals with SAD might benefit less from an increase in the frequency of social interaction. In line with this, one Cyberball study with a non-clinical sample provided preliminary evidence that individuals high in social anxiety subjectively do not benefit from social overinclusion[39]. In this study, women high in social anxiety reported worse mood and less self-esteem in the overinclusion compared to the inclusion condition; a worsening of mood and self-esteem was not reported for women low in social anxiety. It could be speculated that the negative, external attributional style, which characterizes individuals with SAD[37,40,41], contributes to these impairments in SAD.

Individuals with BPD are also highly impaired in social interactions[6]. They often act in an impulsive manner and easily feel excluded in social interactions[42,43]. Therefore, individuals with BPD might experience an increase in the frequency of social interaction as a protection from social exclusion and experience positive effects when socially overincluded. In line with this, a previous Cyberball study showed that participants with BPD experience reduced levels

of negative mood in the overinclusion compared to the inclusion condition[44]. However, feelings of social belonging did not differ between conditions.

To summarize, previous Cyberball studies indicated that HCs experience positive effects from an increase in the frequency of social interaction. However, no study so far examined whether these positive effects also apply to individuals with SAD and individuals with BPD.

The current study seeks to close this gap and examines how participants with SAD process an increase in the frequency of social interaction compared to participants with BPD and HCs relying on EEG data. In a previous study, we focused on the analysis of expectancy processes in individuals with BPD and SAD. This process was tracked by the P3 component, which is related to context-updating processes[45,46]. In line with previous reports, individuals with BPD revealed a significant bias concerning the expected social involvement: Independently of the actual participation (inclusion and overinclusion), the P3 signaled an expectancy violation. In line with the ERP data, participants with BPD felt more excluded[47].

Whereas our previous analysis was focused on the expectancy-based processing of social participation in BPD, the current analysis focuses on the processing of social reward signals in SAD. As mentioned above, a corresponding ERP signature – a P2 component – can be elicited if a participant experiences the transition from social inclusion to overinclusion[13,25].

We used a version of the Cyberball game established for EEG recording[18]. On a computer display, avatars of the participant and two co-players were displayed. Following the reception of the ball, the participant had the task to pass it to a co-player by pressing a corresponding button. In the first round of the Cyberball game, participants received the ball in 33% of the throws (inclusion). In the second round, the frequency of social interaction was increased and participants received the ball in 45% of all throws (overinclusion).

We hypothesized that the increase in the P2 amplitude from the inclusion to the overinclusion condition can be replicated in HCs and also applies to participants with BPD but does not apply to participants with SAD. Likewise, we hypothesized that HCs and participants with BPD, but not participants with SAD, report more positive emotions due to the transition from social inclusion to social overinclusion.

3.2 Results

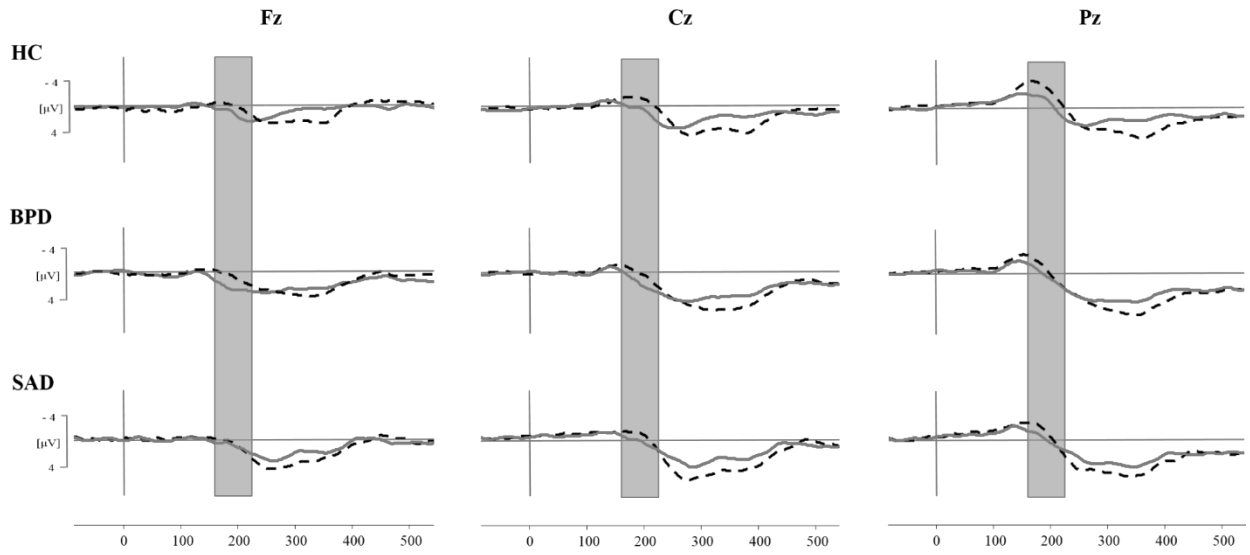
First, we confirmed that our experimental manipulation was successful: participants estimated to have received the ball more often in the overinclusion (M = 44.33 %, SD = 17.31) than in the inclusion condition (M = 29.1 %, SD = 10.84; $t(81) = -7.69$, $p < 0.001$, $r = 0.65$).

3.2.1 Change in P2 amplitude

Figure 6 depicts the grand-averaged ERPs for the three groups. The analysis focused on the time range from 160 to 225 ms: The P2 is defined as a frontally more positive-going wave in the overinclusion compared to the inclusion condition. This effect is markedly expressed in HCs and patients with BPD (see Figure 6, left column). Means and standard deviations for the P2 amplitude are displayed in Table 4.

Figure 6

Grand averages of event-related potentials of each group at the frontal (Fz), central (Cz) and parietal (Pz) position



Note. Dashed black line = inclusion condition, solid grey line = overinclusion condition. HC = healthy controls, BPD = borderline personality disorder, SAD = social anxiety disorder. Amplitude differences between the conditions and groups were examined for the P2 time window at 160 - 225 ms (grey square).

The Greenhouse-Geisser corrected three-way interaction between "group", "electrode position" and "condition" was significant, $F(3.12) = 3.62$, $p = 0.01$ (see supplementary information A for results of all lower order effects). We further explored this three-way interaction by focusing on the relevant interaction between "group" and "condition" separately for each electrode position. As expected, only at the frontal position (Fz), the change in the P2 amplitude between conditions differed between groups: The interaction between "group" and "condition" was significant at Fz ($F(2) = 3.62$, $p = 0.03$), but not at Cz ($F(2) = 1.79$, $p = 0.17$) and Pz ($F(2) = 1.95$, $p = 0.15$). Hence, we focused on the frontal position Fz for the Tukey corrected post-hoc analyses. In line with the visual inspection of Figure 6 (left column), patients with BPD and HCs showed a significant increase in the P2 amplitude at the frontal electrode position from the inclusion to the overinclusion condition (HC: $t(82) = -3.11$, $p = 0.03$, $r = 0.32$; BPD: $t(82) = -3.19$, $p = 0.024$, $r = 0.33$), whereas patients with SAD did not ($t(82) = 0.16$, $p =$

1.00, r = 0.02). Results of group differences per condition can be found in supplementary information A.

Table 4

Means and SDs of the P2 amplitude in social anxiety disorder, borderline personality disorder and healthy controls

		HC (n = 28)	SAD (n = 28)	BPD (n = 29)
	Condition	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
P2 Fz	Inclusion	0.05 (3.56)	1.87 (3.18)	1.39 (4.19)
	Overinclusion	2.04 (2.62)	1.76 (3.40)	3.40 (3.93)
P2 Cz	Inclusion	-0.33 (3.92)	2.03 (3.43)	2.09 (5.62)
	Overinclusion	1.93 (2.87)	2.29 (3.53)	3.55 (4.93)
P2 Pz	Inclusion	-2.18 (3.52)	0.05 (4.11)	0.60 (5.23)
	Overinclusion	0.40 (2.85)	0.95 (2.82)	1.47 (5.08)

Note. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder. Fz = frontal, Cz = central, Pz = parietal.

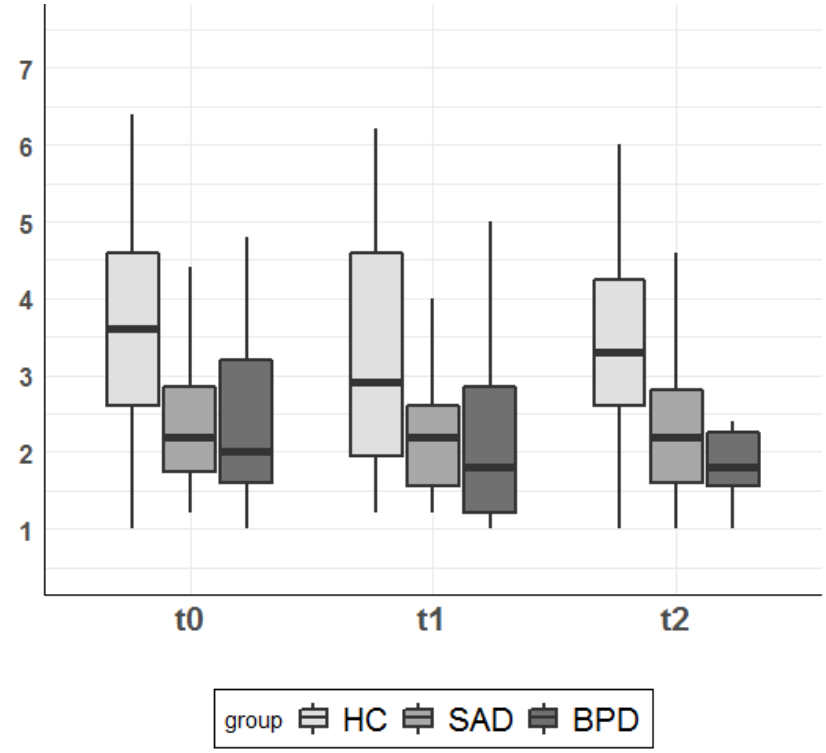
Relation of the P2 component to later cognitive components: As mentioned in the introduction, a previous analysis focused on differences in the parietal P3 amplitude between groups to examine biases concerning the expected level of social involvement in BPD[47]. To test the assumption that the P3 amplitude - an indicator for expectancy violation - is related to a different information-processing step, we correlated the frontal P2 amplitude and the parietal P3 amplitude in all three groups. The result showed that the frontal P2 and parietal P3 amplitude were not significantly correlated in any of the groups (all Pearson's $r < 0.25$, all $p > 0.19$).

3.2.2 Change in positive emotions

Figure 7 displays positive emotions for each group before the Cyberball game (t0), after the inclusion condition (t1) and after the overinclusion condition (t2).

Figure 7

Box plots of positive emotions (range 0-7) for each group before the Cyberball game (t0), after the inclusion condition (t1) and after the overinclusion condition (t2)



Note. Boxes range from first to third quartile and represent the middle 50% of the data. Whiskers represent minimum and maximum scores. HC = healthy controls, BPD = borderline personality disorder, SAD = social anxiety disorder.

Positive emotions changed over time ($F(2) = 5.74$, $p = 0.004$) and differed between groups ($F(2) = 8.93$, $p < 0.001$). However, positive emotions did not change differently over time in each group ($F(4) = 0.52$, $p = 0.73$). Note that the assumptions of homogeneity of variance and sphericity were violated. Therefore, we repeated the analyses within a multi-level model, which did not change results (see https://osf.io/sqgbr/?view_only=917a4a545f144ddd948c4ae6a3bcb2e5). The Tukey corrected

post-hoc analyses revealed that positive emotions decreased from before the Cyberball game to after the inclusion condition (t0 to t1: $t(162) = -3.38$, $p = 0.003$, $r = 0.26$), but did not change significantly from after the inclusion to after the overinclusion condition (t1 to t2: $t(162) = 1.94$, $p = 0.13$, $r = 0.15$). Moreover, both clinical groups reported less positive emotions than HCs (HC vs SAD: $t(81) = -3.68$, $p = 0.001$, $r = 0.38$; HC vs BPD: $t(81) = -3.64$, $p = 0.001$, $r = 0.37$), while clinical groups did not differ from each other ($t(81) = -0.03$, $p = 1.00$, $r = 0.003$).

Means and standard deviations for self-report data (positive emotions as well as self-focused and other-focused negative emotions) can be found in Table S1 in supplementary information B. Results of the ANOVA on self-focused and other-focused negative emotions can also be found in supplementary information B. Note that internal consistency was questionable for both negative emotions scales (see methods) and results have to be interpreted with caution.

3.2.3 Secondary analysis: Differences in the attribution of increased frequency of the social interaction

Previous studies showed that individuals with SAD are characterized by a negative, external attributional style[37,40,41]. Therefore, in an exploratory analysis, we examined whether patients with SAD attributed the reason for receiving the ball more often in the second round differently than both other groups (see Table 5). Four possible attributions were provided: internal, chance or external, co-players' dislike of each other, and co-players' consideration. Groups differed in the extent to which they thought they received the ball more often in the second round because the other co-players didn't like each other, but did not differ on the other three predetermined possible attributions (see Table 5). The post-hoc analyses revealed that patients with SAD attributed the reason for being overincluded more strongly to the co-players' dislike for each other than HCs ($t(79) = -2.99$, $p = 0.01$, $r = 0.32$) and patients with BPD ($t(79)$

= 2.94, p = 0.01, r = 0.31) did. Patients with BPD and HCs did not differ in their attribution, $t(79)$ = - 0.08, p = 1, r = 0.01.

Table 5

Results for attribution of the increased frequency of social interaction

	HC	SAD	BPD	ANOVA	
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*df*	*F*
Internal	2.18 (1.09)	1.96 (1.17)	1.68 (1.25)	2, 81	1.28
Chance	2.57 (1.45)	3.26 (1.40)	2.61 (1.55)	2, 80	1.90
Co-Players' Dislike	1.37 (0.69)	2.19 (1.30)	1.39 (0.92)	2, 79	5.84*
Co-Players' Consideration	2.25 (1.04)	2.46 (1.23)	2.38 (1.52)	2, 82	0.20

Note. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder.

