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Alterations in Interpersonal Relations in Borderline Personality Disorder: Loneliness, Rejection, and Belonging

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“Because as humans, we need to belong.

To one another, to our friends and families, to our culture and country, to our world.

Belonging is primal, fundamental to our sense of happiness and well-being.”

Amanda Enayati

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ABBREVIATIONS

ANCOVA	Analysis of covariance
ANOVA	Analysis of variance
AM	Arithmetic mean
BDI	Beck Depression Inventory
BPD	Borderline personality disorder
BSL	Borderline Symptom List
cf.	Confer, compare
CI	Confidence interval
DSM	Diagnostic and Statistical Manual of Mental Disorders
ECG	Electrocardiography
EEG	Electroencephalography
e.g.	Example gratia, for example
etc.	Et cetera, and so forth
GAF	Global Assessment of Functioning
HC	Healthy control
HR	Heart rate
i.e.	Id est, that is
IPDE	International Personality Disorder Examination
MEC-SPQ	MEC-Spatial Presence Questionnaire
MU	Monetary unit
MVGIP	Mannheim Virtual Group Interaction Paradigm
PTSD	Posttraumatic stress disorder
RSQ	Rejection Sensitivity Questionnaire
SAD	Social anxiety disorder
SCID	Structured Clinical Interview for DSM
SD	Standard deviation
SFS	Social Functioning Scale
SNI	Social Network Index
VR	Virtual reality

1 THEORETICAL BACKGROUND

Humans are inherently social. Given the tremendous meaning of social relationships for human life (see e.g., Caporael & Brewer, 1995; House, Landis, & Umberson, 1988; S. Young, 2008) and the harm that can be caused through social interaction or a lack thereof (see e.g., Shaver & Mikulincer, 2011; Williams, 1997), it is not surprising that a broad area of psychological and especially clinical psychological research has focused on this topic. Enlightening social interaction is, however, a difficult task. The diverse ways to interact with one another can range from positive to negative with innumerable intermediate stages. They are highly dependent on a large amount of factors, such as the number of interaction partners, their closeness to each other, affections, intentions, cognition, and biographic history of every single interaction partner and so forth. Moreover, social interaction consists of complicated action-reaction circuits, which renders drawing sharp reliable conclusions about causes, mechanisms, and consequences of interpersonal behavior an extremely challenging task. It becomes even more complex, when investigating pathological alterations of social behavior, which represent core issues of various psychological disorders. Among those, borderline personality disorder (BPD) constitutes a disorder with extremely severe and complicated alterations in social life (see e.g., Lis & Bohus, 2013). Hence, it is important to gain insight into the processes at hand, in order to get one step closer to the ultimate goal of developing adequate therapeutic interventions. The present thesis tries to contribute to this goal by studying aspects of interpersonal relations especially relevant for understanding development and maintenance of BPD.

In Chapter 1, theoretical background necessary to understand origination of the studies included in Chapters 2-4 of this thesis is provided. First, characteristic symptomatology of BPD is described with special regard to alterations relevant for social interaction. Second, on the basis of this characterization, an overview over general social interaction behavior in this patient group is given. In the third part, specific concepts highly relevant for BPD pathology and assumed to be modulating social interactions described in the second part are discussed: Loneliness, social rejection, and belonging. Therein, previous literature on social rejection in healthy subjects is outlined as a basis, followed by a characterization of according alterations in patients with BPD with a special focus on reactions to social acceptance and rejection on a cognitive, physiological, affective, and behavioral level. In the end of Chapter 1, the research questions of the present thesis are derived from the preceding theoretical background. Finally, in Chapter 5, findings from Chapters 2-4 are discussed in detail with focus on integration into previous research and future directions for research and therapy, taking limitations into account and concluding with practical implications.

1.1 Borderline Personality Disorder from an Interpersonal Perspective

BPD is a severe and complex mental disorder characterized by affective dysregulation, impulsivity, identity disturbance, and difficulties with social interaction. It usually begins during adolescence with lowest life-satisfaction during young adulthood and a subsequent slow symptom decline (Kaess, Brunner, & Chanen, 2014; Schmahl et al., 2014; Winograd, Cohen, & Chen, 2008). Epidemiological studies suggest a prevalence of about 1-3% in the general population, and high rates in clinical settings (see Trull, Jahng, Tomko, Wood, & Sher, 2010; for a review see Trull, Tomko, Brown, & Scheiderer, 2010). Clinical treatment of patients with BPD causes substantial costs, accounting for about 25% of all costs for psychiatric inpatient treatment in Germany (Bohus, 2007). Moreover, BPD is associated with high comorbidity rates of other mental disorders; many patients simultaneously suffer from mood disorders, anxiety disorders, or substance use disorders (see e.g., Carpenter, Wood, & Trull, 2016; Dell'Osso, Berlin, Serati, & Altamura, 2010; Fornaro et al., 2016; Skodol et al., 2002; Tomko, Trull, Wood, & Sher, 2013; Zanarini et al., 1998; Zanarini, Frankenburg, Hennen, Reich, & Silk, 2004).

BPD first made its entry into the Diagnostic and Statistical Manual of Mental Disorders (DSM) in 1980 (3rd ed.; DSM-III; American Psychiatric Association, 1980). Since then, it has been described as a disorder characterized by marked impulsivity as well as instability of relationships, self-concept, and affectivity (see Skodol et al., 2002). A factor analysis confirmed that disturbed relatedness, affective dysregulation, and behavioral dysregulation constitute three primary factors that best describe BPD psychopathology (Sanislow et al., 2002). Within these, especially interpersonal disturbances discriminate between BPD and other personality disorders (Gunderson, 2007; Gunderson, Zanarini, & Kisiel, 1995). Moreover, alterations in social functioning are particularly persistent (Gunderson et al., 2011; Zanarini, Frankenburg, Bradford Reich, & Fitzmaurice, 2012; Zanarini et al., 2007; Zanarini, Frankenburg, Reich, & Fitzmaurice, 2010a, 2010b). Beyond the ongoing debate about the relative centrality of the three symptom domain factors (see e.g., Leichsenring, Leibing, Kruse, New, & Leweke, 2011; Schmahl et al., 2014), the following description of BPD psychopathology is focused on interpersonal aspects of the disorder, since the present thesis aims at investigating alterations in interpersonal relations in BPD.

According to the current fifth version of the DSM (DSM-5; American Psychiatric Association, 2013) diagnosis of BPD requires presence of at least five out of nine criteria. Taking a closer look at the DSM-5's diagnostic criteria, it becomes indeed evident that BPD is characterized by interpersonal difficulties to a large extent. Two of the nine diagnostic criteria refer directly to social relationships: BPD patients are known for their pattern of unstable and intense interpersonal relationships, characterized by alterations between extremes of idealization and devaluation (BPD diagnostic criterion 2; American Psychiatric Association, 2013). Additionally, frantic efforts to avoid real or imagined aban-

donment constitute an important part of this severe interpersonal dysfunction that plays a key role in the development and maintenance of BPD (BPD diagnostic criterion 1; American Psychiatric Association, 2013). This symptom is reflected in increased rejection sensitivity, that has been empirically corroborated in BPD patients or individuals with high BPD features (Ayduk et al., 2008; Bungert, Liebke, et al., 2015; Staebler, Helbing, Rosenbach, & Renneberg, 2011), i.e., a "disposition to anxiously expect, readily perceive, and overreact to rejection" (Downey & Feldman, 1996, p. 1338). BPD patients have been shown to both expect and fear rejection more than healthy control (HC) subjects (Bungert, Liebke, et al., 2015; Staebler, Helbing, et al., 2011) and patients with other disorders (Staebler, Helbing, et al., 2011). Moreover, rejection sensitivity is still increased in individuals whose BPD-symptomatology is otherwise remitted (Bungert, Liebke, et al., 2015). Maladaptive responses to rejection have also been reported in BPD, behaviorally (Berenson, Downey, Rafaeli, Coifman, & Paquin, 2011), as well as cognitively, and emotionally (Dixon-Gordon, Gratz, Breetz, & Tull, 2013; for details see 1.4.3). While being alert to rejection and detecting it overly sensitive interferes with well-being, and even endangers maintenance of social relationships if present in harmless contexts (Downey & Feldman, 1996), it can be adaptive in malicious environments. Consequently, intense sensitivity to rejection in BPD can be explained through learning history: Etiologically, adverse family situations are highly prevalent in BPD patients and likely to contribute to the development of BPD (Ball & Links, 2009; Battle et al., 2004; Linehan, 1993; Zanarini et al., 1997). In such an environment, characterized by abuse, neglect, and/or rejection, rejection sensitivity can develop as an adaptive mechanism to prevent potentially harmful incidents. However, once developed as a disposition, rejection sensitivity undermines social relationships (Downey & Feldman, 1996): High sensitivity to rejection is associated with actual rejection, low relationship satisfaction, and ultimately relationship break-ups (Downey, Freitas, Michaelis, & Khouri, 1998).