* $p < 0.01$

3.3 Discussion

This study examined how individuals with SAD, BPD and healthy individuals process an increase in the frequency of social interaction in a virtual ball-tossing game (Cyberball) based on EEG data. As expected, healthy individuals and individuals with BPD, but not individuals with SAD, showed an increased P2 amplitude in transition from social inclusion to overinclusion. This provides preliminary evidence that individuals with SAD evaluate an increase in the frequency of social interaction as less rewarding than the other two groups. However, groups reported no changes in positive emotions due to the increased frequency of

social interaction. In the following sections, results are discussed in more detail as well as embedded into the context of previous findings.

Our data confirmed the P2 effect in healthy individuals playing Cyberball: we replicated that the transition from social inclusion to overinclusion induces an increase in the P2 amplitude[13]. This indicates that healthy individuals may evaluate the increased frequency of social interaction as socially rewarding. As expected, this replicable P2 effect in healthy controls also applied to participants with BPD.

Our finding that individuals with SAD might not process increased frequency of social interaction as rewarding is in line with the impaired positivity hypothesis in SAD[37,38]. According to this hypothesis, individuals with SAD process and experience positive social information in a more negative way. In the context of social reward processing, Cremers and colleagues showed that individuals with SAD might lack a motivational drive to obtain a social reward, which was indicated by less striatal activity[48]. Moreover, Cao and colleagues reported that compared to healthy controls individuals with SAD show a smaller P2 amplitude when getting negative *or* positive social feedback[26]. These results are in line with the idea that social anxiety may impair the experience of social reward.

Both clinical groups reported less positive emotions than healthy participants did. This is in line with previous findings that individuals with SAD[49,50] and BPD[51,52] experience less positive emotions than healthy individuals do. However, changes in positive emotions did not reflect EEG results: Positive emotions did not change from social inclusion to overinclusion. This contrasts the results of a previous Cyberball study, in which participants reported greater than anticipated enjoyment due to increased frequency of social interaction[17]. Moreover, this seems to contrast our interpretation that the P2 amplitude indicates reward processing. However, it has to be kept in mind that EEG data was assessed continuously throughout the Cyberball game, while positive emotions were assessed retrospectively after each condition.

Hence, the different timing of assessment might have influenced our results. All in all, more studies are needed to investigate the effect of the transition from social inclusion to overinclusion on the P2 amplitude and on positive emotions.

However, our exploratory analyses provided preliminary evidence that the type of attribution might explain why specifically participants with SAD benefit less from the transition to social overinclusion. Compared to participants with BPD and HCs, participants with SAD attributed the reason for the increased frequency of social interaction more strongly to an external factor: the co-players' dislike for each other. It is known that individuals with SAD tend to interpret ambiguous social events as more negative and tend to disqualify positive social events in a post-event process[37]. Hence, the external attributional style in individuals with SAD might have disqualified the positive aspects of more social interaction[41]. Future research should examine the association between reward processing, social anxiety and attributional style.

Next, strengths and limitations of this study will be summarized. The strengths of this study are twofold. First, we examined differences in processing of social overinclusion in two clinical groups compared to a healthy control group. This highlights the specificity of altered cognitive processing in SAD. Second, EEG data provide a simultaneous measurement of the evaluation of social interaction and monitor processes not covered by self-report data[22].

Several limitations need to be mentioned: First, we only examined effects of the transition from social inclusion to overinclusion and did not randomize order of conditions. Second, we did not corroborate the EEG data with self-report data directly linked to the experience of social reward. Third, our exploratory analyses pointed towards the importance of an external attributional style in SAD. However, other underlying factors such as deviations in motivational preference for social reward[48] might have also influenced the P2 effect. Fourth, we have to consider that the ERP effect might also be related to other processes, because the

P2 effect is not selective for social reward processing (see introduction). This is especially important, as the increase in the P2 amplitude was not associated with an increase in positive emotions in our study. However, as argued in the introduction, other cognitive processes that are associated with the P2 amplitude (e.g., feature detection, attentional processes) cannot explain the increase of the P2 amplitude from the inclusion to the overinclusion condition. Furthermore, we can rule out that the P2 amplitude is directly related to expectancy-related processes reflected in the P3 amplitude. Nevertheless, these limitations underline the importance of future research on the P2 effect in the context of the Cyberball paradigm.

To conclude, we replicated previous findings[13,17] that healthy individuals show an increase in the P2 amplitude in the transition from social inclusion to overinclusion. This might indicate that healthy individuals process increased frequency of social interaction as rewarding. Importantly, we showed that this process can also be observed in individuals with BPD, but not in individuals with SAD. However, these results were not reflected in self-reported positive emotions. Future studies are needed to examine the P2 effect in the Cyberball paradigm.

3.4 Methods

The current data were derived within a larger project on processing of social participation in BPD and SAD. Data on the bias in processing of social participation was published previously[47].

The study was approved by the ethics committee of Freie Universität Berlin (ID 97 II /2016). The study was conducted in compliance with national legislation and the Code of Ethical Principles for Medical Research Involving Human Subjects of the World Medical Association (Declaration of Helsinki). All participants provided written informed consent.

3.4.1 Participants

Overall, we included 85 participants in our analyses (identical to the sample in Weinbrecht *et al*.[35]): 28 HCs, 28 patients with SAD and 29 patients with BPD. All three groups were matched on age, IQ and gender (all $p > 0.6$). Participants were on average 28 years old (*SD* = 5.64) and mostly female (83.53%). Patients had on average 1.46 (*SD* = 1.18) comorbid diagnoses. The most common comorbid diagnosis was a remitted depressive disorder (total = 38.60%; SAD = 28.57%, BPD = 48.28%). Eight patients had a current mild depression (total = 14.04%; SAD = 21.43%, BPD = 6.90%). Fisher's exact test revealed that patient groups did not differ in the number of comorbid current ($p = 0.14$) or remitted depressive disorders ($p = 0.18$). Antidepressant medication was taken by 29.83% of the patients (SAD = 25.00%, BPD = 34.48%).

Inclusion criteria for all participants were ages between 18 and 40 years. Exclusion criteria were mental retardation, epilepsy or organic brain disease, any psychotic disorder, current substance abuse/dependency, and intake of psychotropic medication within the last 4 weeks (antidepressant medication without any changes in the dose in the last 4 weeks was allowed). Note that we did not exclude participants with mutual comorbidity. One participant with BPD had a comorbid SAD diagnosis. Excluding this participant from the analyses did not change results.

Participants were recruited via media advertisement, the Department of Psychiatry of Charité Berlin and two university outpatient clinics in Berlin. Clinical psychologists, who were trained and supervised, confirmed DSM-IV diagnoses with the German versions of SCID I and SCID II [43]. Thirty patients (52.63%) were in ongoing psychiatric/psychotherapy treatment and had recently received a structured clinical interview. In these cases, DSM-IV diagnoses were available, and no additional diagnostic interview was conducted.

3.4.2 Materials

Cyberball paradigm

Cyberball is a virtual ball-tossing game, in which the participants believe that they are tossing a ball with two other co-players[7]. The participant sits in front of a computer screen, on which the participant and the other two co-players are represented as avatars. Players can pass the ball to each other by pressing a corresponding button. However, the co-players are computer-generated, so that it is possible to manipulate how often the participant receives the ball from the co-players. We used the EEG-compatible version of Cyberball[18] to manipulate the frequency of social interaction. In the first round, participants received the ball in 33% of the throws (inclusion condition). In the following round, participants received the ball in 45% of all throws (overinclusion condition). Each block consisted of 200 throws. The duration of the Cyberball task was about 14 min. Like most Cyberball studies, we used a cover story that informs the participant that Cyberball aims to test visual imagination capabilities. Participants rated the cover story to be plausible (M = 2.67, SD = 1.16).

The Cyberball game was presented on a computer screen (7° x 7° at a viewing distance of 140 cm) on which the avatars of the participant and the two putatively connected co-players were displayed. To indicate ball possession, the ball appeared in front of the avatar. When the participant decided to pass to one of the co-players, the participant had to press a corresponding button. Then, the ball appeared at a central position for 500 ms and next to the co-player for 500–2500 ms.

Questionnaires

EMOTION SCALE[54,55]: The Emotion Scale is a 14-item self-report inventory, which enables the assessment of positive emotions as well as self-focused negative and other-focused negative emotions. Participants rate on a 7-point scale (1 = not at all, 7 = very strongly) how

much they experience a specific emotion at the moment. Mean scores are calculated for each scale: positive emotions (amusement, affection, contentment, pride), self-focused negative (loneliness, hurt, despair, sadness, fear, shame, guilt), and other-focused negative emotions (contempt, anger, resentment). Internal consistency was good for positive emotions (Cronbach`s $\alpha = 0.83 – 0.87$). For self-focused negative ($\alpha = 0.64 – 0.85$) and other-focused negative emotions ($\alpha = 0.49 – 0.69$) internal consistency was questionable[56].

MANIPULATION CHECK: Participants had to estimate the percentage of ball tosses received per condition (open question) and the extent to which they believed in the cover story (range 1 - 5). The manipulation check questionnaire also included four items assessing the participants' attribution of the increased frequency of social interaction in the second Cyberball round. Four possible attributions were provided (range 1 – 5): 1) internal (due to oneself), 2) chance, or external, 3) co-players' dislike of each other, 4) co-players' consideration.

EEG recording and data preparation

We recorded EEG data during the Cyberball game at three positions: frontal (Fz), central (Cz) and parietal (Pz) positions. Previous research provided evidence that these positions along the midline are sufficient to record the component of interest[13,45]. Moreover, focusing on these electrode positions allowed us to compare the pattern of results with previous studies using the same electrode montage[13,45]. Biosignals were recorded continuously with a sampling rate of 250 Hz.

We used Ag/AgCl electrodes, which were filled with electrode cream (Abralyt 2000, EASYCAP). Electrodes were embedded in an electrode cap (EASYCAP, Herrsching, Germany) to make sure positions were consistent across participants. Electrodes attached to the earlobes (impedance < 10 kΩ) served as the reference electrodes, with FCz serving as

ground. Vertical and horizontal electrooculogram (EOG) were recorded to control for ocular artifacts (< 20 kΩ).

The onset of a ball possession (participant, co-player) was marked by a trigger signal. Offline, the EEG signal was segmented based on this trigger signal (-200 to 600 ms epoch length) and then these EEG segments were baseline corrected (-150 to 50 ms) and filtered (0.3 – 30 Hz band pass filter and 50 Hz notch filter). Artifacts (muscular or ocular artifacts, high alpha activity) were manually identified and excluded. The number of segments for the event "self overinclusion" was matched to the number of segments for the event "self inclusion" to ensure comparable signal-to-noise ratios. Participants in whom the averaged signal was based on less than 15 segments per condition following artifact rejection were excluded (in total 10 participants: 4 BPD, 1 SAD, 5 HC), leading to the sample of 85 participants as described above. The analysis focused on all events, in which the participant received the ball (self).

Averages for each participant were calculated, separately for condition (inclusion, overinclusion) and electrode position (frontal, central, parietal). Afterwards, grand averages were calculated for the P2 time window (average amplitude in the time frame from 160 - 225 ms), separately for the three groups (HC, SAD, BPD). The P2 time window for analysis was determined based on the grand averages of the ERPs. A corresponding time window was determined in the previous Cyberball study on the P2 effect[13].

3.4.3 Procedure

This study was part of a larger project[47,57]. Therefore, participants completed a web-based battery of questionnaires before the lab session. At the lab, we conducted clinical interviews if no diagnostic information was available. Electrodes were attached and participants completed a subcomponent of the "Leistungsprüfungssystem" (performance assessment system)[58] to measure IQ. Participants played two blocks of Cyberball: First, all

participants played the inclusion (33% ball possession) and afterwards the overinclusion condition (45% ball possession).

The study by Niedeggen und colleagues revealed that only *the transition from inclusion to overinclusion* is associated with the P2 effect[13]: When they played the inclusion condition first, healthy participants showed a larger P2 amplitude in the overinclusion condition, but not when they played the overinclusion condition first. Based on this previous result, we examined the transition from inclusion to overinclusion. Hence, we did not randomize order of conditions, which allowed us to obtain statistical power.

Each block consisted of 200 throws and lasted about 7 minutes. Participants answered the Emotion Scale before the Cyberball game (t0), after the inclusion condition (t1), and after the overinclusion condition (t2). After the Cyberball game (t2), participants also answered the manipulation check questionnaire. At the end of the lab session, participants were debriefed and signed informed consent again.

3.4.4 Statistical analysis

We performed a mixed ANOVA on the P2 amplitude. Independent variables were the between-subject factor *group* (3 levels: HC, SAD; BPD) and the within-subject factors *condition* (2 levels: inclusion, overinclusion) and *electrode position* (3 levels: Fz, Pz, Cz). Furthermore, we performed a mixed ANOVA on positive emotions. Independent variables were the between-subject factor *group* (3 levels: HC, SAD; BPD) and the within-subject factors *time* (3 levels: t0, t1/ after the inclusion condition, and t2/ after the overinclusion condition). We further examined significant interaction effects with Tukey corrected post-hoc analyses. Pearson's *r* was used as an effect size measure (small effect: $r = 0.10$; medium effect: $r = 0.30$; large effect: $r = 0.50$).

Analyses were conducted using R version 4.0.0[59] and jamovi version 1.1.9.0[60]. An alpha level of 0.05 was applied.

3.4.5 Data availability

Data set and R syntax are available at

https://osf.io/sqgbr/?view_only=917a4a545f144ddd948c4ae6a3bcb2e5

https://doi.org/10.17169/refubium-30541

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3.6 Supplementary information

Supplementary information A: Detailed results of the ANOVA on the P2 amplitude

Significant main effect of "condition" $F(1) = 13.01$, $p < 0.001$) and of the Greenhouse-Geisser corrected main effect of "electrode position" ($F(1.42) = 27.99$, $p < 0.001$). Main effect of "group" was not significant, $F(2) = 2.23$, $p = 0.11$. The Greenhouse-Geisser corrected two-way interactions between "group" and "electrode position" ($F(2.84) = 0.45$, $p = 0.71$) as well as between "condition" and "electrode position" ($F(1.56) = 0.22$, $p = 0.75$) were not significant. The two-way interactions between "group" and "condition" ($F(2) = 2.18$, $p = 0.12$) was also not significant. As described in the main text, the Greenhouse-Geisser corrected three-way interaction between "group", "electrode position" and "condition" was significant, $F(3.12) = 3.62$, $p = 0.01$. Most importantly, the relevant interaction between "group" and "condition" was only significant at Fz ($F(2) = 3.62$, $p = 0.03$), but not at Cz ($F(2) = 1.79$, $p = 0.17$) and Pz ($F(2) = 1.95$, $p = 0.15$). Main effects at the frontal position: Main effect of "group" ($F(2) = 2.40$, $p = 0.10$) and "condition" ($F(1) = 0.47$, $p = 0.50$) were not significant.