Those DSM diagnostic criteria which do not originally refer to disturbed interpersonal relatedness have been linked to it in empirical studies or theoretically. Both suicide attempts and non-suicidal self-injurious behavior (BPD diagnostic criterion 5; American Psychiatric Association, 2013) are frequently associated with interpersonal situations in BPD (Brodsky, Groves, Oquendo, Mann, & Stanley, 2006; Brown, Comtois, & Linehan, 2002; Kosson, Walsh, Rosenthal, & Lynch, 2015; Welch & Linehan, 2002; Yen et al., 2005). Amongst others – regulating intense negative affect has proven to be the most common function of non-suicidal self-injury (Brown et al., 2002; Klonsky, 2007) – also interpersonal functions of self-injury, such as interpersonal influence, peer bonding, and other social reinforcements, have been identified in the literature (Klonsky, Glenn, Styer, Olino, & Washburn, 2015; Nock & Prinstein, 2004). Closely linked to the diagnostic criterion of inner emptiness (BPD diagnostic criterion 7; American Psychiatric Association, 2013), are feelings of loneliness (Klonsky, 2008) which characterize BPD patients' psychopathology (Bohus et al., 2007). Loneliness is an ex-

tremely hurtful social feeling stemming from a perceived lack of close interpersonal relations (see e.g., Bhatti & Haq, 2017; Weiss, 1973; for details see 1.3). In addition to chronic feelings of emptiness also marked impulsivity (BPD diagnostic criterion 4; American Psychiatric Association, 2013) has been shown to be related to distressing interpersonal life events, e.g., separation from a spouse or major arguments in close relationships (Powers, Gleason, & Oltmanns, 2013). Social relationships are likely to be compromised by intense, inappropriate, or uncontrolled feelings of anger (BPD diagnostic criterion 8; American Psychiatric Association, 2013) and in turn bear huge potential to influence anger: Empirically, anger has been shown to occur as response to interpersonal distress, such as rejection, teasing, or disagreements (Berenson et al., 2011; Hepp, Lane, Wycoff, Carpenter, & Trull, 2018; Scott et al., 2017; Tragesser, Lippman, Trull, & Barrett, 2008). Interestingly, BPD patients have also been found to react ambiguously to proximity of social interaction partners: While these situations are clearly positive for healthy participants, BPD patients experience both increases in positive affect, as well as in anger and shame (Gadassi, Snir, Berenson, Downey, & Rafaeli, 2014; for details see 1.4.4). In turn, BPD patients' high feelings of anger can lead to aggressive acts (Kolla, Meyer, Bagby, & Brijmohan, 2017; Mancke, Herpertz, Kleindienst, & Bertsch, 2017; Scott et al., 2017), and interaction partners might withdraw from individuals who behave aggressively or frequently show intense anger. Furthermore, affective instability (BPD diagnostic criterion 6; American Psychiatric Association, 2013) has also been linked to interpersonal events: In a study investigating affective reactions to daily social interactions, Sadikaj, Russell, Moskowitz, and Paris (2010) found that high negative affect variability was explained by perceptions of interaction partners' behaviors that can be interpreted as triggers of rejection concerns, i.e., low warmth and agreeableness. Affective dysregulation has even often been proposed to account for maladaptive interpersonal behaviors and other BPD symptoms (see Linehan, 1993; Schmahl et al., 2014), supported e.g., by a study showing that affective instability predicted future borderline personality features most strongly and consistently (Tragesser, Solhan, Schwartz-Mette, & Trull, 2007). In another study, rapid increases of BPD patients' typical aversive inner tension or very high levels of such tension were preceded by interpersonally relevant events, i.e., rejection or being alone, in 22% of the cases (Stiglmayr et al., 2005). As regards identity disturbance in BPD (BPD diagnostic criterion 3; American Psychiatric Association, 2013), Jørgensen (2006) argues that identity is socially constructed and hence links BPD-characteristic unstable relationships to unstable identity. However, this association is of theoretical nature and empirical confirmation is missing. Finally, severity of dissociative symptoms in BPD patients (BPD diagnostic criterion 9; American Psychiatric Association, 2013) has been shown to be predicted by interpersonal traumatic experiences during childhood (Zanarini et al., 2000). In conclusion, it has to be noticed that the preceding overview over diagnostic criteria for BPD from an interpersonal point of view is in no way meant to imply that disturbed relatedness is sufficient to explain the disorder, but rather illustrates the multifaceted impli-

cations of this symptom domain within the complex interrelatedness of different pathological symptoms.

Diverse prominent etiological theories as explanatory frameworks for the development of BPD psychopathology coexist and are briefly outlined in the following. Object relations theorists (Kernberg, 1975, 1976) assume that during childhood individuals form mental images of their social relations with caregivers and these images are called object representations. According to Kernberg (1975, 1976), BPD patients are predisposed to an inability to regulate affect in interpersonal relations. Together with early traumatic experiences of abuse or neglect in object relations this leads to conflictual object representations. Since these representations are relatively stable, they strongly influence later social relationships. Consequently, BPD patients might expect similar abusive behavior from all interaction partners, according to their object relations from early childhood, which causes problems in social interaction. Just as object relations theory, an extension of Bowlby's (1973) attachment theory also postulates that BPD pathology develops through early disturbances in interactions between child and caregiver. Infants whose needs are not met by their caregivers develop maladaptive attachment styles – like insecure disorganized attachment or attachment anxiety – that are closely linked to personality disorders (for a review see Levy, Johnson, Clouthier, Scala, & Temes, 2015). Again, attachment styles are relatively stable, and thus influence later social interaction. In this way evoked reactions can cause problems when carried out towards non-abusive interaction partners, e.g., individuals with disorganized attachment often show behaviors like unwillingness or fear of becoming attached and denial of needs (Gunderson, 1996). Among all personality disorders, BPD has been proposed to be the one with the least adaptive attachment (Levy, Beeney, & Temes, 2011). Also rooted in attachment theory, Fonagy and Bateman (2008) proposed a mentalization-based model of BPD development. The ability to mentalize, i.e., to understand mental states of oneself and others, is developed through childhood and strongly influenced by current arousal. Both constitutional vulnerability and environmental influences, e.g., neglect in early relationships, can hamper the development of mentalization ability. Traumatic childhood experiences can also lead to hypersensitivity of the arousal system. Hence, BPD patients exhibit severe difficulties with mentalizing in intense interpersonal encounters which are accompanied by strong emotional arousal (Fonagy & Bateman, 2008). At the core of schema theory (J. Young, Klosko, & Weishaar, 2003) there are persistent dysfunctional themes concerning oneself and one's social relationships, so-called early maladaptive schemas. They develop during childhood e.g., when basic needs (like need for security or acceptance) are unmet, or through traumatization. The resulting early and thus enduring maladaptive coping strategies explain problems in interpersonal relationships throughout one's lifetime. Last but not least, Linehan's bisocial theory (1993) explains development of BPD patients' interpersonal problems by a transaction of biological vulnerability, i.e., emotion dysregulation, and environmental

stressors, i.e., invalidating environment: When individuals with dispositional difficulties to regulate intense emotional experiences grow up in an invalidating environment that produces such emotional responses while simultaneously signaling that coping with these emotions should be done internally, they cannot learn how to handle their emotional reactions. Emotional inhibition and extreme emotional lability are the results. Interestingly, according to all frameworks, problems in interpersonal relationships play an important role in both causes and consequences of BPD.

Taken together, leading theorists converge that development and symptomatology of BPD are strongly influenced by interpersonal disturbances (for a review see also Lazarus, Cheavens, Festa, & Rosenthal, 2014). Hence, identifying prerequisites, causes, and consequences of these interpersonal disturbances is fundamental in trying to understand this severe personality disorder and ultimately contributes to improvements in its therapeutic treatment. To facilitate a deeper understanding of the specifics of interpersonal problems associated with BPD, the following paragraphs characterize BPD-specific social relations and interaction. Since BPD is a rather heterogeneous disorder, it is not surprising that there are various kinds of interpersonal problems associated with BPD (Wright et al., 2013). Therefore, this thesis provides details on such hallmarks of social interaction that are especially important to comprehend origination of the studies presented in Chapters 2-4.

1.2 Interpersonal Relations in Borderline Personality Disorder

In the following, I will present alterations in interpersonal relations in BPD, and thereby distinguish different aspects of social interaction according to the degree of familiarity of interaction partners. There is an important distinction to be made between both extremes: Interaction with significant others versus interaction with formerly completely unknown others. State of research on both kinds of relationships in general as well as specific alterations in BPD are discussed in the following paragraphs, to provide background knowledge on interpersonal relations for development and consequences of feelings of loneliness, rejection, and belonging which are later suggested as important cornerstones in understanding BPD.

1.2.1 Relationships with Significant Others

The importance of intimate relationships for maintenance of BPD becomes evident in a quote from Marsha Linehan: “In my experience, borderline individuals, more so than most, seem to do well when in stable, positive relationships and to do poorly when not in such relationships” (Linehan, 1993, p. 11). This observations has been confirmed empirically by Gunderson et al. (2006), who found that high quality of interpersonal relationships was linked to improvements in the course of the disorder, and by Kuhlken, Robertson, Benson, and Nelson-Gray (2014), who found that satisfying romantic relationships can function as a buffer against anger in individuals with high BPD symptom

scores. Unfortunately often, intimate relationships of BPD patients rather seem to be characterized by difficulties: From their experiences in couples therapy with BPD patients, Oliver, Perry, and Cade (2008) conclude that "The nature of this disorder leads to severe conflict, pain, and dysfunction in relationships. This level of dysfunction increases as the intimacy of the relationship intensifies. Hence, intimate relationships are particularly vulnerable" (p.68). In line, current research paints a picture of BPD patients' low abilities to form and maintain positive intimate relationships: Both relationship status and quality are diminished in BPD, meaning that these patients are less often married (Swartz, Blazer, George, & Winfield, 1990) or in a romantic relationship (Bernstein et al., 1993), and when they are, they report higher relationship dissatisfaction (Bouchard, Sabourin, Lussier, & Villeneuve, 2009; South, Turkheimer, & Oltmanns, 2008; Zanarini, Frankenburg, Hennen, Reich, & Silk, 2005), and exhibit more frequent conflicts (Daley, Burge, & Hammen, 2000; Lavner, Lamkin, & Miller, 2015), break-ups (Bouchard et al., 2009), and intimate violence (M. A. Jackson, Sippel, Mota, Whalen, & Schumacher, 2015) than nonclinical and clinical comparison groups (for a review see Bouchard & Sabourin, 2009). These findings were retrieved via self-, and other-reports, i.e., interviews, surveys, questionnaires. Clifton, Pilkonis, and McCarty (2007) analyzed the composition of social networks using a more sophisticated methodology, namely social network analysis, which uses a variety of calculations to quantify important parameters of social networks (see Borgatti, Everett, & Johnson, 2013, for details). They found that BPD patients' networks include significantly more former romantic partners and significant others whose relationships to the patients were terminated (Clifton et al., 2007). Using a comparable methodological approach in larger samples, Lazarus and Cheavens (2017) confirmed that BPD patients have smaller social networks than healthy individuals and describe them as less satisfying and characterized by poorer social support and more conflict; and Beeney, Hallquist, Clifton, Lazarus, and Pilkonis (2018) found that most significant others are less centrally located in BPD patients' networks than those of HCs, meaning that they are less socially connected to other members of the patients' social networks. Unfortunately, further studies of BPD patients' social networks are rare. Nonetheless, it becomes evident that BPD patients' relationships with others are problematic. Furthermore, as explicitly stated in the DSM diagnostic criteria for BPD, these patients tend to show patterns of oscillating between the extremes of idealization and devaluation (American Psychiatric Association, 2013), when it comes to relationships with significant others. Distorted functioning of intimate relationships seems to be rather specific for BPD symptomatology, differentiating it from avoidant personality disorders (Hill et al., 2008).