Results of Tukey corrected post-hoc analyses of differences between groups per condition at the frontal position: no significant differences between groups in the inclusion (all $p > 0.39$) or in the overinclusion condition (all $p > 0.50$). Results of Tukey corrected post-hoc analyses of differences between conditions per group at the frontal position: No significant differences for patients with SAD ($t(82) = 0.16$, $p = 0.87$, $r = 0.02$). Significant differences for patients with BPD ($t(82) = -3.19$, $p = 0.002$, $r = 0.33$) and HCs ($t(82) = -3.11$, $p = 0.003$, $r = 0.32$).

Supplementary information B: Emotion Scale

Table S1

Means and SDs of emotion subscales (positive emotions, self-focused negative and other-focused negative emotions) in social anxiety disorder, borderline personality disorder and healthy controls.

		HC (*n* = 28)	SAD (*n* = 28)	BPD (*n* = 29 [a])
	Time	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)
Positive emotions	t0	3.68 (1.36)	2.42 (0.98)	2.45 (1.13)
	t1	3.21 (1.46)	2.18 (0.78)	2.26 (1.21)
	t2	3.39 (1.33)	2.38 (1.03)	2.37 (1.52)
Negative self-focused emotions	t0	1.15 (0.31)	1.73 (0.74)	2.40 (1.30)
	t1	1.14 (0.24)	1.44 (0.67)	2.10 (1.46)
	t2	1.08 (0.18)	1.29 (0.44)	1.97 (1.27)
Negative other-focused emotions	t0	1.23 (0.37)	1.44 (0.50)	1.94 (1.14)
	t1	1.33 (0.43)	1.56 (0.52)	2.14 (1.16)
	t2	1.31 (0.47)	1.42 (0.54)	1.86 (0.85)

Note. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder. t0 = before the Cyberball game, t1 = after the inclusion condition, t2 = after the overinclusion condition

[a] at t2: *n* = 28

Results of the ANOVA on self-focused and other-focused negative emotions

Self-focused negative emotions:

Significant main effect of “time” ($F(2) = 8.59$, $p < 0.001$) and “group” ($F(2) = 11.80$, $p < 0.001$). The two-way interaction between “time” and “group” was not significant, $F(4) = 1.59$, $p = 0.18$. Results of Tukey corrected post-hoc analyses of differences in self-focused negative emotions between groups: Patients with BPD experienced significant more self-focused negative emotions than patients with SAD ($t(81) = 2.98$, $p = 0.01$) and HCs ($t(81) = 4.82$, $p < 0.001$). Patients with SAD and HCs did not differ from each other, $t(81) = 1.83$, $p = 0.17$. Results of Tukey corrected post-hoc analyses of differences in self-focused negative emotions over time: Negative self-focused emotions decreased from t0 to t1 ($t(162) = -2.95$, $p = 0.01$), but did not change from t1 to t2 ($t(162) = -1.05$, $p = 0.55$).

Other-focused negative emotions:

Significant main effect of “group” ($F(2) = 8.43$, $p < 0.001$). The main effect of “time” ($F(2) = 2.48$, $p = 0.09$) and the two-way interaction between “time” and “group” were not significant ($F(4) = 0.37$, $p = 0.83$). Results of Tukey corrected post-hoc analyses of differences in other-focused negative emotions between groups: Patients with BPD experienced significant more other-focused negative emotions than patients with SAD ($t(81) = 2.86$, $p = 0.02$) and HCs ($t(81) = 3.98$, $p < 0.001$). Patients with SAD and HCs did not differ from each other, $t(81) = 1.13$, $p = 0.50$.

Chapter 4: Study 3

FEAR OF POSITIVE EVALUATION IN BORDERLINE PERSONALITY DISORDER

The following paper was published in PLOS ONE:

Weinbrecht, A., Roepke, S., & Renneberg, B. (2020). Fear of positive evaluation in borderline personality disorder. *PLOS ONE, 15*(8), e0237944. https://doi.org/10.1371/journal.pone.0237944

Note that the formatting was adjusted to be consistent throughout the thesis.

Abstract

Background: Being afraid of others' positive appraisal of oneself is called fear of positive evaluation. Fear of positive evaluation has been studied intensively in the context of social anxiety disorder (SAD). It is not known if individuals with borderline personality disorder (BPD) fear positive evaluation and which factors are associated with fear of positive evaluation in BPD. *Methods:* We applied the fear of positive evaluation scale and further self-report measures (e.g., social phobia inventory, rejection sensitivity questionnaire) to 36 patients with BPD, 29 patients with SAD and 35 healthy controls (HC). *Results:* A one-way ANOVA revealed that patients with BPD and patients with SAD reported significantly higher fear of positive evaluation than HC. Patients with BPD and SAD did not differ in their fear of positive evaluation. A hierarchical regression analysis revealed an association between rejection sensitivity and fear of positive evaluation in the BPD sample. However, this association disappeared when controlling for social anxiety. *Conclusion:* Our results indicate that individuals with BPD fear positive evaluation as much as individuals with SAD do, which has implications for clinical practice. Our results further imply that social anxiety is decisive for high fear of positive evaluation in patients with SAD and patients with BPD.

Keywords: Fear of positive evaluation, borderline personality disorder, social anxiety disorder, positivity impairments, rejection sensitivity

4.1 Introduction

Borderline personality disorder (BPD) is a severe mental disorder that affects approximately 1.6% of the general population (1). Individuals with BPD suffer from emotional instability, impulsive behavior, fear of abandonment, and strong social impairments (1, 2). Researchers try to understand the nature of these strong social impairments to improve psychological interventions for BPD. There is extensive research showing that social impairments in BPD are associated with a negativity bias, which means that individuals with BPD process social information in a negative manner (3-7).

A new line of research revealed that this also applies to positive social information, in that way that individuals with BPD process and react differently to positive social information. In the context of these positivity impairments in BPD, it is important to study how individuals with BPD appraise positive social information. An interesting candidate to do so is fear of positive evaluation. This study examines fear of positive evaluation and its correlates in BPD in comparison to another clinical group and healthy individuals.

4.1.1 Positivity impairments in BPD

Positivity impairments can be defined as alterations in the experience of positive affect as well as alterations in the processing of positive information (8-10). Concerning the experience of positive affect, there is robust evidence that individuals with BPD experience less positive affect in their daily life (e.g., 11, 12) and report to down-regulate positive affect (e.g., 13). Moreover, individuals with BPD experienced positive affective states (e.g., to feel accepted, to feel safe) and cognitive states (e.g., “I trust myself”) less frequently than individuals with another personality disorder (14). Importantly, these impairments seem to predict recovery of BPD over time (15).

Concerning the processing of positive information, research revealed that individuals with BPD process positive information in a more negative manner. For example, individuals with BPD experienced less positive emotions such as pride and happiness after reading self-relevant appreciating sentences (16) and rated positive, self-relevant words as more negative than a non-clinical control group (17). Moreover, individuals with BPD seem to be impaired in the processing of positive social feedback. An experimental study indicated that individuals with BPD integrate negative self-relevant social feedback to a greater extent than positive social feedback (18), while healthy individuals show the opposite updating bias (integrating positive feedback to a greater extent than negative). Another experimental study indicated that individuals with BPD change their social expectations in response to negative, but not positive, social feedback (19).

Hence, there is evidence for positivity impairments in BPD, which includes relevant findings for alterations in the processing of positive social feedback. However, it is not known if individuals with BPD appraise positive social feedback / evaluation differently.

4.1.2 Fear of positive evaluation

Fear of evaluation is a hallmark feature of individuals with social anxiety disorder (SAD; 20). Most research focused on fear of negative evaluation in SAD (1, 21). However, recent research indicates that individuals with SAD are also characterized by fear of positive evaluation (e.g., 22, 23). Fear of positive evaluation is defined as fearing others' favorable social appraisal (22).

The evolutionary model of social anxiety describes why social anxiety is characterized by fear of positive *and* negative evaluation (24). According to this model, individuals in a group try to avoid a decrease, but also an increase in the social rank, as the latter might lead to conflicts with more dominant group members. Consequently, fear of negative and positive evaluation is adaptive for social individuals as it decreases the likelihood of social conflicts.

Fear of positive evaluation has rarely been studied in other mental disorders than SAD and, to our knowledge, has not been studied in BPD. Reichenberger and Bleichert (2018) asked for studies on fear of positive evaluation in BPD. They argued that fear of positive evaluation in BPD might be relevant, because high fear of positive evaluation (25) as well as BPD symptoms (e.g., 26) are associated with social impairments.

4.1.3 Correlates of fear of positive evaluation in BPD

There are preliminary results for an association between fear of positive evaluation and BPD symptoms. In an undergraduate sample, students with heightened symptoms of BPD reported high fear of positive evaluation (27). However, this association disappeared when controlling for social anxiety. The author concluded that the association between BPD symptoms and fear of positive evaluation was due to high social anxiety in BPD (27).

Linehan (28) described a different approach for high fear of positive evaluation in BPD. She argued that individuals with BPD fear praise, because praise implies that the person will no longer require the support of others. In the therapeutic context, no requirement of further support could lead to the termination of sessions and the therapeutic relationship. Hence, individuals with BPD might fear positive evaluation because they fear abandonment / rejection. This is especially interesting in the context of high rejection sensitivity in BPD (e.g., 29).

4.1.4 Research questions and hypotheses

In this study, we compared fear of positive evaluation in individuals with BPD to fear of positive evaluation in individuals with SAD and healthy controls (HC). Moreover, we examined the association of fear of positive evaluation, social anxiety and rejection sensitivity. Based on the results of Rodman (27) and the theoretical considerations of Linehan (28), the following hypotheses were examined:

1) We hypothesized that individuals with BPD show higher levels of fear of positive evaluation than healthy participants. On an exploratory level, we compared fear of positive evaluation in BPD to fear of positive evaluation in SAD.
2) We hypothesized that social anxiety explains most of the variance in fear of positive evaluation. Based on theoretical considerations (28), we assumed that specifically in individuals with BPD rejection sensitivity is associated with fear of positive evaluation over and above social anxiety.

4.2 Materials and methods

The study was approved by the ethics committee of Freie Universität Berlin (ID 97 II /2016).

4.2.1 Participants

Overall, 100 participants took part in the study: 35 HCs, 29 patients with SAD and 36 patients with BPD. A subsample of this sample was described in Weinbrecht et al. (30). Table 6 displays sample characteristics as well as comorbid diagnoses of the BPD and SAD groups. Groups did not differ in age and gender (all $p > 0.53$).

Table 6

Sample characteristics

	HC (n = 35)	SAD (n = 29)	BPD (n = 36)
Female, *n* (%)	29 (83)	23 (79)	31 (86)
Age, *M (SD)*	27.69 (5.66)	28.83 (6.10)	28.08 (4.95)
Number of comorbid diagnoses, *M (SD)*	0	1.21 (1.15)	1.70 (1.10)
Antidepressant medication, *n* (%)	0	8 (27.59)	13 (36.11)
MDE current, *n* (%)	0	7 (24.18)	2 (5.56)
MDE lifetime, *n* (%)	0	8 (27.59)	15 (41.67)
SAD, *n* (%)	0	29 (100)	1 (2.78)
Other anxiety disorders, *n* (%)	0	0	11 (30.56)
PTSD, *n* (%)	0	5 (17.24)	11 (30.56)
BPD, *n* (%)	0	0	36 (100)
AVPD, *n* (%)	0	7 (24.18)	0
Other personality disorders, *n* (%)	0	1 (3.45)	3 (8.33)

Note. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder; MDE = major depressive episode, PTSD = posttraumatic stress disorder, AVPD = avoidant personality disorder.

4.2.2 Questionnaires

Beck Depression Inventory – II (BDI-II; 31)

We applied the German Version (32) of the BDI-II to measure severity of depressive symptoms. Participants have to rate the occurrence of depressive symptoms within the last two weeks on 21 items (range 0 - 63). The German version of the BDI-II shows good psychometric properties (33). In our sample, Cronbach`s α was excellent (α = 0.96).

Brief Fear of Negative Evaluation Scale–Revised (BFNE-R; 21)

We used the German version of the BFNE-R (34) to assess fear of negative evaluation by others. The German version of the BFNE-R contains 12 items (e.g., “I am frequently

afraid of other people noticing my shortcomings") with a 5-point Likert scale ranging from 1 (*not at all characteristic of me*) to 5 (*extremely characteristic of me*). The final scores (sum of item scores) range from 12 to 60. The German version of the BFNE-R shows excellent psychometric properties (34). In our sample, Cronbach`s α was excellent (α = 0.95).

Fear of Positive Evaluation Scale (FPES; 35)

We used the German version of the FPES (36) to assess fear of positive evaluation by others. The FPES contains 10 items (e.g., "I don't like to be noticed when I am in public places, even if I feel as though I am being admired") with a 10-point Likert scale ranging from 0 (*not at all true*) to 9 (*very true*). Two of the 10 items are reversed-coded to detect response biases and were not used for the calculation of the total score (sum of item scores: range 0 - 72). The German version of the FPES shows good psychometric properties (36).

In our study, the FPES showed good psychometric properties. The internal consistency with Cronbach`s α = 0.85 was good. To examine construct validity, we performed a confirmatory factor analysis examining if FPES and BFNE-R load on distinct factors. A root mean square residual (RMSR) of ≤ 0.08 indicates a good model fit. In our analysis, the model fit for the two-factor solution (FPES and BFNE-R are distinct factors) was good (RMSR = 0.05).