As became evident so far, alterations in relationships with significant others in BPD have been extensively documented in the existing literature. However, investigations of underlying mechanisms of these alterations are rather sparse. There are a few empirical studies starting to shed light on potential mechanisms: In their attempt to explain BPD-characteristic difficulties in intimate relation-

ships, Miano, Fertuck, Roepke, and Dziobek (2017) found that instability of relationships can stem from a lack of trust towards a romantic partner. Specifically after discussions about potentially threatening situations (both personally threatening and relationship threatening as opposed to a neutral condition) trustworthiness appraisals of their romantic partners were significantly lower in BPD patients than in HCs. That such reduced trust interferes with relationship quality has been shown in social psychological studies, where low trust in close relationships impeded conflict resolution (Kim et al., 2015) and forgiveness after transgressions (Strelan, Karremans, & Krieg, 2017). Tragesser et al. (2008) investigated different potential reasons for individuals with high BPD features to react to ambiguous or negative social situations in a maladaptive way: While ruling out perceptual biases as an explanation, they found emotional reactivity and impulsivity to be relevant factors in predicted aggressive reactions to teasing by a stranger or a friend. The authors showed that these predicted aggressive reactions were specifically due to higher predicted anger, thus, supporting the assumption that BPD-typical emotion dysregulation leads to other symptoms (Linehan, 1993). Additionally, BPD-specific affective instability and marked impulsivity have been shown to hamper positive outcomes like relating well with significant others and meeting social role obligations towards friends, family, or romantic partners (Bagge et al., 2004). Next to impulsivity and impaired emotion regulation, also disturbed empathy and intimacy may at least partially contribute to difficulties in forming and maintaining satisfying and stable interpersonal relationships (Jeung & Herpertz, 2014), since empathy has been shown to be a stable predictor for relationship satisfaction (Cramer & Jowett, 2010) and – at least the cognitive component of empathy – is significantly reduced in BPD under certain circumstances (Guttman & Laporte, 2000; Harari, Shamay-Tsoory, Ravid, & Levkovitz, 2010; New et al., 2012). As mentioned earlier, rejection sensitivity, which is significantly heightened in BPD (Bungert, Liebke, et al., 2015), compromises intimate relationships (Downey & Feldman, 1996). Individuals who constantly feel rejected by their romantic partner, are more jealous and hostile, and in the end less satisfied with their relationships (Downey & Feldman, 1996). Additionally, relationships with rejection-sensitive partners tend to be less supporting (Downey & Feldman, 1996). However, these connections have been studied in healthy individuals and have yet to be confirmed empirically for BPD patients.

Finally, in order to develop relationships that become significant over time it takes positive social interaction with unknown others to provide the basis for mutual interest in maintaining the interaction over longer terms. Thus, next to maintaining existing relationships, initiating social interaction with strangers is essential to gradually establish somewhat large and dense satisfying social networks. And vice versa, close interpersonal relations can influence social interaction with strangers (Feeney, Cassidy, & Ramos-Marcuse, 2008). Therefore, research findings on BPD-specific alterations in social interaction with unknown others are presented in the following paragraph.

1.2.2 Relationships with Unknown Others

While relationships with significant others are difficult to investigate in experimental designs and thus have to employ other methodological approaches (such as questionnaires, interviews, or social network analysis; see 1.2.1), relationships with unknown others have often been studied in experiments. Herein, one prominent approach is based on interaction games from behavioral economy. This approach is used to investigate basal interaction behavior to draw inferences about fairness, cooperation, trust, etc. which are important underlying aspects of social interaction behavior even in interactions with unknown others. Through such economic games described in the following, researchers try to standardize the behavior of interaction partners as well as other context variables of social interaction, using e.g., real or virtual co-players with whom participants can interact in certain predefined ways. Prominent examples are dictator games (see Forsythe, Horowitz, Savin, & Sefton, 1994; Hoffman, McCabe, & Smith, 1996; Kahneman, Knetsch, & Thaler, 1986), ultimatum games (see Güth & Tietz, 1990), prisoner's dilemma games (see Rapoport & Chammah, 1965), and trust games (see Berg, Dickhaut, & McCabe, 1995), which will be briefly outlined in the following as background knowledge for drawing conclusions from subsequently summarized studies on BPD patients' relationships with unknown others.

In a dictator game, participants act as allocators and arbitrarily divide a certain amount of monetary units (MUs) between themselves and a co-player, i.e., the recipient (see Forsythe et al., 1994). There is no possibility for the recipient to interfere in any way, which renders equal division of MUs by the participant an act of altruistic fairness (as long as it is anonymous). In an ultimatum game, the prisoner's dilemma, and in trust games, the co-player shows certain behavior as well, which can be pre-programmed in different ways as to tailor it to the purpose of the investigation. The ultimatum game is designed just as the dictator game, with the single decisive difference that the recipient can either accept or reject the proposers offer; if he/she rejects the offer, both interaction partners leave the game without any earnings (see Güth & Tietz, 1990). In the prisoner's dilemma both co-players simultaneously make the same decision between two behavioral alternatives: Cooperation or defection (see Rapoport & Chammah, 1965). Before the game starts they are informed about a chart that specifies wins of MUs, with the exact amounts depending on both, their own and their partner's behavior. Usually, mutual cooperation ensures fair wins for both players, but bears the risk of defection of the co-player, in which case the cooperative subject gains less and the defective co-player more than under mutual cooperation; mutual defection turns out worse for both players than mutual cooperation (see Rapoport & Chammah, 1965).

Trust games are even more complex than the prisoner's dilemma, since usually players have a wider range of possible actions than just those two options of cooperation or defection. Classic trust games consist of two players, i.e., an investor and a trustee. The investor is endowed with a certain

amount of MUs that he/she can divide between him-/herself and the trustee. The trustee obtains his/her share – multiplied by a certain factor – and is then asked to again divide it between him-/herself and the investor (see Berg et al., 1995). Why is a trust game called "trust game" (note that Berg et al., 1995, actually called it "investment game", but others refer to it as "trust game", see e.g., Johnson & Mislin, 2011)? Given the composition of the game, the investor has to consign MUs to the trustee in order to make more of it. However, if the trustee decides to keep all the consigned MUs to him-/herself, the investor ends up with nothing. Hence, it requires trust to give own possessions of MUs to the trustee: One has to trust the trustee to cooperate in order to achieve a maximum outcome for both players, which is feasible only under mutual cooperation. The amount of investment in the trust game is not only a measure of trust, but also of cooperation, since the investor's behavior affects not only his/her own but also the trustee's outcome (see Thielmann & Hilbig, 2015). If a game where both players actively take part (i.e., all previously explained games except from the dictator game) consists of multiple rounds we can learn something about development and maintenance of cooperation over a longer time-course. In case of the trust game, if the trustee is entrusted with unfair sharings of the investor he/she will likely return a small amount also. If the investor does not get anything in return from the trustee, he/she will likely reduce his/her investments in the following round. From the perspective of the trustee, who comes away empty-handed if he/she does not get any MUs from the investor in the first place, it is of outright importance to encourage the investor to share his stock. Thus, it requires the ability and willingness to coax (see King-Casas et al., 2008). Findings derived from such paradigms that allow conclusions to be drawn in respect of BPD patients' interaction behavior will be summarized in the following paragraphs.

BPD patients have been characterized as less trustful and cooperative (King-Casas et al., 2008; Saunders, Goodwin, & Rogers, 2015; Unoka, Seres, Áspán, Bódi, & Szabolcs, 2009). In a multi-round prisoner's dilemma game where the virtual co-player was pre-programmed to always use a tit-for-tat strategy (i.e., always acting exactly as the interaction partner did in the previous round), BPD patients were less cooperative than HCs and patients with bipolar disorder (Saunders et al., 2015). Additionally, in King-Casas et al.'s study (2008) participants played a trust game in the role of the trustee and after reception of a small investment HCs were more likely to make a large repayment while contrarily BPD patients were more likely to make a small repayment. Hence, the authors conclude that BPD patients significantly less coaxed their co-playing investors into cooperation lacking the ability to maintain cooperation over a longer time-course. Having subjects play a similar game in the role of the investor, Unoka et al. (2009) were able to show that reduced investments in BPD are specific for social interaction: Instructions were varied such that repayment was either attributable to a social co-player or to a random lottery. BPD patients made lower investments, i.e., displayed reduced trust,

only when they thought their repayment depended on a real other person, not when it was assumed to be dependent on chance.

However, these difficulties in interaction behavior in BPD have not been observed consistently (for a review see Lis & Bohus, 2013). Franzen et al. (2011) adapted their trust game by showing pictures of four different co-players who varied in their facial emotional expression, i.e., happy, neutral, or angry. While healthy subjects' investments depended solely on these facial expressions of their co-players (i.e., they endowed higher investments towards smiling than towards angry-looking co-players independent of their fairness), BPD patients not merely relied on emotional facial cues, but also invested higher amounts towards fair than towards unfair co-players. Hence, the authors conclude that BPD patients are superior in attributing mental states to their interaction partners in the presence of emotional cues. Important to notice, both groups did not differ in emotion recognition or perception of the co-players' fairness. Polgár, Fogd, Unoka, Sirály, and Csukly (2014) investigated the influence of interaction partners' facial expressions on responses towards offers in an ultimatum game, also finding that BPD patients are influenced by these expressions only in the case of fair offers. In another study, participants observed others playing a dictator game (Wischniewski & Brüne, 2013). The participants' only way to intervene was by subtracting points from the proposer to punish him for unfair behavior towards the receiver. Results show that punishment increases with unfairness equally in BPD patients and HCs, suggesting similar perception of fairness (Wischniewski & Brüne, 2013). Nonetheless, despite similar behavior, there might be differences in underlying motivations as suggested by distinct correlation patterns with personality traits between both groups (Wischniewski & Brüne, 2013).