Questionnaire of *Thoughts and Feelings (QTF; 37)*

We applied the QTF (38) to measure BPD specific cognitions and emotions (range 1 - 5). The German version shows solid psychometric properties (38). In our sample, Cronbach`s α was excellent (α = 0.95).

Rejection Sensitivity Questionnaire (RSQ; 39)

We used the German short version of the RSQ to measure rejection sensitivity (29). The RSQ-9 contains nine hypothetical interpersonal situations, in which a significant other might refuse a request for support, guidance or companionship. Participants have to rate a)

their expectation of being rejected (e.g., “I would expect that he or she would willingly agree to help me out.”) and b) their anxiety of being rejected (e.g., “How concerned would you be over whether or not your friend would want to help you out?”) on a 6-point Likert scale. The calculation of the total RSQ score is described in Gutz, Renneberg (40) and ranges from 1 – 36. The German version of the RSQ shows good psychometric properties (29). In our sample, internal consistency was good (Cronbach’s $\alpha = 0.89$).

Social Phobia Inventory (SPIN; 41)

We applied the German Version (42) of the SPIN to measure severity of social anxiety symptoms (range 0 - 68). The SPIN consists of 17 items, with a 5-point Likert scale (from 0 = “*not at all true”* to 4 = “*extremely*”). The German version shows solid psychometric properties (42). In our sample, Cronbach`s α was excellent ($\alpha = 0.95$).

4.2.3 Procedure

Questionnaires were assessed online using the survey program Unipark (QuestBack GmbH, Germany). Participants were then invited to participate in an experimental study to assess EEG data on the processing of social participation in BPD and SAD (for results see 30). At the lab, participants completed the BDI-II (31). Moreover, if no diagnostic information was available, clinical psychologists conducted diagnostic interviews with the German versions (43) of SCID I and SCID II (44). At the beginning and at the end of lab sessions, participants provided written informed consent.

We recruited participants via media advertisement, an inpatient clinic and two university outpatient departments. We only recruited participants between 18 and 40 years of age, who had no psychotic disorder, no current substance abuse/dependency and did not take psychotropic medication in the last 4 weeks.

4.2.4 Statistical analysis

To compare fear of positive evaluation between groups, we performed a one-way ANOVA with *group* (3 levels: HC, SAD, BPD) as the independent variable and FPES scores as the dependent variable. Significant group effects were further examined with Bonferroni corrected post-hoc analyses. We used Hedges *g* as an effect size measure.

To examine the influence of rejection sensitivity (RSQ scores) and social anxiety (SPIN scores) on fear of positive evaluation (FPES scores), we performed a hierarchical regression analysis. First, we entered the group factor as a predictor to control for ecological fallacy. Next, we entered RSQ scores and then SPIN scores. In a last step, the interaction term between RSQ scores and group was entered. Assumptions (linearity, independent and normal distributed errors, homoscedasticity, multicollinearity) were not violated.

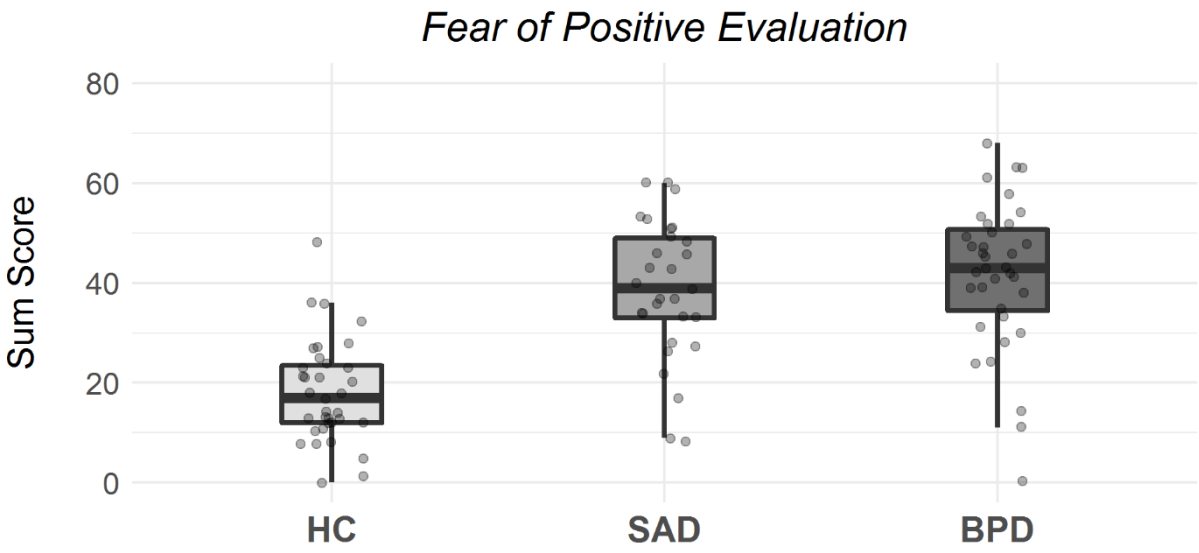
Analyses were conducted using R version 3.4.0 (45) and an alpha level of 0.05 was applied.

4.3 Results

Figure 8 depicts box plots of group-specific FPES scores. Table 7 displays exact values (MD and SD) for all applied questionnaires. Individual questionnaire data are in the supporting information file (S1 Table).

Figure 8

Box plots for FPES scores with individual data points



Note. Boxes range from first to third quartile and represent the middle 50% of the data. Whiskers represent standard errors. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder.

We compared group-specific means in a one-way ANOVA to examine differences in fear of positive evaluation between patients with BPD, patients with SAD and HC. Groups differed significantly on FPES scores (see Table 7). The post-hoc analyses revealed that patients with BPD ($p < 0.001$, $g = 1.83$) and patients with SAD ($p < 0.001$, $g = 1.63$) reported higher FPES scores than HC. Patients with SAD and patients with BPD did not differ significantly on their fear to be positively evaluated ($p = 1$, $g = 0.20$). In an exploratory analysis, we further compared differences between groups on the item level of the FPES. Clinical groups differed only on two items: Patients with BPD reported significantly higher values on two items related to being uncomfortable when receiving a compliment than patients with SAD (item 4 and 8, both $p < 0.01$).

Table 7

Results of self-report questionnaires

	HC	SAD	BPD	ANOVA
	M (*SD*)	*M* (*SD*)	*M* (*SD*)	*F*(2, 97)
Fear of Positive Evaluation [FPES]	18.06 (10.30)	38.69 (13.99)	41.67 (14.80)	33.12*
Fear of Negative Evaluation [BFNE-R]	29.91 (10.50)	48.62 (6.74)	44.06 (12.01)	30.3*
Rejection Sensitivity [RSQ]	8.43 (3.24)	15.97 (5.59)	17.93 (6.54)	31.37*
Social Anxiety [SPIN]	12.86 (8.41)	41.79 (11.47)	37.03 (12.91)	65.45*
BPD Specific Cognitions [QTF]	1.43 (0.45)	2.32 (0.77)	3.53 (0.81)	81.97*
Depressive Symptoms [BDI-II]	4.10 (5.10)	16.86 (10.78)	32.51 (12.01)	75.95*

Note. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder; FPES = Fear of Positive Evaluation Scale, BFNE-R = Brief Fear of Negative Evaluation Scale–Revised, SPIN = Social Phobia Inventory, BDI-II = Beck Depression Inventory II, QTF = Questionnaire of Thoughts and Feelings, RSQ = Rejection Sensitivity Questionnaire.
* $p < 0.001$

Patients with BPD and patients with SAD reported higher rejection sensitivity than HC (both $p < 0.001$ and $g > 1.67$), but did not differ between each other ($p = 0.43$, $g = 0.32$). Comparable results were obtained for fear of negative evaluation (HC vs. SAD: $p < 0.001$, $g = 2.05$; HC vs. BPD: $p < 0.001$, $g = 1.24$; SAD vs. BPD: $p = 0.23$, $g = 0.45$). Patients with BPD reported the highest depressive symptoms (HC vs. BPD: $p < 0.001$, $g = 3.03$; SAD vs. BPD: < 0.001, $g = 1.35$; HC vs. SAD: $p < 0.001$, $g = 1.54$).

QTF scores reflected the diagnostic grouping: Patients with BPD reported more BPD specific cognitions than patients with SAD ($p < 0.001$, $g = 1.50$) and HC ($p < 0.001$, $g = 3.14$). Patients with SAD reported more BPD specific cognitions than HC ($p < 0.001$, $g = 1.44$). SPIN scores did not entirely reflect the diagnostic grouping: Patients with SAD reported higher social anxiety than HC ($p < 0.001$, $g = 2.88$), but did not differ from patients with BPD (SAD vs. BPD: $p = 0.26$, $g = 0.38$; HC vs. BPD: $p < 0.001$, $g = 2.19$).

4.3.1 Association between social anxiety, rejection sensitivity and fear of positive evaluation

In a further step, we looked at correlates of fear of positive evaluation in BPD. FPES scores were highly correlated with the other questionnaires (see Table 8). Interestingly, fear of positive evaluation and social anxiety were significantly correlated in all groups. However, fear of positive evaluation and rejection sensitivity were only significantly correlated in patients with BPD (see Table 8).

Table 8

Correlations between FPES and other questionnaires

	HC (n = 35)	SAD (n = 29)	BPD (n = 36)
	FPES r	*FPES r*	*FPES r*
Fear of Negative Evaluation [BFNE-R]	0.50*	0.10	0.68**
Rejection Sensitivity [RSQ]	0.09	0.33	0.55**
Social Anxiety [SPIN]	0.55**	0.44*	0.80**
BPD Specific Cognitions [QTF]	0.37*	0.23	0.60**
Depressive Symptoms [BDI-II]	0.28	0.29	0.44*

Note. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder; FPES = Fear of Positive Evaluation Scale, BFNE-R = Brief Fear of Negative Evaluation Scale–Revised, SPIN = Social Phobia Inventory, BDI-II = Beck Depression Inventory II, QTF = Questionnaire of Thoughts and Feelings, RSQ = Rejection Sensitivity Questionnaire.

* $p < 0.05$ ** $p < 0.005$

The hierarchical regression analysis (see Table 9) revealed that rejection sensitivity explained 48.37% of the variance in fear of positive evaluation while controlling for diagnostic group, $F(1,96) = 26.02$, $p < 0.001$, adj. $\Delta R^2 = 0.09$ (see Model 2, Table 9). Adding social anxiety scores to the model significantly increased the explained variance in fear of positive evaluation, $F(1,95) = 44.07$, $p < 0.001$, adj. $\Delta R^2 = 0.16$. In this model, only social anxiety significantly predicted fear of positive evaluation while controlling for diagnostic group (see *b*-values of

Model 3, Table 9). Adding the interaction term did not explain significantly more variance in fear of positive evaluation, $F(2,93) = 1.16$, $p = 0.32$, adjusted $\Delta R^2 = 0.01$.

Table 9

Hierarchical regression analyses predicting fear of positive evaluation

	F-statistic	adj. R^2	*b*	*SE b*	*β*
Model 1: *M* (SAD) = 38.69	$F(2, 97) = 33.12$	0.39**			
SAD vs. HC			-20.63**	3.30	-1.22**
SAD vs. BPD			2.99	3.28	0.18
Model 2: *M* (SAD) = 22.98[a]	$F(3, 96) = 31.91$	0.48**			
SAD vs. HC			-13.21**	3.51	-0.78**
SAD vs. BPD			1.06	3.06	0.06
Rejection Sensitivity [RSQ]			0.98**	0.23	0.39**
Model 3: *M* (SAD) = 4.18[b]	$F(4, 95) = 45.61$	0.64**			
SAD vs. HC			1.85	3.70	0.11
SAD vs. BPD			5.39	2.63	0.32
Rejection Sensitivity [RSQ]			0.40	0.21	0.16
Social Anxiety [SPIN]			0.67**	0.10	0.67**

Note. HC = healthy controls, SAD = social anxiety disorder, BPD = borderline personality disorder; SPIN = Social Phobia Inventory, RSQ = Rejection Sensitivity Questionnaire.

[a] group mean of SAD sample on FPES when controlling for RSQ scores

[b] group mean of SAD sample on FPES when controlling for RSQ and SPIN scores

* $p < 0.05$ ** $p < 0.005$

4.4 Discussion

To our knowledge, this is the first study that examined fear of positive evaluation in individuals with BPD. Individuals with BPD did not differ in their fear to be positively evaluated from individuals with SAD.

Furthermore, we examined which factors were associated with high fear of positive evaluation in a regression analysis. As hypothesized, social anxiety explained most of the variance in the fear to be positively evaluated.

4.4.1 High fear of positive evaluation in individuals with BPD

Until now, fear of positive evaluation in clinical samples seemed to be highest in SAD (25). For example, fear of positive evaluation was higher in individuals with SAD compared to individuals with other anxiety disorders (46). In non-clinical samples, fear of positive evaluation was more strongly related to social anxiety than to depressive symptoms (23, 35). Our results show that individuals with SAD do not differ from individuals with BPD in their fear of positive evaluation.

Fear of positive evaluation has been described in the context of positivity impairments in SAD (see 8, 9 for reviews). Our finding on high fear of positive evaluation in BPD adds to literature on positivity impairments in BPD. For example, individuals with BPD seem to have problems integrating positive (self-referential) social information (e.g., 18, 19, 30, 47). Our study extends previous findings showing that individuals with BPD also appraise positive social information more anxiously than healthy individuals do.

To shed more light on high fear of positive evaluation in BPD, we compared differences between clinical groups on the item level of FPES in an exploratory analysis. Individuals with BPD reported to be more uncomfortable when receiving a compliment than individuals with SAD. It could be speculated that a compliment is incongruent with the negative self concept

(e.g., 48) of individuals with BPD. Therefore, a compliment might trigger unwanted negative emotions such as anger (e.g., “the therapist is lying to me”) or shame (e.g., “the therapist has no idea how unworthy I am”).

What are the implications of high fear of positive evaluation in BPD? High fear of positive evaluation has been associated with social impairments and less quality of life (see 25 for a review). Fear of positive evaluation might contribute to the well described long term impaired psychosocial functioning in BPD (26). Moreover, fear of positive evaluation has been associated with diminished positive affect (see 25 for a review). Diminished positive affect was also found in BPD (14) and has been related to higher BPD symptom severity (12). Future research should examine if fear of positive evaluation contributes to diminished positive affect as well as social impairments in BPD.