Bartz et al. (2011) had their subjects play a so-called assurance game, a variation of the prisoner's dilemma, where mutual cooperation turns out best for both players. Besides the assessment of their actual behavior, subjects were asked to indicate their expectations about their co-player's behavior, and what they would do if they knew for sure that their partner would cooperate, a question designed to disentangle aggressive behavior (defection despite guaranteed cooperation from the co-player) from self-protection (defection in order to avoid being exploited by a co-player). Bartz et al. (2011) did not find any differences in self-reported trust or actual cooperative behavior between BPD patients and healthy individuals, neither in case of aggressive behavior, nor self-protection. However, in the same study, BPD patients' self-reported trust was significantly diminished via oxytocin in both cases. This is surprising, since from studies in healthy individuals oxytocin is known to increase trust (see e.g., Kosfeld, Heinrichs, Zak, Fischbacher, & Fehr, 2005). However, recently this assumption has been questioned due to methodological reasons as well as unsuccessful replication-attempts (for a review of this critisism, see Nave, Camerer, & McCullough, 2015), and also Bartz et al. (2011) could not replicate it. Nonetheless, regardless of the association between oxytocin and trust in HCs, the

decrease of trust under oxytocin in BPD patients in Bartz et al.'s study (2011) is certainly different from what has been observed in HCs. The authors interpret this as a sign that oxytocin increases the salience of social cues – in this case trust-related cues – thus activating BPD patients' anxious attachment and rejection sensitivity which leads to maladaptive behavioral responses like defection in the assurance game. For further details on BPD patients' social interaction in exchange games see reviews by Jeung, Schwieren, and Herpertz (2016) and Lis and Kirsch (2016).

So far, experimental findings on trust and cooperative behavior in BPD are heterogeneous, with some studies reporting reduced trust and cooperation towards social interaction partners in BPD (King-Casas et al., 2008; Saunders et al., 2015; Unoka et al., 2009), while others do not (Bartz et al., 2011; Franzen et al., 2011; Wischniewski & Brüne, 2013), or only under certain circumstances (i.e., after oxytocin intake and only when measured via self-reports, see Bartz et al., 2011). Thus, further potentially modulating factors have to be investigated. In a recent attempt to identify circumstances responsible for reduced cooperative behavior, Thielmann, Hilbig, and Niedtfeld (2014) found that BPD features did not predict differences in investments in a dictator game, but only in an ultimatum game that subjects played in the role of the recipient, which means they could decide whether to accept or reject the virtual proposer's offers. These findings imply that higher BPD features are related to reduced reactive cooperation (since individuals high in BPD features rejected their proposer's offers more often than individuals low in BPD features, i.e., they do retaliate against their co-players), while active cooperation is not diminished (since individuals high in BPD features behaved exactly as cooperative towards an un-reactive co-player in the dictator game as individuals low in BPD features, i.e., they do not exploit their co-players). The authors conclude that while individuals with high BPD features are not per se less giving than control participants, they are significantly less willing to forgive interaction partners after a break in cooperation. Further studies disentangling the exact specifications of conditions that diminish trust and cooperative behavior in BPD are needed in order to precisely address such specific trust issues in psychotherapy, which might hopefully yield positive effects on BPD patients' interpersonal relations.

1.3 Loneliness

The above mentioned difficulties in BPD patients' relationships with both unknown others as well as with those interaction partners that have evolved to being significant others, can be assumed to increase the likelihood and severity of experiencing loneliness. Effects of loneliness on health and well-being and thus the importance of elucidating the role of loneliness in BPD are outlined in the following.

Loneliness is a relatively common experience in the general population (Peplau & Perlman, 1982; Weiss, 1973), so everybody seemingly has an idea of what loneliness is. In medical, sociologi-

cal, and psychological research it has often been defined as perceived social isolation (see e.g., Bhatti & Haq, 2017; Cacioppo & Hawkley, 2009; Weiss, 1973). With the word "perceived" this definition emphasizes the subjectivity of loneliness: If someone is under the impression that he or she is isolated from others, he feels lonely. Beyond this general definition, literature suggests that the concept of loneliness can be seen as multifaceted. Three distinct dimensions of loneliness have been proposed: State-, trait-, and existential loneliness (Mayers, Khoo, & Svartberg, 2002). State loneliness comprises circumscribed experiences of loneliness that occur in reaction to social circumstances, and thus are rather unstable across time. Trait loneliness is a more stable form that can be seen as a facet of personality. These two dimensions of loneliness are thought to be remediable, e.g., through improving social situations, social skills, or social cognition (Masi, Chen, Hawkley, & Cacioppo, 2011). More fundamental is the so-called existential loneliness, a dimension of loneliness that emerges due to impossibility of perfect interpersonal communication and unavoidability of separation or death, and endures across the life-span, since there is no permanent relief (Mayers & Svartberg, 2001).

A multitude of empirical studies has shown that loneliness can be severely distressing. "The need for affiliation and engagement in rewarding social relationships is intrinsic to human beings" (Lauder, Mummery, Jones, & Caperchione, 2006, p. 233). Thus, if this need is not being met, it deeply impacts our lives: Studies have shown that loneliness is linked to increases in negative and decreases in positive affect (Cacioppo et al., 2006). It is also closely linked to health and well-being, since it has often been revealed that lonely people show worse health outcomes, both psychologically and physically (for a review see Hawkley & Cacioppo, 2010): For example, loneliness increases the risk for depression (J. Jackson & Cochran, 1991; Victor & Yang, 2012) and is closely linked to sleep disturbance (Cacioppo, Hawkley, Berntson, et al., 2002; Cacioppo, Hawkley, Crawford, et al., 2002). It is also associated with poor health behaviors, like smoking and little physical activity (Lauder et al., 2006; Shankar, McMunn, Banks, & Steptoe, 2011). Even cardiovascular health has been shown to be reduced in lonely people (Hawkley, Thisted, Masi, & Cacioppo, 2010). So ultimately, loneliness is even linked to mortality (Holt-Lunstad, Smith, Baker, Harris, & Stephenson, 2015; Patterson & Veenstra, 2010; Shiovitz-Ezra & Ayalon, 2010).

It can be expected, that loneliness is especially pronounced in BPD, as Gunderson (1996) stated that "intolerance of being alone was identified as one of the defining criteria for the diagnosis of BPD when it made its entry into the official diagnosis system (DSM III) in 1980" (Gunderson, 1996, p. 752). The previously described problems in interpersonal relationships with significant as well as with unknown others are essential factors enhancing feelings of loneliness (see, e.g., Rotenberg et al., 2010, for the relationship between trust and loneliness). Since BPD patients have been shown to have smaller and less dense social networks than HCs (e.g., Beeney et al., 2018; Clifton et al., 2007; see 1.2.1), indicated by fewer social contacts as well as more frequent break-ups and less closeness

among network members, experiences of loneliness seem to be more likely in these patients. Moreover, recent research on interpersonal interaction in BPD consistently shows that in BPD patients social integration is not as satisfactory as it is in healthy subjects (De Panfilis, Riva, Preti, Cabrino, & Marchesi, 2015). Consequently, even if they are not actually isolated from others, they might nonetheless feel lonely, potentially due to a high need to belong and simultaneous reduced feelings of belonging (which will be described in more detail in 1.4.4). Not only alterations in social networks, but also difficulties in social functioning, i.e., "the level at which an individual functions in his or her social context" (Tyrer & Casey, 1993, p. 8), have to be investigated as potential contributors to increased loneliness in BPD. Social functioning has often been shown to be impaired in BPD (Gunderson et al., 2011; Hill et al., 2008; Stepp, Hallquist, Morse, & Pilkonis, 2011; Zanarini et al., 2005), and reduction in diverse aspects of social functioning have been shown to be associated with loneliness in healthy individuals, e.g., maintaining conversations, and expressing emotions (Cacioppo et al., 2006; DiTommaso, Brannen-McNulty, Ross, & Burgess, 2003). Despite the strong theoretical linkage of BPD and loneliness that has been summarized here, feelings of loneliness in BPD have never been focused on empirically, beyond its inclusion as one aspect of symptomatology in the Borderline Symptom List (BSL; Bohus et al., 2007). Moreover, aspects of one's social life contributing to ostensibly increased loneliness in BPD remain to be clarified: Does severe loneliness stem from a lack of social interaction and/or a lack of interaction abilities? And are disturbances in social functioning and social networks sufficient to explain severe loneliness as a part of BPD symptomatology or is there even more to it? This last question is especially important to answer, since research on loneliness in BPD is largely missing so far, and many further contributing factors are imaginable that should be addressed in the future. Existential aspects of loneliness, which might over the long term be unaffected by social networks and social functioning, since e.g., Mayers et al. (2002) proposed positive relationships to be only temporary distractions, might play a role in experiences of loneliness in BPD. Supporting this notion, loneliness has been described as particularly existential in patients with severe mental illnesses (for a review see Linz & Sturm, 2013).

The link between loneliness and BPD seems even more reasonable in light of increased rejection sensitivity. If one often feels rejected by others, as BPD patients do (Bungert, Liebke, et al., 2015; Renneberg et al., 2012; Staebler, Helbing, et al., 2011), loneliness is a common emotional reaction (Leary, 2015). That rejection sensitivity and loneliness are indeed significantly and moderately related has recently been shown empirically in a meta-analytic review by Gao, Assink, Cipriani, and Lin (2017). The following paragraphs provide detailed insight into reactions to social rejection and its converse, social belonging.

1.4 Social Rejection and Belonging

As we have seen so far, social interaction can express itself in various ways. One phenotype of social interaction with substantial impact on human life is social rejection. From an evolutionary perspective, social rejection is even life-threatening, since for our early ancestors, being part of a group was absolutely essential to survive (Sudnow, 1967; Williams, 2007b). Had they not joined together in groups, they would not have been able to provide food, protect themselves from dangerous animals, and raise their offspring. This evolutionary approach can explain our deep routed fear of rejection and by that our efforts to avoid being rejected. Consequently, the need to belong is one of the most fundamental human needs (Baumeister & Leary, 1995) and humans aim at avoiding rejection to preserve the need to belong. This need constitutes a powerful motivational drive, i.e., an important motivator for initiating and maintaining contact with others (Baumeister & Leary, 1995). Since nearly every social situation bears the potential of rejection, it is not surprising that social rejection is frequently experienced in daily life (Fanger, Frankel, & Hazen, 2012; Leary, 2005; Nezlek, Wesselmann, Wheeler, & Williams, 2012; Williams, Forgas, von Hippel, & Zadro, 2005). Again, this can be explained evolutionary: Social rejection is an adaptive strategy in situations where an individual weakens the group or endangers group cohesion, since rejecting this individual increases the likelihood of the other group members' survival (Williams, 2009) and reproduction (Gruter & Masters, 1986).

Before I start going into detail on research on reactions to social rejection in healthy individuals and its alterations in BPD, I would like to briefly clarify the according terminology. The literature consists of several terms, which can be used in slightly different ways. To render distinctions even more complicated, different views on how to use these terms coexist. According to Williams (1997), the term o*stracism* is used to describe the situation of being excluded and ignored by a specific group or individual. It is hard to distinguish from *social exclusion* which describes being kept from any other person (Williams, 2007a). In this context, the term *rejection* is used to indicate situations where explicit announcements are made that someone is not wanted or welcome (Williams, 2007a). Under the terms of Blackhart, Nelson, Knowles, and Baumeister (2009) on the other hand, the relevant differentiation consists in *rejection* requiring the individual's pre-existing wish to bond, while *exclusion* as well as *ostracism* can take place regardless of the individuals attitude towards the perpetrators. A third perspective from Rajchert and Winiewski (2016) claims that *rejection* refers to losing pre-existing interpersonal belonging while *ostracism* describes an act from strangers, thus constitutes a term for „failing to achieve […] interpersonal belonging" (Rajchert & Winiewski, 2016, p. 272).

Mostly, all of these terms are used interchangeably throughout the literature for any instance characterized by being left out of a dyad or a group (Williams, 2007a) – be it explicit or implicit, with or without a pre-existing wish for or actually existing bond. In this thesis I stick to the term *rejection*, since according to Williams' definition (2007b) strictly speaking it is the correct description for explic-

it negative feedback on evaluation of the self by others, which we manipulated experimentally in studies II and III of this thesis (for details see Chapter 3 and 4; note that we are not able to draw definite conclusions about our subjects' desire to bond with their interaction partners nor about the extent of interpersonal belonging elicited within our paradigm, and furthermore would have to consider individual differences between our subjects, thus rendering application of Blackhart et al.'s, 2009, or Rajchert and Winiewski's, 2016, definition impractical). Moreover, in order to integrate all past research findings relevant regarding this topic, in this introduction I subsume them using *rejection* as a generic term – as others did before (see e.g., Blackhart et al., 2009; Premkumar, 2012; Smart Richman & Leary, 2009) – including all kinds of actions that involve the opposite of being implicitly included or explicitly accepted by any individual or group. All of these specific forms subsumed as *rejection* in the present thesis have in common that they pose a substantial threat to belonging (Leary, 2005; Williams, 2007a).

1.4.1 Paradigms in Research on Social Rejection

Findings on reactions to social rejection are diverse and to some extent dependent on the paradigm used to induce rejection (Gerber & Wheeler, 2009). Therefore, in this paragraph, an overview of available rejection paradigms will be given, with emphasis on especially prominent ones. Specific advantages and disadvantages of the different paradigms as well as underlying processes will be highlighted to facilitate understanding of the afterwards presented research findings on reactions to rejection in healthy subjects as well as their comparison with alterations in such reactions that have been found in patients with BPD.

As an attempt to structure the various paradigms to investigate social rejection available so far, they can be separated with regard to temporal aspects of rejection into those using memory of rejection experienced in the past, those that predict social rejection in the future, and those during which individuals are rejected by real or virtual others during the course of social interaction. Beyond that, some rejection paradigms exist, for which this temporal classification is not suitable, like e.g., priming of rejection (e.g., Baldwin & Main, 2001), or imagining rejection experiences (e.g., Craighead, Kimball, & Rehak, 1979); but since they constitute rather vague or impersonal manipulations of rejection and are less frequently used (cf. Blackhart et al., 2009; Williams, 2007a), I will not go into detail on these paradigms here. In rejection-memory paradigms, subjects relive in their minds or write about a personal experience of rejection from their past. Such visualization of one's own experiences has been shown to manipulate rejection successfully (Gardner, Gabriel, & Diekman, 2000; Pickett, Gardner, & Knowles, 2004). As opposed to paradigms that use future or present rejection, these ones might be able to target long term or delayed effects of rejection, since the rejection experience actually happened some time before the study takes place (cf. Blackhart et al., 2009). Conversely, a life-

alone prognosis paradigm induces the anticipation of social isolation later in life by manipulating feedback of the results of a personality questionnaire (e.g., Baumeister, Twenge, & Nuss, 2002; Twenge, Baumeister, Tice, & Stucke, 2001). Participants fill out a personality questionnaire and are subsequently told that examination of their answers indicated that even though they might have a group of friends for now, they are going to end up all alone later in life. Note that predicted future rejection differs from paradigms using past or present rejection, since rejection is hypothetical and does not actually happen to the participant. Hence, participants could potentially find reasons to doubt or even dismiss the interpretation of the personality test results as a coping strategy. Instead, interaction-related paradigms induce social rejection by having real or virtual others reject the subjects directly within the experimental setting. Such paradigms where subjects are actually rejected at the time of testing have been shown to yield stronger effects than others like priming rejection or evoking anticipation of rejection in the future (see meta-analysis by Blackhart et al., 2009). One prominent example for such an interaction-related paradigm is Cyberball, a virtual ball-tossing game (Williams, Cheung, & Choi, 2000; Williams & Jarvis, 2006). Herein, the subject engages in ball-tossing with two alleged other participants. In fact, these participants are computer-programmed to engage in specific behaviors: While in the inclusion condition, even allocation of the ball tosses among all three players is ensured, in the rejection condition, after receiving a few tosses in the beginning, the subject is completely left out of the game by the other two players. Such confederate-free, highly controlled designs allow for investigation of social interaction as standardized as possible. Additionally, compared to the life-alone prognosis paradigm this approach bears higher ecological validity, since rejection currently takes place at the time of testing rather than merely being predicted for the future, which does usually not happen in real life. Still, it can be argued that being left out of a computer game does not resemble rejection conditions that occur in real life very closely (see Nezlek et al., 2012).

Opposed to the huge variety of Cyberball-studies, rather few studies aimed at inducing social rejection through more detailed manipulations representing rejection situations that similarly occur in everyday life, like for example becoming acquainted and subsequently rejected by real other people. One of these detailed manipulations with real other people as rejecters was introduced by Nezlek, Kowalski, Leary, Blevins, and Holgate's (1997), where participants filled in information questionnaires about themselves which were exchanged with other participants. Later on they were told that based on this information the others did or did not want them as coworkers on an upcoming task, inducing acceptance or rejection, respectively. This kind of induction is rich in mundane realism, i.e., the experimental design is very similar to what could happen in real life (for a more detailed definition, see Aronson & Carlsmith, 1969). On the other hand, the authors themselves broach the subject of standardization, which in their following experiment forced them to provide participants

with information exchange questionnaires filled in by confederates rather than other participants, to ensure that all participants were provided with the exact same information. While studies with confederates yield higher standardization of interaction than studies with real other participants, they still cannot ensure exactly the same behavior in every session of the study. Here, virtually programmed interaction partners, as in the Cyberball paradigm, are the only way to guarantee that even subtle social signals are identical for every subject. Consequently, combining those two advantages, i.e., experimental standardization to the maximum possible extent as well as mundane realism of enriched environments, seems to be an important challenge for rejection research. Moreover, the strength of the rejection experience has been proposed to be a relevant factor for reactions to rejection (B. Iffland, Sansen, Catani, & Neuner, 2014, see 1.4.2 for details). Cyberball comprises a rather mild form of rejection due to being decontextualized and not providing individual information of the co-players, thus, preventing attribution of rejection to ones' own personal characteristics: "The participant has never met, nor intends to meet the other players, and they are engaged in a minimal form of computer mediated interaction" (Williams, 2009, pp. 293-294). However, a rejection paradigm comprising the ecological validity of real life social interaction and consequently the strong impact of an according rejection while simultaneously using computer controlled co-players to standardize social interaction is lacking so far. Recently, Goodacre and Zadro (2010) developed a paradigm called O-Cam, a simulated web conference during which in the rejection condition participants are ignored by two real other persons that have been videotaped prior to the study. Compared to Cyberball, O-cam represents an enriched social situation that could similarly occur in real life, while simultaneously standardizing behavior of the interaction partners by pre-programming it. However, both in Cyberball and O-Cam, participants are implicitly rejected by being left out of a game or by being ignored while they talk. Hence, these paradigms do not necessarily allow for conclusions about reactions to explicit rejection that is tailored to personal characteristics.

Keeping in mind the mentioned differences between rejection paradigms as potentially modulating factors of reactions to social rejection, the following paragraphs can be understood as summaries of what is known so far about such reactions in healthy individuals as well as in BPD patients.

1.4.2 Reactions to Social Rejection in Healthy Individuals

Williams (2009) proposed a framework illustrating the complexity of reactions to social rejection, the so-called temporal need-threat model. Herein, different phases are distinguished: Initial reactions comprise emotional and physical pain, negative emotions, and threat of the four fundamental needs for belonging, control, self-esteem, and meaningful existence. Afterwards, in the reflective phase, cognitive processing takes place and initiates certain coping strategies, tailored to fortify the threatened needs, like e.g., prosocial behavior to facilitate future inclusion and thus re-establish the need

to belong. In the third phase of the model, long-term effects of rejection are described: When coping-mechanisms are depleted, it results in depression, helplessness, and feelings of unworthiness, thus resignation. Given all these negative consequences of social rejection for the rejected individual, it is important to detect potential rejection quickly, in order to initiate timely countermeasures. Consequently, humans even show an over-detection bias, i.e., a tendency to perceive rejection even if it is not present (Williams, 2009).

Consequences of social rejection affect human life in a multitude of ways. Physiological arousal has been found as a consequence of rejection, e.g., increased cortisol activity (Blackhart, Eckel, & Tice, 2007; Zwolinski, 2008). In terms of heart rate (HR) inconsistent findings have been observed, i.e., either a downshift (Gunther Moor, Crone, & van der Molen, 2010; Mooren & van Minnen, 2014), or an increase (B. Iffland et al., 2014). Amongst other possible explanations, these differences might depend on the severity of the rejection manipulation (see B. Iffland et al., 2014), since Gunther Moor et al. (2010) had participants provide personal information (i.e., a photo of themselves) on which rejection feedback was based, whereas B. Iffland et al. (2014) used Cyberball which might be regarded as a less severe form of rejection, since it is executed through implicit ignoring that is not tailored to any personal characteristics of the rejected participant (see 1.4.1 and see also Williams, 2009, conceding that Cyberball constitutes a mild form of rejection). Hence, one might suppose that mild forms of rejection might increase heart rate in order to activate counterbalancing behaviors, while stronger or repeated rejection experiences might lead to some kind of numbing in the form of a deceleration of heart rate instead, as comparable to the resignation in the third stage of Williams' (2009) model. On a cognitive level, social rejection has been shown to alter cognitive control, with increased detection of response conflicts and decreased inhibition of unwanted responses, implying that behavioral reactions to rejection might not be based on depletion but rather on re-allocation of cognitive processes (Otten & Jonas, 2013). Affectively, different extreme reactions to rejection have been displayed, which might be linked to the previously mentioned physiological differences. On the one hand, social rejection can evoke a huge variety of strong negatively valenced emotional responses: Hurt feelings, jealousy, loneliness, shame, guilt, social anxiety, embarrassment, sadness, and anger (for a review see Leary, 2015). Moreover, it has been shown that negative emotions as a consequence of rejection even occur when rejection is tried to be counterbalanced by offering monetary compensation (van Beest & Williams, 2004). At first glance contradictory, others argued that rejection leads to emotional numbness instead (e.g., DeWall & Baumeister, 2006; Twenge, Catanese, & Baumeister, 2003). However, these findings fit into the picture, considering that emotional numbness cannot be put on a level with "no affective response", since even observations of emotional numbness are not likely to stem from indifference towards the rejection experience, but rather from a defense mechanism against distress (Twenge et al., 2003), which makes it a rather extreme response

as well. Taking all relevant studies into account, it is not safe to say that social rejection generally causes one specific kind of emotional response. It becomes, however, evident that social rejection of any kind has strong impact on affective experiencing.