What are the clinical implications of high fear of positive evaluation in BPD? Therapists should be aware that complimenting or giving positive feedback might be frightening and / or difficult to accept for patients with BPD. Therefore, it could be helpful if the therapist prefaces compliments to the patient by pointing out that this might trigger aversive emotions. Moreover, therapist and patient should explore why a compliment triggers negative emotions (e.g., the compliment is schema-incongruent, the patient is suspicious regarding the intentions behind the compliment). This way, the patient might learn to understand the experience of negative emotions before or after receiving positive social feedback. In the long term and accompanied by further interventions (e.g., development of a suitable skill to accept positive feedback), this might help patients with BPD to experience less negative and more positive emotions in the context of positive social feedback.

4.4.2 Association between social anxiety, rejection sensitivity and fear of positive evaluation

We also examined which factors are associated with high fear of positive evaluation. In line with our assumption, only in patients with BPD, rejection sensitivity was associated with fear of positive evaluation. However, the regression analysis revealed that the association between rejection sensitivity and fear of positive evaluation disappeared when controlled for social anxiety and that social anxiety accounts for most of the variance in fear of positive evaluation. Hence, social anxiety might have driven the association between rejection sensitivity and positive evaluation in our sample. This is in line with previous results showing that the association between BPD symptoms and fear of positive evaluation was driven by high social anxiety in BPD (27).

However, this finding is limited by the fact that social anxiety and fear of positive evaluation were highly correlated in our BPD sample (r = 0.80), which raises the question if the applied questionnaires measure the same underlying construct. Indeed, there is an overlap in some items of both applied questionnaires (e.g., SPIN: “I am afraid of people in authority”, “I avoid activities in which I am the center of attention.”; FPES: “I feel uneasy when I receive praise from authority figures.”, “I don’t like to be noticed when I am in public places, even if I feel as though I am being admired.”). However, the high correlation between both questionnaires was specific for the BPD sample. In healthy participants and the SAD sample, the correlation was lower (r = 0.55, r = 0.44) and comparable to previous studies (23, 46). Moreover, fear of positive evaluation relates to being afraid of others’ positive appraisal, while social anxiety is characterized by fear of negative evaluation and less well researched fear of positive evaluation (e.g., 23, 49). This favors the distinctiveness of both constructs.

It is noteworthy that in the BPD sample, different self-report measures were highly correlated. It is possible that a generalized negative affectivity or a negativity bias (3-6) drives this correlation pattern.

It should further be noted that individuals with SAD did not differ in their rejection sensitivity from individuals with BPD. This is in contrast to previous findings that individuals with BPD are characterized by higher rejection sensitivity than individuals with SAD (29, 40). A possible explanation for this is the high symptom load of participants with SAD in our study (see 30).

Future studies need to clarify the underlying mechanism of high fear of positive evaluation in BPD. As speculated above, a positive evaluation might be incongruent with the negative self concept (e.g., 48) of individuals with BPD or related to impairments in social cognition in BPD (e.g., 3, 50), which lead to being suspicious regarding the intentions behind a positive evaluation.

4.4.3 Strength and limitations

This is the first study that compared fear of positive evaluation in BPD to fear of positive evaluation in SAD and healthy individuals. Data allowed us to examine if high fear of positive evaluation is specific to individuals with SAD or if it is also present in BPD. Diagnostic groups were confirmed with structured clinical interviews and were reflected in BPD specific cognitions and emotions (QTF scores; 38). Moreover, we were able to confirm that the FPES is a valid and reliable questionnaire (36).

The following limitations need to be considered: 1) we relied exclusively on self-report measures, 2) we designed a cross-sectional study, which provided no conclusion on causality, and 3) we were not able to look at sex differences in fear of positive evaluation.

4.4.4 Conclusion

This study showed that individuals with BPD highly fear positive evaluation. This is important for clinical practice. Therapists should be aware that complimenting or giving positive feedback might be frightening to patients with BPD and apply suitable interventions.

Future research should examine why individuals with BPD fear positive evaluation and explore strategies to diminish this fear of positive evaluation.

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4.6 **Supporting information**

"S1 Table. Complete data set of questionnaires" is available at http://www.plosone.org/article/fetchSingleRepresentation.action?uri=info:doi/10.1371/journal.pone.0237944.s001

Chapter 5: General Discussion

The aim of the thesis was to unpack biases in the processing of positive social information in BPD and SAD. To this end, this thesis compared how individuals with BPD and SAD process inclusive social situations (study 1 and study 2) and whether individuals with BPD fear positive evaluation (study 3).

In this chapter, I will summarize and interpret the main findings of all three studies (chapter 5.1). Subsequently, I will discuss how these findings advance our understanding of BPD and SAD (chapter 5.2) and present limitations as well as strengths of this thesis (chapter 5.3). Finally, I will propose conclusions and clinical implications (chapter 5.4).

5.1 Summary and interpretation of findings

Individuals with BPD and SAD are characterized by severe interpersonal problems (see chapter 1.2). According to cognitive theories, biased processing of social information contributes to these interpersonal problems in BPD and SAD (Beck et al., 2015; Clark & Wells, 1995). Previous research focused on the processing of *negative* social information in BPD and SAD and neglected the processing of *positive* social information (see chapter 1.3). Moreover, no study so far has compared the processing of positive social information between BPD and SAD. The three studies at the core of this thesis tried to understand better in which way individuals with BPD and SAD differ in their processing of positive social information from individuals without a mental disorder. In the long term, this might help ameliorate interpersonal problems of these disorders more effectively.

In the following sub-chapters, I will summarize the main findings of each study in order to answer the three research questions. In each sub-chapter, I will also integrate my findings as well as previous findings into a model on the processing of inclusive social situations (chapter 5.1.1.) as well as into a model on the processing of positive social feedback in BPD and SAD (chapter 5.1.2). These models will be based on the framework of this thesis (see Figure 3; Crick & Dodge, 1994). Finally, I will propose directions for future research.

5.1.1 Research question 1 and 2: Do individuals with BPD and SAD process inclusive social situations in a biased manner?

Given the centrality of the human need to affiliate with others (Baumeister & Leary, 1995; Hill, 1987), the first two studies of this thesis focused on the processing of affiliative signals: being included or overincluded into a group. More precisely, study 1 examined whether individuals with BPD and SAD *perceive*, *expect* and *emotionally respond* to inclusive situations

in a biased manner, while study 2 examined whether individuals with BPD and SAD process an increase in the level of social inclusion in a biased manner.

STUDY 1 – SUMMARY OF FINDINGS: EEG data of study 1 showed that the P3 amplitude – an indicator of a violation of social expectations (e.g., Gutz et al., 2011; Schuck et al., 2018; Weschke & Niedeggen, 2015; see 1.4.2 and 5.2.3) - was enhanced for participants with BPD and SAD compared to HCs irrespective of the condition. This finding revealed an *expectancy bias* for individuals with BPD and SAD: they expected to be excluded even in inclusive situations. Moreover, study 1 revealed a *bias in the emotional response* to social inclusion. In the inclusion condition, participants with BPD and SAD reported to experience more ostracism and negative emotions than HCs did. In the overinclusion condition, groups did not differ in reported ostracism and negative emotions. However, participants with BPD reported more threat to their social needs in the overinclusion condition than HCs did. Results of study 1 further indicated that individuals with BPD and SAD show *no biases* in the *perception* of inclusive situations: Participants with BPD and SAD did not differ from HCs in the estimated percentage of ball tosses they received.

In answer to research question 1, findings of this thesis revealed that individuals with BPD and SAD, indeed, process inclusive social signals in a biased manner. Specifically, individuals with BPD and SAD expect to be excluded even in inclusive social situations and they respond emotionally more negatively to the situation of social inclusion. However, study 1 also indicated that individuals with BPD and SAD perceive their level of social involvement in inclusive social situations accurately.

STUDY 2 – SUMMARY OF FINDINGS: Study 2 examined how individuals with BPD and SAD process an increase in the level of social inclusion. EEG results of study 2 showed that the transition from social inclusion to social overinclusion was accompanied by an enhanced P2 amplitude. This enhanced P2 amplitude was found for HCs and participants with

BPD, but not for participants with SAD. While there is an ongoing debate which cognitive process is reflected by the P2 amplitude (see chapter 5.3.1 for a detailed discussion), previous Cyberball studies repeatedly showed that the P2 amplitude is an indicator for social reward processing (Niedeggen et al., 2014; Weschke & Niedeggen, 2013; 2015). Hence, EEG results of study 2 indicated that individuals without a mental disorder and individuals with BPD, but not individuals with SAD, process the transition from social inclusion to overinclusion as rewarding. In contrast to the EEG results, participants did not experience more positive emotions due to the increase in the level of social inclusion. It could be speculated that there was a small increase in positive emotions, which was not detected because of the retrospective assessment of self-report data. An alternative explanation is that the increase in the ball reception is too weak a stimulus to induce changes in positive emotions. Future research should examine this in more detail, also relying on additional paradigms to the Cyberball game (in 5.2.1, I suggest promising paradigms).

Interestingly, an exploratory analysis showed that participants with SAD externalized the reason for overinclusion: Participants with SAD, compared to participants with BPD and HCs, attributed the reason for having received the ball more often in the second condition more strongly to the co-players' dislike for each other. Hence, participants with SAD attributed the reasons for the increase in the level of social inclusion negatively and in an external manner.

In answer to research question 2, findings of this thesis provided preliminary evidence that specifically individuals with SAD do not process an increase in the level of social inclusion as rewarding. This could be due to a negative and external attributional style of individuals with SAD.

MODEL PROPOSAL: Next I will discuss how the presented findings above advance our knowledge on the processing of inclusive social situations in BPD and SAD. To do so, I

will integrate the findings of this thesis and previous evidence into a model on the processing of inclusive social situations in BPD and SAD (see Figure 9).

Findings of this thesis as well as previous studies underline the central role of social expectations in the processing of positive social information (Gutz et al., 2015; Liebke et al., 2018). More precisely, results indicate that individuals with BPD and SAD constantly expect to be excluded. In Figure 9, I propose that this constant expectation to be excluded crucially influences how individuals with BPD and SAD preceive and respond to inclusive situations. Following this line of thought, the constant expectation to be excluded might decisively contribute to the biased emotional response of individuals with BPD and SAD to social inclusion: they respond with ostracism and negative emotions even to social inclusion (results of study 1; Domsalla et al., 2014; Gutz et al., 2015). Importantly, individuals with BPD and SAD do not respond with ostracism and negative emotions to social overinclusion (results of study 1; De Panfilis et al., 2015). Hence, the constant expectation to be excluded might be less influential in clearly inclusive social situations. This is in line with cognitive theories (Beck et al., 2015) and supports the notion that individuals with BPD and SAD process ambiguous positive social information (i.e., being included) in a negative way, while unambiguous positive social information (i.e., being overincluded) is less affected.

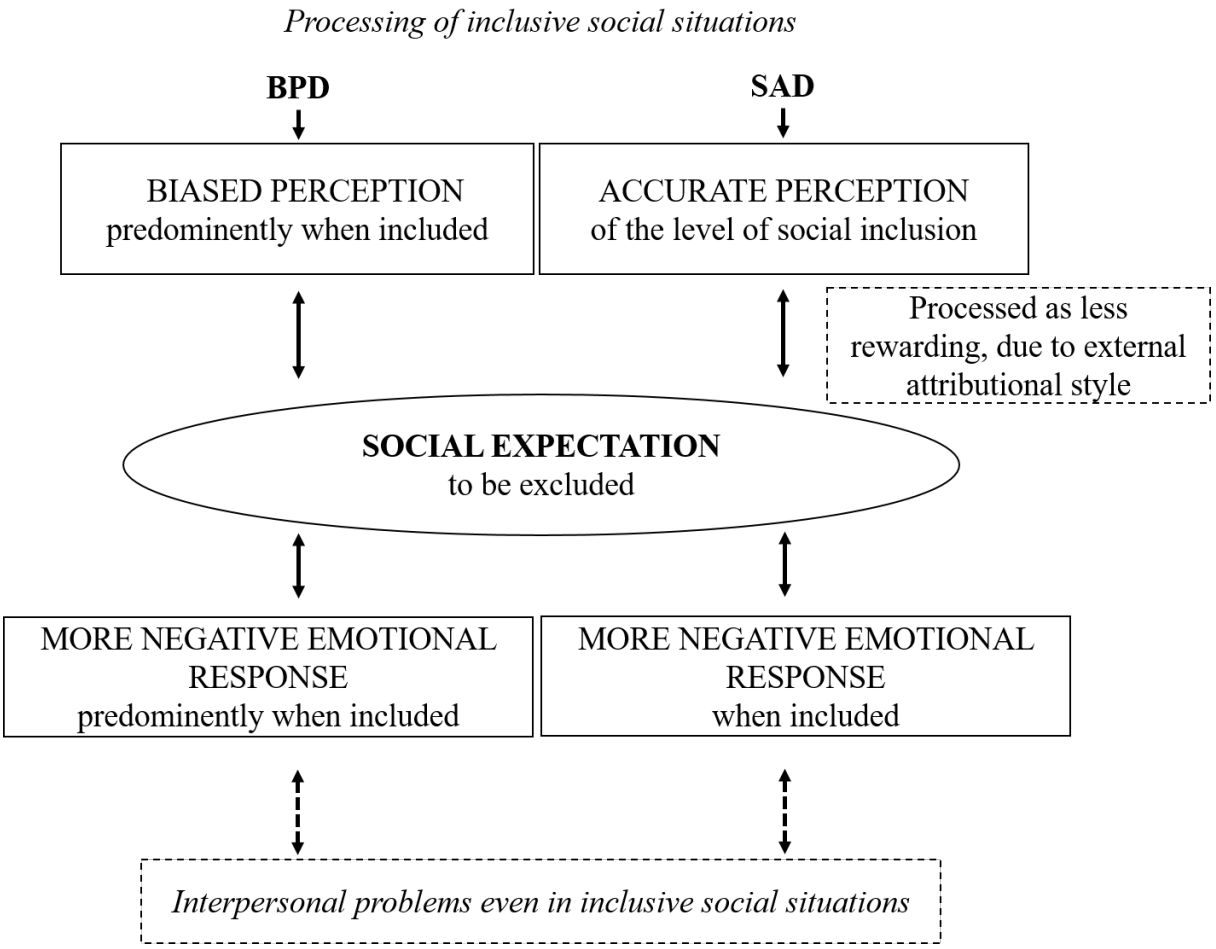
Regarding the perception of inclusive situations, previous Cyberball studies showed that individuals with BPD underestimate their level of social inclusion (see Cavicchioli & Maffei, 2019 for a review). Interestingly, results of study 1 indicated that this misperception of the level of social inclusion can be “repaired” when individuals with BPD are overincluded after having been included.