The previously described reactions to rejection have the potential to initiate behavior: For example, accelerated HRs can activate fight or flight behavior (Richter, Schumann, & Zwiener, 1990); if being rejected, diminished cognitive control renders individuals less able to inhibit unwanted behavior (Otten & Jonas, 2013). Consequently, it is not surprising that the experience of social rejection has also been shown to affect subsequent interaction behavior (Williams, 2007b). Thereby, opposite effects have been observed: Prosocial behavior, antisocial behavior, or withdrawal. In studies by Twenge et al. (2001) participants reacted aggressively in the rejection condition by rating others as more negative on an evaluation form ostensibly used for application to a job, or by choosing higher aversive noises to punish others for losing a game. Such an increase of aggressive behavior is assumed to reflect revenge and punishment of perpetrators of rejection or – particularly when observed towards others not involved in the preceding rejection – a lack in regulating negative emotions (Catanese & Tice, 2005; Leary, Twenge, & Quinlivan, 2006; Twenge et al., 2001). In contrast, Williams et al. (2000) found increases in prosocial behavior following rejection in Cyberball. Such an increase of prosocial behavior has been linked to the aim of re-establishing social relations (Cheung, Slotter, & Gardner, 2015; Lakin & Chartrand, 2005). Previous research explored these differential effects of rejection on subsequent behavior, showing that different behavioral reactions to rejection that are elicited in the reflective phase according to the temporal need-threat model can be explained by the needs most saliently threatened (Williams, 2009). While prosocial behavior serves to satisfy the need to belong (Baumeister & Leary, 1995), aggressive behavior aims at re-establishing the need to control (Warburton, Williams, & Cairns, 2006). Later on it has been found that also withdrawal can result from rejection, as an attempt to avoid further rejection, although this alternative has been less extensively studied than the other two. In a review on all three behavioral alternatives Smart Richman and Leary (2009) question Williams' (2009) need-fortification hypothesis. They argue that threats to the fundamental needs are not specific to rejection and instead describe the different behavioral reactions as consequences of the three motives to regain acceptance, retaliate against the perpetrators, or avoid any further contact. These motives are activated through different construals and can even be activated at the same time. Examples for such construals are perceived unfairness, value of the relationship, or possibility of alternative relationships (Smart Richman & Leary, 2009). Both models agree that rejection can have multiple effects detrimental to well-being.

To sum it up, humans are inherently social and thus largely dependent on being part of a group to ensure survival and reproduction (Sudnow, 1967; Williams, 2007b). As such, they had to develop a strong need to belong as well as high sensitivity to social rejection. Through these mechanisms hu-

mans seek interpersonal interaction and maintenance of once established social bonds and exhibit a variety of strong reactions to social rejection. As regards the extent of behavioral reactions to rejection, many studies have found differences of more than one standard deviation between rejection and non-rejection conditions (Oaten, Williams, Jones, & Zadro, 2008; Twenge et al., 2001; Warburton et al., 2006). Since these are strong but nonetheless absolutely common reactions, it becomes even more important to discover alterations of these reactions in patients with BPD, who are known to be especially vulnerable to real or imagined rejection (American Psychiatric Association, 2013).

1.4.3 Reactions to Social Rejection in Borderline Personality Disorder

Although rejection is already detected quickly and even tending to be over-detected in healthy subjects (Williams, 2009), it might be even more frequently perceived by BPD patients, as studies on rejection sensitivity suggest (Ayduk et al., 2008; Bungert, Liebke, et al., 2015; Staebler, Helbing, et al., 2011). Also in a diary study BPD patients reported more rejection incidents than healthy subjects did (although the absolute amount of reported rejection incidents was rather small in both groups; Berenson et al., 2011).

Next to more ready perception of rejection, compared to healthy individuals altered reactions to rejection have also been described in BPD. After social rejection, BPD patients report even higher threats of the four fundamental needs for belonging, control, self-esteem, and meaningful existence than HCs (Dixon-Gordon et al., 2013). On the affective level, they exhibit stronger negative emotions (Berenson et al., 2011; Sadikaj et al., 2010; Staebler, Renneberg, et al., 2011) particularly after social rejection feedback as compared to negative academic feedback in individuals high in BPD features (Chapman, Walters, & Dixon-Gordon, 2014). In a study by Lawrence, Chanen, and Allen (2011), adolescents with BPD also experienced significant increases in negative affect in response to rejection, but despite overall stronger negative affect in BPD, their rejection-dependent increases were not stronger than those of HCs. Dixon-Gordon, Chapman, Lovasz, and Walters (2011) were able to show that in individuals high in BPD features such increased negative affect after rejection has behavioral consequences: They performed worse in solving interpersonal problems. In line, Dixon-Gordon et al. (2013) found enhanced cognitive and emotional reactions to rejection in BPD to be mediated through emotion dysregulation. Furthermore, in BPD patients, rejection has also been associated with severe negative behavioral responses, like self-injurious behaviors (Herpertz, 1995). Additionally, BPD patients show fewer positive as well as more ambiguous facial expressions in response to rejection (Staebler, Renneberg, et al., 2011), confirming that rejection plays a significant role in driving disturbed social cognition. Moreover, Bungert, Koppe, et al. (2015) found differing neural processing of physical pain after rejection indicating increased pain sensitivity in BPD, which was modulated by rejection sensitivity only in BPD patients, not in HCs. Berenson et al. (2011) found an in-

creased relationship between rejection and rage. First, in a priming-pronunciation experiment they had their participants read out loud words that where either neutral or related to rage or rejection. BPD patients reacted significantly faster specifically when reading rage words that had been preceded by rejection words. This link was unidirectional, meaning that priming with rage words did not affect latencies of subsequent rejection words, confirming the directionality of the rejection-rage contingency. Moreover, in a diary study, the authors predicted feelings of rage by individual increases in perceived rejection, finding a stronger association in BPD patients than in HCs. Berenson et al. (2011) even found that findings of both studies were related: The shorter the individuals' latency to respond to rejection-primed rage words in the computer experiment, the stronger his/her feelings of rage after rejection episodes reported in the diary.

Taken together, studies on responses to rejection in BPD find enhanced negative consequences in regard to expectations, satisfaction of needs, affect, and behavior. Interestingly, the herein summarized studies use imagination, or diary methods, and those that use experimental induction of rejection all deploy Cyberball, except for one priming experiment (cf. available paradigms 1.4.1). Moreover, they strongly focus on rejection, with some studies including no positive control condition at all (e.g., rejection priming task by Berenson et al., 2011; negative emotion induction procedure by Dixon-Gordon et al., 2011; Cyberball rejection condition in studies by Dixon-Gordon et al., 2013 and by Lawrence et al., 2011). Hence, the following paragraph shifts focus on studies suggesting important alterations regarding the processing of positive social interaction in BPD.

1.4.4 The Importance of Belonging

Strikingly, most of past research has focused on rejection as compared to effects of belonging. There is a multitude of different forms of rejection – ostracism, exclusion, abandonment, ignoring, bullying, discrimination, stigmatization, unrequited love, betrayal, etc. – all of which have in common that they threaten the fundamental human need to belong (see Smart Richman & Leary, 2009). Opposed to the harmful effects of rejection that have been outlined above, acceptance and belonging are usually positive experiences for healthy subjects (see Blackhart et al., 2009). In their meta-analysis, Blackhart et al. (2009) describe rises in positive mood and self-esteem as a result of acceptance. Furthermore, feelings of belonging have been shown to beneficially impact both physical and psychological health (Begen & Turner-Cobb, 2015; Hale, Hannum, & Espelage, 2005), hence showing opposite effects than those of loneliness outlined in 1.3.

However lately, in research on BPD, experimental studies revealed not only stronger reactions to social rejection, but also altered experiences of social participation: BPD patients experience a lower sense of belonging in the interaction game Cyberball even when included by their co-players (De Panfilis et al., 2015; Domsalla et al., 2014; Renneberg et al., 2012; Staebler, Renneberg, et al.,

2011). Moreover, adaptations of the standard inclusion condition have been used to gain further insight into reduced belonging in BPD. Domsalla et al. (2014) investigated an interaction situation where direction of the ball tosses was determined by instruction. Hence, participants knew that receiving the ball had nothing to do with the players' intentions, but followed pre-defined rules. Nonetheless, BPD patients reported stronger feelings of rejection than HCs, suggesting a tendency to hypermentalize, i.e., overattributing (extreme) mental states to others in order to explain their behavior, which has been found to be more likely in BPD patients (Sharp et al., 2011). Hereby, the authors also found attenuated differentiation between situations of inclusion and rejection in BPD on a neural level, which involved brain areas such as the insula and precuneus (Domsalla et al., 2014). Furthermore, De Panfilis et al. (2015) extended the Cyberball design by an over-inclusion condition, i.e., the participants received 45% of the ball tosses (instead of around 33% in the standard inclusion condition). Still, BPD patients felt less socially connected than HCs even during over-inclusion. They exhibited high needs for inclusion and indeed needed to be over-included to reach a level of negative emotions equally low as HCs' experiences under "normal" inclusion conditions (De Panfilis et al., 2015). In line with this experimental finding, others also described extreme emotional closeness as helpful for BPD patients (Hooley & Hoffman, 1999). Moreover, in a functional magnetic resonance imaging study Hooley et al. (2010) showed that BPD patients perceive emotional overinvolvement as rewarding. Since such over-inclusion of one interaction partner requires less interaction towards the others in Cyberball and potentially also in real life due to limited time resources, it seems rather likely that these heightened needs of BPD patients cannot be met completely by their interaction partners, making it fairly difficult for BPD patients to develop a sense of belonging, which is yet so important for health, well-being (Baumeister & Leary, 1995), and in BPD patients also conduces to better clinical outcome (Hooley & Hoffman, 1999). In accordance, in a survey by Bailey and Grenyer (2015) carers of a relative with BPD expressed tremendous personal difficulties in satisfying patients' needs for closeness: The carers' overinvolvement is oftentimes good for the patients, however, associated with their own reduced wellbeing (Bailey & Grenyer, 2015). Moreover, in addition to their heightened longing for closeness, BPD patients simultaneously present fears of becoming attached (Gunderson, 1996) and difficulties to tolerate closeness, which obviously renders satisfaction with relationships quite impossible, thus leading to marked feelings of loneliness or even despair (Simon, 1984).