For individuals with SAD, findings of study 1 as well as previous studies indicated that they perceive the level of social inclusion accurately (Gilboa-Schechtman et al., 2014; Zadro et al., 2006). Hence, in contrast to the finding of this thesis, previous studies indicated that

individuals with BPD and SAD differ in their perception of inclusive situations. Future research is needed to examine this in more detail and clarify how the expectation to be excluded influences these differing perception processes.

Figure 9

Proposed model for the processing of inclusive social signals in borderline personality disorder and social anxiety disorder



Note. Dotted lines indicate that this aspect needs further research.

Findings of study 2 showed that participants with SAD, in contrast to participants with BPD and HCs, are less likely to process an increased level of inclusion as rewarding. This finding is in line with previous evidence that individuals with SAD are impaired in social reward processing (Cao et al., 2015; Cremers et al., 2015). Findings also pointed towards their

externalizing attributional style as an explanatory mechanism for this lack of reward processing. This adds to sound evidence that individuals with SAD are characterized by a negative attributional style (Farmer et al., 2014; Weeks, 2010). Future research should investigate this mechanism in more detail as well as other possible factors as to why persons with SAD do not process overinclusion as rewarding.

All in all, the findings of this thesis point towards shared as well as disorder-specific biases of individuals with BPD and SAD in the processing of inclusive social situations. On the one hand, individuals with BPD *and* individuals with SAD seem to be characterized by the constant expectation to be excluded even in inclusive social situations and seem to respond emotionally more negatively to social inclusion. On the other hand, specifically individuals with BPD might perceive social inclusion in a biased manner and experience threat to social needs even when overincluded. Moreover, specifically individuals with SAD might not process an increase in the level of social inclusion as rewarding (see Figure 9).

FUTURE RESEARCH: Most importantly, future research has to investigate how the described biases in the processing of inclusive social situations contribute to interpersonal problems in BPD and SAD. It could be speculated that the described biases manifest differently in BPD and SAD. For example, individuals with BPD might feel disconnected from others even in inclusive situations, which could lead to impulsive behavior. Individuals with SAD might withdraw from a social interaction (Voncken et al., 2020) or completely avoid social situations, even if these are probably socially welcoming and inclusive. Furthermore, future research could benefit from examining whether individuals with BPD and SAD show alterations in their prolonged reaction to inclusive social situations. This is especially interesting in the light of findings that highly socially anxious individuals differ in their prolonged reaction to social exclusion (Oaten et al., 2008; Zadro et al., 2006) and that individuals with SAD tend to

disqualify positive social events in a post-event process (Alden et al., 2008; Vassilopoulos & Banerjee, 2010).

5.1.2 Research question 3: Do individuals with BPD fear positive evaluation and which factors are associated with fear of positive evaluation in BPD?

Next to biases in the processing of inclusive social situations, previous research indicated that individuals with BPD and SAD share biases in the processing of positive social feedback (e.g., Budnick et al., 2015; Korn et al., 2016; Reichenberger et al., 2015). Therefore, study 3 examined an emotion process, which might influence the processing of positive social feedback – using the example of fear of positive evaluation.

STUDY 3 – SUMMARY OF FINDINGS: There is sound evidence that individuals with SAD highly fear positive evaluation (Weeks, 2015). However, previous research did not examine fear of positive evaluation in BPD. The results of study 3 close this gap by revealing that individuals with BPD highly fear positive evaluation. In fact, individuals with BPD did not differ in their fear of positive evaluation from individuals with SAD. Study 3 also examined associated factors of fear of positive evaluation in BPD and SAD. Results confirmed that social anxiety explains high fear of positive evaluation in both disorders (Rodman, 2008; Weeks & Howell, 2012). Interestingly, an explorative item analysis provided preliminary evidence that the fear to receive a compliment is a central component of high fear of positive evaluation in BPD, but future research is needed to support this idea.

In answer to research question 3, findings of this thesis showed that individuals with BPD and individuals with SAD highly fear positive evaluation and that social anxiety is an important associated factor of high fear of positive evaluation in both disorders.

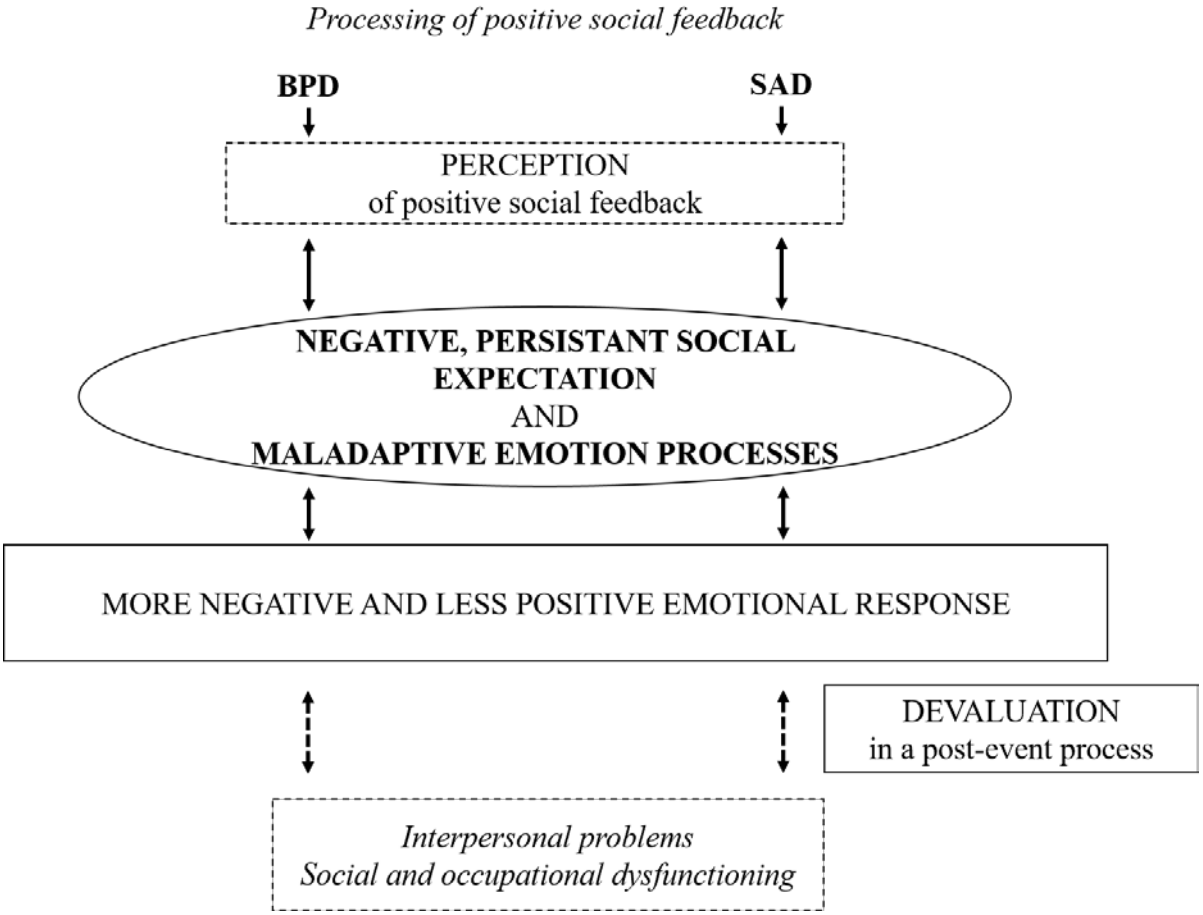
MODEL PROPOSAL: Applied to the adapted version of the information processing model by Crick and Dodge (1994), findings of study 3 indicated that individuals with BPD and SAD are characterized by *maladaptive emotions* (here: fear of positive evaluation) in the

processing of positive social feedback. This adds to previous evidence that individuals with BPD and SAD are characterized by *negative and persistent expectations* when processing positive social feedback (see Figure 10). For example, individuals with BPD were less likely to expect positive social feedback and updated their social expectations in response to negative, but not positive, social feedback (Liebke et al., 2018). For individuals with SAD it was observed that positive social feedback violated their expectations (Harrewijn et al., 2018). Moreover, this adds to previous evidence that individuals with BPD and SAD respond with more negative and fewer positive emotions to positive social feedback than HCs: Individuals with BPD and SAD reported more negative and fewer positive emotions in response to appreciating sentences (Reichenberger et al., 2017; Reichenberger et al., 2019). Moreover, socially anxious individuals reported more anxiety and received lower performance ratings in response to a positive feedback on their own interview performance (Budnick et al., 2015). Interestingly, individuals with SAD might devalue positive social feedback in a post-event process (Cody & Teachman, 2010; Glazier & Alden, 2019). Figure 10 integrates available evidence for the processing of positive social feedback in BPD and SAD.

All in all, available evidence indicates that individuals with BPD and SAD share negative and persistent expectations and maladaptive emotions in the processing of positive social feedback. Moreover, evidence indicates that individuals with BPD and SAD respond to positive social feedback in a negative manner and that individuals with SAD devalue positive social feedback in a post-event process.

Figure 10

Proposed model for the processing of positive social feedback in borderline personality disorder and social anxiety disorder



Note. Dotted lines indicate that this aspect needs further research.

FUTURE RESEARCH: More research is needed to examine how individuals with BPD and SAD perceive positive social feedback and how the processes influence each other (e.g., how does the fear of receiving positive feedback influence the perception of positive feedback?). It could also be fruitful to corroborate self-report data with neurophysiological measurements. For example, future studies could combine the assessment of self-reported fear before and after receiving a positive feedback with neurophysiological measures like skin conductance or heart rate. Last, future research should investigate how these processes contribute to interpersonal problems as well as social and occupational dysfunctioning in BPD and SAD.

5.2 Advances and future directions of findings

Chapter 5.1 focused on the three research questions at the core of this thesis with regard to the information processing model by Crick and Dodge (1994). Next, I will discuss how the findings of this thesis advance our understanding of the processing of positive social information in BPD and SAD (chapter 5.2.1) as well as our understanding of expectancy processes in BPD and SAD (chapter 5.2.2). In each sub-chapter, I will also highlight aspects that need to be clarified in future research.

5.2.1 Processing of positive social information in BPD and SAD

Results of this thesis revealed that individuals with BPD and SAD process inclusive social situations in a biased manner and are afraid to receive a positive evaluation. Hence, findings of this thesis indicate that individuals with BPD and individuals with SAD process positive social information in a negative manner and even fear specific kinds of positive social information, such as compliments. Next, I will discuss four questions about what we can take away from the findings of this thesis in relation to previous findings on the processing of positive social information in BPD and SAD.

WHAT KIND OF POSITIVE SOCIAL INFORMATION IS PROCESSED IN A BIASED MANNER? Findings of study 1 indicated that individuals with BPD and SAD process ambiguous positive social information (i.e., being included) in a biased manner, while unambiguous positive social information (i.e., being overincluded) is less affected. Interestingly, biases in the processing of ambiguous positive social stimuli were also found in symptom-remitted individuals with BPD (Kleindienst et al., 2019). Accordingly, these biases might be a trait-like feature of BPD. Moreover, given that individuals with BPD and SAD are characterized by the expectation to be excluded (e.g., Cavicchioli & Maffei, 2019; Staebler, Helbing, et al., 2011; Voncken et al., 2020), it could be speculated that signs of affiliation are especially schema-incongruent for individuals with BPD and SAD as compared to other

positive information which is, for example, pleasure-related. Indeed, results of this thesis and previous Cyberball studies indicate that individuals with BPD and SAD process signs of affiliation – that is social inclusion - in a biased manner (e.g., Domsalla et al., 2014; Gutz et al., 2015). However, in the context of the Cyberball game, signs of affiliation are operationalized by a frequent ball reception, which is a rather subtle way of expressing affiliation. Future research could profit from examining how individuals with BPD and SAD process signs of affiliation which are *expressed directly*. Liebke et al. (2018) and Somerville et al. (2006) introduced interesting paradigms to do so. For example, the Mannheim Virtual Group Interaction Paradigm simulates a comprehensive social interaction, in which participants have to introduce themselves to co-players and afterwards receive direct feedback on whether the others liked them (Liebke et al., 2018).

DO INDIVIDUALS WITH BPD AND SAD SHARE BIASES IN THE PROCESSING OF POSITIVE SOCIAL INFORMATION? This thesis provides evidence that individuals with BPD and individuals with SAD are characterized by shared as well as disorder-specific biases in the processing of positive social information. Future research should further explore transdiagnostic aspects of biases in the processing of positive social information (e.g., does the social expectation to be excluded characterize further mental disorders and influence their processing of affiliative signals?). This could add relevant information to the Research Domain Criteria (RDoC), a dimensional classification framework for transdiagnostic alterations of mental disorders (Insel et al., 2010; Kozak & Cuthbert, 2016). More precisely, this could add relevant information to the RDoC construct *affiliation*, which describes alteration in mental disorders when engaging in positive social interactions with other individuals.

WHY DO INDIVIDUALS WITH BPD AND SAD PROCESS POSITIVE SOCIAL INFORMATION IN A BIASED MANNER? Findings of this thesis indicate that individuals with BPD and SAD do not expect inclusive social signals and even fear positive feedback. This

might be attributed to the fact that positive social information is incongruent with the negative self concept of individuals with BPD and individuals with SAD (e.g., Heimberg et al., 2010; Hirsch & Clark, 2004; Winter et al., 2017). In line with this, previous studies showed that individuals with BPD and SAD integrate schema-congruent negative social feedback easily, while schema-incongruent positive social feedback can not be integrated (Harrewijn et al., 2018; Koban et al., 2017; Korn et al., 2016; Liebke et al., 2018). However, further mechansims, like negative learning experiences concerning positive social information, might also contribute to biases in the processing of positive social infromation.

WHAT CONSEQUENCES DO BIASES IN THE PROCESSING OF POSITIVE SOCIAL INFORMATION IN BPD AND SAD ENTAIL? In accordance with cognitive theories (Beck et al., 2015; Clark & Wells, 1995), I argued that biases in the processing of positive social information contribute to interpersonal problems in BPD and SAD. However, future research is needed to examine this notion in more detail. For example, ambulatory assessments could help examine biases in the processing of positive social information and interpersonal problems on a daily basis and with high ecological validity. Moreover, future research should untangle the relationship between biases in the processing of positive information and diminished positive affect. More concretely, longitudinal studies could help clarify whether biases in the processing of positive social information contribute to diminished positive affect in BPD and SAD.

To conclude, research on the processing of positive social information in BPD and SAD is promising, but still in the fledgling stages. Future research has to develop a more comprehensive model for biased processing of positive social information in BPD and SAD. For example, it needs to be clarified what kind of positive stimuli are processed in a biased manner (only specific social stimuli or all kinds of positive stimuli?), which moderators influence the information processing (e.g., stress, characteristics of the situation) and to what

extent these biases represent transdiagnostic processes (i.e., apply to further mental disorders). Moreover, future research has to identify the underlying mechanism (e.g., are the biases due to schema-incongruence or other factors?) as well as consequences of these biases in BPD and SAD.

5.2.2 Adjustment of social expectations and the P3 component

Both proposed models (see Figure 9 and Figure 10) underline the importance of negative social expectations and results of study 1 indicate that the expectation to be excluded might be active in individuals with BPD and SAD even in inclusive social situations. From this the question ensues whether individuals with BPD and SAD have difficulty in adjusting their expectation to be excluded to the current inclusive social situation. In other words, are social expectations more persistent in individuals with BPD and SAD than in individuals without a mental disorder? Indeed, previous research showed a greater persistence in social expectations in individuals with BPD (e.g., Liebke et al., 2018). In a recent review, Cavicchioli and Maffei (2019, p. 8) concluded that BPD symptoms are "primarily related to a lack of a situational sensitivity, which is supported by an inflexible cognitive-affective network that is unable to adapt to different contexts, especially the ones with incongruous features of personality system". Thus, individuals with BPD have difficulty adapting a priori expectations to schema-incongruent social situations. Interestingly, current research suggests that persistent negative expectations are a core feature of many mental disorders (Kube et al., 2018; Rief et al., 2015). Hence, the greater persistency in social expectations in BPD might also apply to SAD and further mental disorders.

Future research should clarify in which way individuals with BPD and SAD differ in their adaptation of social expectations from individuals without a mental disorder. For example, do individuals with BPD and SAD need longer than individuals without a mental disorder to adapt their social expectations to the current social situation? Moreover, do the difficulty in

adapting social expectations only occur in schema-incongruent situations? In this context, the P3 component could serve as an objective indicator for adjustment processes of a priori expectations. In the next paragraphs, I will explain this idea in more detail.

As described in the introduction (see chapter 1.4.1), the context-updating model provides a theoretical interpretation for the P3 effect during the Cyberball game (Donchin & Coles, 1988; Polich, 2007): If the current stimulus does not fit the mental representation of one's own inclusionary status, the mental representation needs to be updated and the P3 amplitude is more pronounced. In other words, if an individual expects to be excluded, a ball reception – a sign of social inclusion - induces a larger P3 amplitude. Following this line of thought, a persistently high P3 amplitude during the course of an inclusive Cyberball condition might indicate that an individual has difficulty adjusting a negative a priori expectation to be excluded to the current inclusive social situation.

Indeed, previous studies provided evidence that the P3 component is sensitive to adjustments in expectations during the course of the Cyberball game (Kawamoto et al., 2013; Schuck et al., 2018). Relying on a split-half analysis, Schuck et al. (2018) showed that the P3 amplitude of excluded participants only decreased over time if their avatar was displayed at an inferior position, not if their avatar was displayed at a superior position. The authors concluded that participants expected to be included and that being socially excluded violated this expectation. However, if their avatars' position on the screen signaled that they have low social power, they adjusted their a priori expectation to the current situation of exclusion. Put simply, individuals might only get used to being excluded if this fits to their current social status. Importantly, this showed that the P3 component mirrors adjustments in a priori expectations to the current social situation and that this adjustment process might be sensitive to situational as well as personality factors.

To sum up, there is preliminary evidence that individuals with BPD and SAD have difficulty adjusting their social expectation to be excluded to the current social situation. Future research should examine in more detail how a priori social expectations change during the Cyberball game and how this process differs in mental disorders. The P3 component could serve as a valid and objective indicator for adjusting the a priori social expectations to be excluded to the current social situation. This could be especially interesting in the therapeutic context. For example, future research should examine whether a psychotherapeutic treatment improves persistency of social expectations in mental disorders and which factors influence this process.

5.3 Limitations

The three studies at the core of this dissertation were the first to examine how individuals with BPD and SAD process social inclusion compared to social overinclusion and whether individuals with BPD fear positive evaluation. Findings of study 1 and 2 relied on the EEG version of the Cyberball game, a well-established paradigm (Hartgerink et al., 2015). This way, it was possible to overcome common biases of self-report data and assess cognitive processes which cannot be captured by self-report data (Althubaiti, 2016; Bartholow & Amodio, 2009). Moreover, this thesis compared two clinical groups, participants with BPD and SAD, to a healthy control group. Therefore, it was possible to examine which biases characterize individuals with BPD *and* SAD and which biases are disorder-specific.

However, some aspects limit the validity and generalizability of the research findings presented above. Limitations refer to difficulty in the interpretation of ERP components (chapter 5.3.1) as well as restrictions of the research design (chapter 5.3.2).

5.3.1 Interpretation of ERP components

As stated in the introduction (see chapter 1.4.1), research on ERP components significantly contributes to our knowledge on mental disorders (Hajcak et al., 2019) and offers

important advantages (e.g., objectivity, measurement of unconscious processes, high temporal resolution). However, research on ERP components also yields several disadvantages which will be discussed in more detail in this section.

The greatest disadvantage of ERP components relates to their interpretation: which component reflects which cognitive or affective process (Hajcak et al., 2019)? This is especially challenging as a wide range of cognitive processes might induce the same ERP effect (Poldrack, 2006). In line with this, Kappenman and Luck (2016) argued that multiple factors influence ERP components and that the same ERP effect may reflect a different process depending on the experimental setup as well as sample characteristics. Researchers offered best practice guidelines to overcome these problems and to be able to provide an accurate interpretation of ERP components (Kappenman & Luck, 2016; Keil et al., 2014). Most importantly, clinical EEG research has to build on previous robust evidence.

This thesis focused on the P2 and P3 effect during the Cyberball game. Cyberball is a well-established paradigm, which has been used numerously in combination with neuroscientific techniques (e.g., Reinhard et al., 2019; Wang et al., 2017). However, Cyberball studies still vary in the experimental setup (e.g., between-subject or within-subject design) and the way ERP components are analyzed (e.g., which event was focused on: ball reception or ball pass). This impedes the interpretation and comparability of a specific ERP effect among studies.

Importantly, robust evidence for the P3 effect as an indicator for expectancy violation is available (e.g., Gutz et al., 2011; Gutz et al., 2015; Kiat et al., 2017; Schuck et al., 2018; Weschke & Niedeggen, 2015). However, there are also contrasting results to this interpretation. For example, in one previous Cyberball study, healthy participants reported that the overinclusion condition was more surprising to them than the exclusion condition (Kawamoto et al., 2012). This might indicate that overinclusion violates social expectations. Consequently, overinclusion compared to inclusion should be associated with a greater P3 amplitude (greater

expectancy violation due to overinclusion compared to inclusion), which contrasts findings of this thesis and a previous Cyberball study (Niedeggen et al., 2014). An alternative explanation for the P3 effect is that it reflects attentional activation (e.g., Themanson et al., 2013). Interestingly, the interpretation of the P3 effect as an indicator for attentional activation might be in line with the "expectancy violation interpretation": If a stimulus violates our expectations, naturally, this stimulus will activate more attentional resources. Future research should clarify the compatibility of these differing interpretations.

The P2 component is thought to reflect perception of salient stimuli as well as affective significance of stimuli (e.g., Luck & Hillyard, 1994; Potts et al., 2006). In the context of the Cyberball paradigm, little research on the P2 effect (increase in the P2 amplitude due to the transition from social inclusion to social overinclusion) is available and results are less robust compared to the P3 effect. In this thesis, the P2 effect was interpreted as an indicator for reward processing (Niedeggen et al., 2014; Weschke & Niedeggen, 2013). However, other researchers related the P2 effect during the Cyberball game to attentional processes (e.g., McPartland et al., 2011) or stimulus responsiveness (e.g., Sreekrishnan et al., 2014). A further challenge in the interpretation of the P2 component is that it overlaps with a subsequent ERP component, the reward positivity or feedback-related negativity component (see Holroyd et al., 2011; Proudfit, 2015). Potts and colleagues (2006) even argued that the reward positivity and the P2 component reflect the same process: the motivational value of a stimulus. Future research is needed to clarify which cognitive process is reflected by the P2 effect in the context of the Cyberball paradigm. Moreover, future research should examine the distinctiveness of the P2 and the reward positivity component.

To sum up, there is consistent evidence that the Cyberball paradigm induces the P2 and P3 effect. However, future research is needed to clarify which process is reflected by the P2 effect and has to untangle inconsistencies in the interpretation of the P3 effect.

5.3.2 Research design

Several aspects of the research design limit the findings of study 1 and study 2. First of all, I did not assess self-report data closely linked to the P2 and P3 effect. This restrains the interpretation of the P2 and P3 effect (see chapter 5.3.1). Second, all participants were first included and then overincluded and self-report data was assessed after participants had played both conditions. Hence, research results refer to a specific experience (inclusion and then overinclusion) and cannot be transferred to other scenarios. Last, the current results do not allow the conclusion that the P2 and P3 effect are specific for the social context (see Weschke & Niedeggen, 2016).

Study 3 is limited by the fact that it exclusively relied on self-report data. This self-report data was highly correlated in the BPD sample. For example, fear of positive evaluation and social anxiety were correlated with $r = 0.80$. Thus, it is possible that other factors, such as a generalized negative affectivity or a negative thinking pattern, contributed to high fear of positive evaluation scores in the BPD sample.

5.4 Conclusion and clinical implications

Findings of this thesis contribute to our knowledge on the processing of positive social information in BPD and SAD. Overall, findings provide evidence that individuals with BPD and SAD process positive social information in a negative manner. Future research has to clarify in which particular way the described biases contribute to interpersonal problems in BPD and SAD.

Study 1 and study 2 provided evidence that individuals with BPD and SAD process inclusive social situations – that is social inclusion and overinclusion – in a biased manner. In more detail, EEG data of study 1 indicated that individuals with BPD and SAD show an *expectancy bias* in social situations: They expect exclusion even if they find themselves in an

inclusive social situation. I argued that individuals with BPD and SAD might adapt their social expectation (here: the expectation to be excluded) more slowly to the current social situation if the situation is schema-incongruent (here: being included or overincluded). The investigation of this persistency in a priori social expectations is a promising target for future research. In this context, the P3 effect could serve as an objective indicator for persistency in social expectations.

EEG data of study 2 provided preliminary evidence that individuals with SAD do not benefit from an increase in the level of social inclusion. The P2 effect indicated that participants with BPD and HCs, but not participants with SAD, process the transition to social overinclusion as rewarding. However, this interpretation is contingent on the assumption that the P2 effect reflects reward processing, which is still up for debate. Further research on the P2 effect would help guide the interpretation of my findings and those of other researchers.

Study 3 revealed that individuals with BPD fear positive evaluation as much as individuals with SAD do. This is remarkable since fear of positive evaluation is considered a hallmark feature specifically of individuals with SAD (Weeks, 2015). The findings of study 3 extend previous results by showing that both individuals with BPD and SAD are not only impaired in their ability to integrate positive social feedback (Koban et al., 2017; Korn et al., 2016; Liebke et al., 2018), but they also fear positive social feedback.

The findings outlined above hold important implications for clinical practice. Therapists should be aware that patients with BPD and SAD tend to process inclusive social situations in a biased manner and tend to fear positive social feedback. Detailed situational analyses, psychoeducation, and behavioral approaches could be suitable interventions to explore and target individual impairments. Therapists should explore how patients with BPD and SAD feel and behave in social groups and how they feel and behave when they receive positive feedback. If patients describe impairments, therapists can use psychoeducation to inform patients that they might persistently expect to be excluded and that they might experience feelings of exclusion

as well as negative emotions even while being included into a group. Moreover, therapists can inform patients with BPD and SAD that positive feedback (such as a compliment) might trigger aversive emotions. If applicable, therapist and patient can explore why even social inclusion is experienced negatively and why positive feedback triggers fear.

On a behavioral level, therapist and patient can develop suitable skills which help patients feel included into a group and accept positive social feedback. For example, an "*I belong*"-skill could remind patients to focus on signs of affiliation in a social situation. Moreover, an "*I listen*"-skill could support patients in taking compliments literally and in preventing the devaluing of positive feedback. Of course, this would need continuous practice, for example, in the context of dialectical behavior therapy or further psychotherapeutic approaches.

Before I turn to my final conclusion, I will now discuss how the findings of this thesis advance our knowledge on the processing of positive social information in BPD and SAD on a specific as well as on a more general level. On a specific level, this thesis extends our knowledge on the processing of positive social information in BPD and SAD in three ways. First, individuals with SAD and BPD do not feel excluded no matter what, but they seem to *expect* to be excluded no matter what. Secondly, *the more inclusion the better* seems to be true for individuals with BPD, but not for individuals with SAD. Thirdly, individuals with BPD *fear positive evaluation* just as individuals with SAD do.