Given that research focused on reactions to social rejection more than on effects of its positive counterpart so far, along with recent studies pointing to special problems with the formation of feelings of belonging in BPD, there are many questions left to address in this area. Since belonging is fundamental to human beings (Baumeister & Leary, 1995), difficulties with developing such feelings and dealing with positive social situations might cause tremendous problems in social interaction. Hence, it is important to more closely investigate such usually positive social interaction in BPD.

1.4.5 Social Expectations in the Context of Rejection and Belonging

Social expectations play a significant role in social interaction. Individuals learn from social experiences and accordingly form expectations about future events. Thus, experiences of rejection can lead to increased expectations of rejection, as discussed extensively in the rejection sensitivity literature (see Downey, Khouri, & Feldman, 1997). In line, attachment theory proposes that early interactions between children and their caregivers are internalized over time and thus cause expectations about relationships (Bowlby, 1973). Later on, these expectations generalize to other interaction partners (Dykas & Cassidy, 2011). In case of negative interpersonal events, such as rejection, these generalized expectations serve the function to potentially prevent re-experiencing of such distress (Dykas & Cassidy, 2011). Consequently, social inclusion violates expectations of previously rejected individuals (White, Wu, Borelli, Mayes, & Crowley, 2013). In that way formed expectations also influence perception of following events (Downey et al., 1997; Liao, Kashubeck-West, Weng, & Deitz, 2015) and have huge influence on interaction behavior (Chang & Sanfey, 2013): Playing an economic game, individuals who expected fair offers were more likely to reject unfair offers (Sanfey, 2009). Moreover, in adolescents, rejection expectations have been shown to predict withdrawal (London, Downey, & Bonica, 2007). In the same situation, an individual who expects to be rejected might behave differently from someone who expects to be accepted – thus, increasing the risk of actual rejection via its expectations by means of a self-fulfilling prophecy (Downey et al., 1998). Moreover, expectations have been shown to be an explaining mechanism for rejection evoked psychological distress (Liao et al., 2015).

Since expectations are important in understanding processing of social interaction situations, can shape future behavior, and contribute to psychological distress, in the present context it is especially interesting to gain insight into potential alterations in BPD patients' social expectations. An experimental study using Cyberball and simultaneously recording electroencephalography (EEG) measures found increased amplitudes of the P300-ERP component during social participation (Gutz, Renneberg, Roepke, & Niedeggen, 2015). This suggests that being included violates the patients' expectations. In line with this finding, in another EEG-study by Vega et al. (2013), BPD patients exhibited negative reward expectations. Since social participation can be seen as a certain kind of reward (see Bhanji & Delgado, 2014 for a detailed discussion on reward values of social experiences), this is additional indication of reduced expectations of positive social interaction in BPD.

Taken together, social expectations are formed through experiences and shape perception of and behavior in future situations. Previous research implies negative social expectations in BPD patients, however, measured them implicitly by EEG or explicitly by means of self-report according to hypothetical scenarios. To our knowledge, no one ever asked participants to explicitly indicate their expectations of social rejection or acceptance in an experimental study during a standardized actual-

ly occurring social encounter. On top of examining such initial expectations in real time social interaction, it is also important to investigate adjustment of these initial expectations to actual rejection or acceptance. Since biographical learning history might have led to altered expectations in BPD patients, knowledge about adjustment is important in order to elaborate potential strategies to overcome the burden of negative expectations in BPD patients by learning to change expectations.

1.5 Research Questions

Given the past research findings as well as clinical observations highlighted above, all of the three concepts of interpersonal relations – loneliness, rejection, and belonging – are of special significance in the context of BPD. They share common aspects and are related to each other, but yet are distinct concepts, each worth learning more about: To sum it up, experience of social rejection is a threat to the fundamental need to belong (Smart Richman & Leary, 2009), and may trigger loneliness as one common emotional response (Leary, 2015). Our research questions addressed in the following three studies of Chapters 2-4 focus on these important aspects of interpersonal relations relevant to understanding BPD, in the process taking difficulties and shortcomings from previous research into account. More precisely, they are derived from the preceding theoretical background as follows.

As pointed out earlier, loneliness has been described as a fundamental cause of, as well as burden to social interaction. Although it has been generally linked to aspects of social networks and social functioning known to be altered in BPD patients, a detailed study on these relationships highlighting the role that loneliness plays in these patients' lives was lacking so far. In general, feelings of loneliness have been linked to problems in social functioning (Cacioppo et al., 2006; DiTommaso et al., 2003) and alterations in social network compositions (Dykstra & van Tilburg, 2005; Hawkley & Cacioppo, 2007; Mullins & Mushel, 1992; Pinquart & Sörensen, 2003; Victor, Scambler, Bowling, & Bond, 2005), both of which are also known to be altered in BPD patients (Beeney et al., 2018; Clifton et al., 2007; Gunderson et al., 2011; Hill et al., 2008; Stepp et al., 2011; Zanarini et al., 2005). Therefore, our first research questions addressed in Study I (Chapter 2) of this thesis aim at investigating the relevance of social isolation and social functioning for the experience of loneliness in BPD:

- Do BPD patients report higher levels of loneliness, and impaired social networks and social functioning?
- Is loneliness linked to social isolation and to social functioning in BPD?
- Does loneliness reflect a unique feature in BPD patients or is it totally explained by differences in social networks and social functioning?

With loneliness being one common emotional reaction to rejection (Leary, 2015) and causing opposite effects of feelings of belonging (see 1.3 and 1.4.4), in a next step we broadened our focus from

loneliness as an affective subcomponent of altered social interaction to actual interaction behavior and responses to social rejection and acceptance. Before addressing our specific research questions on altered interpersonal relations in BPD, we focused on reactions to rejection that have been shown to be complex already in healthy individuals. In both investigations, we aimed at investigating initial reactions to current social rejection in an experimental design. For the purpose of our research agenda a social environment was necessary that introduces a social encounter enabling subsequent explicit rejection feedback. Moreover, rejection has been proposed to be especially hurtful when the victim and perpetrators have had the opportunity to build affiliations before (Downey & Feldman, 1996; Williams et al., 2005). Thus, beyond rejection by complete strangers, we considered it important to investigate social rejection in a setting where the participants have had the opportunity to affiliate with their future rejecters and to include a measure that allows for quantification of the affiliation that took place. Given the complexity of interpersonal interaction, standardizing social signals is essential for being able to draw internally valid conclusions about reactions to rejection and acceptance. Standardizing potentially confounding variables is most effectively done by computer-controlled environments and interaction partners. Taken together, existing paradigms do not comprise a social encounter in a group which allows for the building of affiliations with previous strangers and subsequent induction of current explicitly expressed social rejection and acceptance in an ecologically valid manner, while simultaneously controlling for the partners' behavior during social interaction. Since it became obvious throughout past research that the paradigm used to investigate such encounters is a crucial aspect of research on social rejection (Gerber & Wheeler, 2009), we developed a new paradigm specifically tailoring the requirements described above: The Mannheim Virtual Group Interaction Paradigm (MVGIP). It was designed to combine the two great advantages – experimental control and mundane realism – for induction of social acceptance and rejection, since immersive virtual environments enable the investigation of social behavior in a context within which people perceive their environment as real by simultaneously allowing for a high control of the stimuli provided (Blascovich et al., 2002; Kassner, Wesselmann, Law, & Williams, 2012; Loomis, 1999).

First, we analyzed data of the MVGIP in an HC sample, before drawing conclusions on the even more complex (since less extensively investigated) interaction alterations in BPD patients. Specifically, we were interested in social expectations and their adjustment to explicit feedback. Understanding the dynamics of such social expectations is important, because social experiences shape future expectations (Crowley, Wu, Molfese, & Mayes, 2010; Downey et al., 1997) and in turn, these expectations shape future experiences through perception of and behavior in these situations (Chang & Sanfey, 2013; Downey et al., 1997; Liao et al., 2015; Sanfey, 2009). Moreover, we aimed at investigating the role of rejection sensitivity and affiliation with unknown others in expectations as well as both subjective (i.e., self-reported) and objective (i.e., physiological) arousal responses to rejection

and acceptance. Hence, study II (Chapter 3) of this thesis focusses on using the MVGIP in healthy subjects to address the following research questions:

- Is the MVGIP suitable for induction of acceptance and rejection?
- How do healthy people adjust their expectations of social acceptance and rejection after a group situation?
- Do rejection sensitivity and degree of affiliation with the accepting or rejecting persons affect expectations, the adjustment of expectations, and self-reported as well as psychophysiological arousal?

Finally, we aimed at gaining new insights into BPD patients' reactions to social acceptance and rejection by investigating social expectations and their adjustment as well as their potential cooperative and aggressive behavioral responses in an interaction game after having been provided with either positive or negative feedback from people they had just met and affiliated with. Since expectations have been shown to be less positive in BPD patients (Gutz et al., 2015; Vega et al., 2013), but have never been assessed explicitly in an experimental study, we aimed at verifying the assumption of BPD patients' low social expectations and extending it by information on dynamic changes of expectations according to actual feedback.