On a more general level, it can be concluded that the findings of this thesis point towards *shared* as well as *disorder-specific biases* in the processing of positive social information in BPD and SAD. Most importantly, persistent *negative expectations* and *maladaptive emotions* seem to characterize the processing of positive social information in individuals with BPD and SAD. These negative expectations and emotions might explain why individuals with BPD

perceive specific positive social information incorrectly and why individuals with BPD and SAD respond negatively to rather ambiguous positive social information.

As a final conclusion, it remains to be said that, indeed, individuals with BPD and SAD might experience positive social information as “too good to be true”. More precisely, individuals with BPD and SAD might experience fear and might expect a change for the worse even in the context of *clearly* positive social information.

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Appendix

Zusammenfassung in deutscher Sprache

Schwierigkeiten in der sozialen Interaktion sind ein zentrales Charakteristikum der Borderline Persönlichkeitsstörung (BPS) und der sozialen Angststörung (SAS). Kognitive Theorien postulieren, dass diese Schwierigkeiten durch eine verzerrte Verarbeitung sozialer Informationen entstehen. Tatsächlich bestätigten bisherige Forschungsergebnisse, dass Menschen mit BPS und SAS soziale Informationen negativer verarbeiten als Menschen ohne psychische Störung. Beispielsweise konnte gezeigt werden, dass – im Vergleich zu Menschen ohne psychische Störung – Menschen mit BPS Gesichtsausdrücke als negativer wahrnehmen und Menschen mit SAS ihre Aufmerksamkeit schneller auf negative Gesichtsausdrücke richten. Bisherige Forschungsergebnisse beziehen sich allerdings vornehmlich auf die Verarbeitung *negativer oder neutraler* sozialer Informationen. Nur wenige Studien untersuchten bisher, wie Menschen mit BPS und SAS *positive* soziale Informationen verarbeiten, und keine Studie verglich die Verarbeitung positiver sozialer Informationen zwischen den beiden Störungsbildern. Die drei Studien der vorliegenden Dissertation verfolgen das Ziel, den Erkenntnisstand zur Verarbeitung positiver sozialer Informationen bei BPS und SAS zu erweitern, um interpersonelle Probleme der beiden Störungsbilder besser verstehen und behandeln zu können. Insbesondere soll anhand von zwei Beispielen für positive soziale Informationen – *positive Formen der sozialen Teilhabe und positive soziale Rückmeldung* – untersucht werden, welche Verzerrungen für beide Störungsbilder charakteristisch sind und welche Verzerrungen störungsspezifisch auftreten.

Studie 1 und 2 gingen der Fragestellung nach, ob Menschen mit BPS und SAS positive Formen der sozialen Teilhabe verzerrt verarbeiten. Positive Formen der sozialen Teilhabe wurden als soziale Inklusion, also gleichberechtigt Teil einer Gruppe zu sein, und soziale Überinklusion, also innerhalb einer Gruppe bevorzugt zu werden, operationalisiert. Der Fokus auf die soziale Teilhabe wurde gewählt, da Zugehörigkeit ein menschliches Grundbedürfnis

darstellt. Zur Untersuchung der Fragestellung wurde eine experimentelle Studie durchgeführt. 85 Teilnehmer:innen spielten zwei Runden des etablierten Cyberball-Paradigmas, ein virtuelles Ballpassspiel. In der ersten Runde erhielten die Teilnehmer:innen den Ball *genauso häufig* wie ihre virtuellen Mitspieler:innen (soziale Inklusion) und in der nächsten Runde *häufiger* als ihre virtuellen Mitspieler:innen (soziale Überinklusion). Vor der Laborerhebung wurden strukturierte klinische Interviews durchgeführt, sodass die Verarbeitung sozialer Inklusion und Überinklusion zwischen drei Gruppen verglichen werden konnte: BPS-Gruppe (n = 29), SAS-Gruppe (n = 28) und Kontrollgruppe (KG; n = 28). Mithilfe der Elektroenzephalografie war es möglich, Verzerrungen in der Verarbeitung sozialer Inklusion und Überinklusion nicht nur über Selbstberichte, sondern auch über ereigniskorrelierte Potentiale zu erfassen. Dabei lag der Fokus auf der P2-Amplitude, einem Indikator für Belohnungsverarbeitung, und der P3-Amplitude, einem Indikator für Erwartungsverletzung.

Die Ergebnisse von Studie 1 deuten darauf hin, dass Menschen mit BPS und SAS erwarten ausgeschlossen zu werden, selbst wenn sie aktuell gleichberechtigt in eine Gruppe eingeschlossen oder sogar innerhalb der Gruppe bevorzugt sind. Dies wurde durch eine erhöhte P3-Amplitude (unabhängig von der Bedingung) in der BPS- und SAS-Gruppe im Vergleich zur KG indiziert. In den Selbstberichtsmaßen, z.B. im Gefühl ausgeschlossen zu sein, zeigte sich, dass Teilnehmer:innen mit BPS und SAS zwar soziale Inklusion, aber kaum soziale Überinklusion auf verzerrte Weise erleben.

Die Ergebnisse von Studie 2 deuten darauf hin, dass Menschen mit SAS die Erhöhung des Levels der sozialen Teilhabe nicht als belohnend verarbeiten. Dies zeigte sich anhand einer erhöhten P2-Amplitude beim Übergang von der Inklusions- zur Überinklusionsbedingung in der KG- und in der BPS-Gruppe, aber nicht in der SAS-Gruppe. Allerdings hatte der Übergang zur Überinklusion keinen Einfluss auf selbstberichtete positive Emotionen und es bedarf weiterer Forschung zur Interpretation der P2-Amplitude im Kontext des Cyberball-Paradigmas.

Studie 3 verfolgte die Fragestellung, ob Menschen mit BPS und SAS Angst vor positiver sozialer Rückmeldung haben. Zur Beantwortung der Fragestellungen füllten 100 Teilnehmer:innen (drei Gruppen: 36 Personen mit BPS, 29 Personen mit SAS und 35 Personen in der KG) in einer Onlineerhebung Selbstberichtsmaße aus. Die Ergebnisse weisen darauf hin, dass Menschen mit SAS und mit BPS deutlich höhere Angst vor positiver Rückmeldung als Menschen ohne psychische Störung haben. Die Ergebnisse einer Regressionsanalyse deuten des Weiteren an, dass diese Angst vor positiver Rückmeldung mit hoher sozialer Ängstlichkeit in beiden klinischen Gruppen zusammenhängt.

Zusammenfassend erweitern die Ergebnisse dieser Studien den Erkenntnisstand zur Verarbeitung positiver sozialer Informationen bei BPS und SAS in drei Hinsichten. Erstens zeigen die Ergebnisse, dass Menschen mit BPS und SAS positive Formen der sozialen Teilhabe verzerrt verarbeiten. Dies äußert sich einerseits darin, dass Menschen mit BPS und SAS fortwährend erwarten ausgeschlossen zu werden, und außerdem darin, dass Menschen mit BPS und SAS selbst bei gleichberechtigtem sozialem Einschluss negative Emotionen erleben. Zweitens deuten die Ergebnisse darauf hin, dass Menschen mit SAS im Vergleich zu Menschen mit BPS weniger davon profitieren, wenn sie sozial bevorzugt werden. Drittens zeigen die Ergebnisse, dass Menschen mit BPS und SAS große Angst vor positiver Rückmeldung haben. Die vorliegende Dissertation weist damit sowohl auf *störungsübergreifende* als auch auf *störungsspezifische Verzerrungen* bei der Verarbeitung positiver Informationen hin.

Im Allgemeinen deuten die Ergebnisse darauf hin, dass die Verarbeitung positiver sozialer Informationen bei Menschen mit BPS und bei Menschen mit SAS durch negative soziale Erwartungen (z.B. die Erwartung ausgeschlossen zu werden) und maladaptive Emotionen (z.B. die Angst vor positiver Rückmeldung) beeinflusst wird. Dieses Wissen sollte im klinischen Kontext berücksichtigt werden, um interpersonelle Probleme von Menschen mit BPS und SAS effektiver behandeln zu können. Der erste Schritt hierfür ist, dass

Therapeuten:innen ein Augenmerk auf die Erwartungs- sowie Emotionsprozesse ihrer Patienten:innen in *positiven* sozialen Situationen legen.

Auflistung der eigenen Veröffentlichungen

PUBLIKATIONEN IN PEER-REVIEWED JOURNALS

Weinbrecht, A., Roepke, S., & Renneberg, B. (2020). Fear of positive evaluation in borderline personality disorder. *PLOS ONE*, *15*(8), e0237944. https://doi.org/10.1371/journal.pone.0237944

Boettcher, J., Weinbrecht, A., Heinrich, M., & Renneberg, B. (2019). Die Behandlung der sozialen Angststörung und ängstlich-vermeidenden Persönlichkeitsstörung in der Versorgung: eine naturalistische Studie zu einer kombinierten Einzel- und Gruppentherapie. *Verhaltenstherapie*, *30*(3), 189–198. https://doi.org/10.1159/000497620

Weinbrecht, A., Niedeggen, M., Roepke, S., & Renneberg, B. (2018). Feeling excluded no matter what? Bias in the processing of social participation in borderline personality disorder. *NeuroImage: Clinical*, *19*, 343-350. https://doi.org/10.1016/j.nicl.2018.04.031

Vanderlind, W. M., Stanton, C. H., Weinbrecht, A., Velkoff, E. A., & Joormann, J. (2016). Remembering the good ole′ days: Fear of positive emotion relates to affect repair using positive memories. *Cognitive Therapy and Research*, *41*, 362–368. https://doi.org/10.1007/s10608-016-9775-z

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Weinbrecht, A., Schulze, L**.,** Boettcher, J., & Renneberg, B. (2016). Avoidant personality disorder: A current review. *Current Psychiatry Reports*, *18*(3), 1-8. https://doi.org/10.1007/s11920-016-0665-6

KONGRESSBEITRÄGE

Weinbrecht, A., Niedeggen, M., Roepke, S., & Renneberg, B. (2018, Mai). *Gibt es ein "zu viel" des sozialen Einschlusses? Eine EEG-Studie zu übermäßigem sozialen Einschluss bei Borderline Persönlichkeitsstörung und Sozialer Angststörung.* In M. Riehle (Chair), Soziale Zugehörigkeit und psychische Gesundheit: Aktuelle Fortschritte klinisch-psychologischer Forschung zu sozialem Aus- und Einschluss. Symposium der Fachgruppe Klinische Psychologie und Psychotherapie der DGP, Landau.

Weinbrecht, A., Niedeggen, M., Roepke, S., & Renneberg, B. (2017, September). *Social inclusion in borderline personality disorder - an EEG study on extreme social inclusion.* In I. Niedtfeld (Chair), Social cognition in borderline personality disorder. Symposium conducted at the XV International Congress of the International Society for the Study of Personality Disorders, Heidelberg.

Weinbrecht, A., Zitzmann, J., Fehm L., Niedeggen, M., Roepke, S., & Renneberg, B. (2017, Mai). *Soziale Partizipation bei Borderline Persönlichkeitsstörung – eine EEG Studie zu extremem sozialem Einschluss.* In I. Niedtfeld (Chair), Interpersonal impairments in borderline personality disorder. Symposium auf dem 10. Workshopkongress und 35. Symposium der Fachgruppe Klinische Psychologie und Psychotherapie der DGP, Chemnitz.

Weinbrecht, A., Rieckmann, N. & Renneberg, B. (2015, Mai). *„Da kam der Zusammenbruch" – können depressive Symptome bei pflegenden Angehörigen von Personen mit Demenz gelindert werden? Eine Metaanalyse zur Wirksamkeit von Unterstützungsangeboten.* Posterpräsentation auf dem 9. Workshopkongress und 33. Symposium der Fachgruppe Klinische Psychologie und Psychotherapie der DGP, Dresden.

Vanderlind, W. M., Weinbrecht, A., & Joormann, J. (2014, September). *Remembering the good ole' days: Exploring individual differences in positive autobiographical memory recall.* Poster presented at the annual meeting of the Society for Research in Psychopathology, Evanston, IL.

Kurzvita

Der Lebenslauf ist in der Online-Version aufgrund des Datenschutzes nicht enthalten.

Anteilserklärung

Im Folgenden mache ich für alle drei Studien die Beiträge, die anderer Personen zu diesen Studien geleistet haben, separat kenntlich.

STUDIE 1 / STUDIE 2

- Konzeption der Studie und Versuchsdesign: Babette Renneberg, Michael Niedeggen, Stefan Röpke, Anna Weinbrecht
- Datenerhebung: Michael Niedeggen, Stefan Röpke, Jana Zitzmann, Marilú Nolte, Konstantin Nikolaidis, Anna Weinbrecht
- statistische Auswertung: Anna Weinbrecht (bei Unklarheiten Unterstützung durch Lars Schulze und Manuel Heinrich)
- Auswertung der EEG-Daten: Michael Niedeggen, Anna Weinbrecht
- Ergebnisdiskussion: Babette Renneberg, Michael Niedeggen, Stefan Röpke, Anna Weinbrecht
- Literaturrecherche und Anfertigung des Manuskripts: Anna Weinbrecht
- Überarbeitungen des Manuskripts: Babette Renneberg, Michael Niedeggen, Stefan Röpke

STUDIE 3

- Konzeption der Studie und Versuchsdesign: Babette Renneberg, Stefan Röpke, Anna Weinbrecht
- Datenerhebung: Stefan Röpke, Anna Weinbrecht
- statistische Auswertung: Anna Weinbrecht (bei Unklarheiten Unterstützung durch Lars Schulze und Manuel Heinrich)

- Ergebnisdiskussion: Babette Renneberg, Stefan Röpke, Anna Weinbrecht
- Literaturrecherche und Anfertigung des Manuskripts: Anna Weinbrecht
- Überarbeitungen des Manuskripts: Babette Renneberg, Stefan Röpke

Berlin, Februar 2021

Anna Weinbrecht

Eigenständigkeitserklärung

Hiermit versichere ich, dass ich die vorgelegte Arbeit selbstständig verfasst und keine anderen als die angegebenen Hilfsmittel verwendet sowie Zitate kenntlich gemacht habe.

Die Arbeit ist in keinem früheren Promotionsverfahren angenommen oder abgelehnt worden.

Berlin, Februar 2021

Anna Weinbrecht