Behavioral reactions to rejection and acceptance in BPD have been frequently investigated (Berenson et al., 2011; Bungert, Koppe, et al., 2015; De Panfilis et al., 2015; Dixon-Gordon et al., 2013; Domsalla et al., 2014; Gutz et al., 2015; Staebler, Renneberg, et al., 2011), and also general social interaction behavior, like cooperation and trust, in BPD has been studied using economic games (Bartz et al., 2011; Franzen et al., 2011; King-Casas et al., 2008; Saunders et al., 2015; Unoka et al., 2009; Wischniewski & Brüne, 2013), with inconsistent findings leaving open the question of influencing factors. Hence, we felt the need to combine those two areas: We examined in which way cooperative and aggressive behavior is dependent on the preceding social experience of rejection or acceptance. Since recently research has pointed to special problems in inclusion situations (De Panfilis et al., 2015; Domsalla et al., 2014; Gutz et al., 2015) we expected experiences of social acceptance to cause difficulties in both adaptation of expectations and subsequent interaction behavior. Consequently, we were especially interested in elucidating the following questions in study III (Chapter 4):

- Do BPD patients show lower expectations of being accepted than HCs?
- Do BPD patients adjust their expectations to social acceptance and rejection feedback?
- Do social acceptance and rejection alter cooperative and aggressive behavior in BPD?

The exact hypotheses, designs, procedures and analyses of studies I-III are described in detail in the Chapters 2-4.

2 STUDY I: Loneliness, Social Networks, and Social Functioning in Borderline Personality Disorder

An adapted version of this Chapter has been published as "Liebke, L., Bungert, M., Thome, J., Hauschild, S., Gescher, D. M., Schmahl, C., Bohus, M., & Lis S. (2017). Loneliness, social networks, and social functioning in borderline personality disorder. *Personality Disorders: Theory, Research, and Treatment, 8*(4), 349-356. doi:10.1037/per0000208".

2.1 Abstract

Persistent loneliness is often reported by patients with BPD. However, empirical studies investigating this aspect of BPD psychopathology are sparse. Studies from social psychology revealed that social isolation and low social functioning contribute to loneliness, i.e., the subjective feeling of being alone. The aim of the present study was to contribute to the understanding of loneliness in BPD by investigating its relation to social isolation and functioning in different domains of life. Subjective experience of loneliness was measured in 80 women (40 BPD patients, 40 HCs) with the UCLA Loneliness Scale. Social isolation and social functioning were assessed with the Social Network Inventory (SNI) and the Social Functioning Scale (SFS). In addition, we assessed global functioning with the Global Assessment of Functioning. BPD patients reported stronger feelings of loneliness compared to healthy participants. In general, the level of loneliness was linked to network size, social engagement, and prosocial behavior. Diversity of social networks and functioning in the domain of interpersonal communication were associated with the level of loneliness only in BPD. A reduced variety of roles in social life together with impairments in interpersonal communication were particularly relevant for the experience of loneliness in BPD, suggesting an indirect path to target this psychopathological feature in therapeutic interventions. However, both social isolation and social functioning were not sufficient to explain the severely increased loneliness experienced by these patients, stressing the need for further investigation of determinants of loneliness in this clinical population.

2.2 Introduction

Loneliness, i.e., the feeling of being alone, is severely distressing , negatively affects health and well-being (Pinquart & Sörensen, 2003; Queen, Stawski, Rayan, & Smith, 2014), and even increases morbidity and mortality (Cacioppo et al., 2000; Cacioppo & Hawkley, 2009). Persistent loneliness is one of the key experiences reported by individuals with BPD. On the home page of the Brain and Behavior Research Foundation a patient describes BPD as "pretty much the most painful and lonely existence imaginable" (retrieved from http://bbrfoundation.org/bpd).

As early as 1979, Adler and Buie identified the experience of intensely painful aloneness as a core disturbance and central aspect of BPD individuals (Adler & Buie, 1979; Buie & Adler, 1982). Gunderson (1996) emphasized that the inability to cope with aloneness distinguishes BPD from other disorders, such as posttraumatic stress disorder (PTSD) or depressive disorder. He suggests that it may develop as a consequence of abusive primary caretakers. The intolerance of aloneness is so characteristic for BPD patients that it was even one of the diagnostic criteria for BPD when it first came up as independent diagnosis in the DSM–III in 1980 (see Gunderson, 1996). Although the concept of aloneness is close to loneliness, it has primarily been linked to the experience of emptiness, which is one of the diagnostic criteria for BPD in the DSM (see Klonsky, 2008). Psychoanalytic theories distinguish aloneness from loneliness by the inability to maintain an internal representation of a soothing other, resulting in a longing for someone to fill the emptiness, but also the assumption that this will never be possible (Bender & Skodol, 2007; for further discussion on the differentiation of these concepts see Richman & Sokolove, 1992). As such, aloneness has been proposed to be a relevant concept in BPD pathology. Beyond this characterization of aloneness and of BPD patients in psychoanalytic theories, chronic feelings of loneliness have been described as part of the dysphoric affects characterizing BPD patients (Lieb, Zanarini, Schmahl, Linehan, & Bohus, 2004). Moreover, loneliness was implemented as a separate subscale in the BSL, which is a well-established instrument for the quantification of BPD symptom severity (Bohus et al., 2007). Empirical studies focusing on loneliness in BPD, rather than investigating it as one aspect of symptom severity, are largely missing. Findings from a study on the effects of psychotherapeutic interventions suggest that therapeutic approaches may benefit from a deeper understanding of loneliness in BPD: Loneliness and hostility were the only symptom domains that did not respond to successful dialectical behavior therapy residential treatment (Bohus et al., 2007).

Findings from social psychology suggest that social isolation and low social functioning contribute to the development of loneliness. In the present study we investigated whether the intense feelings of loneliness in BPD are linked to stronger social isolation and impaired social functioning in these patients.

2.2.1 Loneliness and Features of Social Networks

Loneliness is different from being alone. Being alone refers to the objective state of social isolation, i.e., when people have no or only a limited number of contacts with others. In contrast, loneliness is defined as “perceived social isolation” emphasizing its subjectivity (Weiss, 1973). It resembles the subjective experience of a “shortfall in one’s social resources” (Cornwell & Waite, 2009, p. i39). Being alone is a state that can, but does not necessarily, lead to loneliness (D. W. Russell, Cutrona, McRae, & Gomez, 2012). On the contrary, people can feel lonely even when they are not socially isolated but

are around others (Cacioppo et al., 2000; Van Baarsen, Snijders, Smit, & Van Dujin, 2001). Peplau and Perlman (1982) emphasized that feelings of loneliness arise when participants perceive a discrepancy between desired and actual social relationships. Nevertheless, loneliness has been linked to being alone (Witvliet, Brendgen, van Lier, Koot, & Vitaro, 2010). Studies using social network parameters to quantify social isolation have linked loneliness to smaller (Dykstra & van Tilburg, 2005; Pinquart & Sörensen, 2003) and less dense (Stokes, 1985) social networks as well as to the loss of important members of a social network (Dykstra & van Tilburg, 2005; Hawkley & Cacioppo, 2007; Mullins & Mushel, 1992; Victor et al., 2005).

To date, knowledge about social networks in BPD is limited. Stepp, Pilkonis, Yaggi, Morse, and Feske (2009) reported that the frequency of social interactions of BPD patients equals that of healthy participants. However, these involved a lower number of interaction partners, suggesting that the patients' networks were smaller than those of the healthy participants. In addition, the networks of BPD patients were characterized by a larger number of former romantic partners and a frequent loss of network members, i.e., break-ups with around a third of their relationships within the past year (Clifton et al., 2007). These findings suggest that features of the social network may contribute to the feeling of loneliness in BPD.

2.2.2 Loneliness and Social Functioning

Social functioning was defined as "the level at which an individual functions in his or her social context, such function ranging between self-preservation and basic living skills to the relationship with others in society" (Tyrer & Casey, 1993, p. 8). Several studies have linked social skills to loneliness. Cacioppo et al. (2006) showed that loneliness is negatively correlated with social skills such as maintaining conversations or expressing feelings. Reduced social skills, for example, in terms of emotional expressivity and social control, have also been linked to higher perceived levels of loneliness (DiTommaso et al., 2003). Moreover, experimental induction of loneliness via hypnosis decreased social skills (Cacioppo et al., 2006). Impairments in social skills might promote feelings of loneliness, because adequate social functioning is required to maintain close contacts to other people, which is the best strategy for meeting the need to belong and prevent feelings of loneliness (Baumeister & Leary, 1995).

Several studies observed reduced social functioning in BPD compared to healthy participants and clinical control groups, even after successful psychotherapeutic treatments of BPD symptoms (Gunderson et al., 2011; Hill et al., 2008; Stepp et al., 2011; Zanarini et al., 2005; see also Lis & Bohus, 2013). So far, no studies have addressed whether impaired social skills contribute to elevated feelings of loneliness in BPD. Social functioning has mostly been assessed as part of global functioning by the Global Assessment of Functioning (GAF; American Psychiatric Association, 2013). The GAF is an

observer-based one-dimensional rating of general functioning that collapses patients' reports across multiple social domains. Although a reliable, valid, and well-established instrument, i.e., sensitive to change over time, the GAF has been criticized due to its intermingling of symptom severity and psychological, social, and occupational functioning (Gold, 2014). The investigation of functioning in BPD, particularly in regard to its relevance for the experience of loneliness, requires a finer-grained assessment that focuses on social aspects of functioning and takes the heterogeneity of social skills into account. Aspects of social functioning that tap social skills and behaviors in regard to social engagement or withdrawal, interpersonal communication, prosocial behavior, or recreational activities may have a stronger association to loneliness compared to more basic domains of social functioning, such as skills required for independent living (Birchwood, Smith, Cochrane, Wetton, & Copestake, 1990).

To summarize, loneliness constitutes a prominent feature in self-descriptions of BPD psychopathology. From social psychology, it is known that loneliness, i.e., perceived social isolation, is linked to actually being alone and poor social functioning. The aim of the present study was to investigate the relevance of social isolation and social functioning for the experience of loneliness in BPD. We hypothesized that BPD patients would report higher levels of perceived loneliness, and smaller and less diverse social networks, and lower social functioning across different domains of social skills and behaviors. We expected that high loneliness is linked to actual social isolation and to reduced social functioning in BPD. Finally, we were interested in whether increased loneliness reflects a unique feature in these patients, which is separable from pure alterations in social isolation and social functioning; or whether differences in the level of loneliness between BPD und HC groups vanish when taking participants' social isolation and social functioning into account.

2.3 Methods

2.3.1 Sample

A total of 80 women participated in this study. Forty BPD patients and 40 HCs were matched for age (HC: 27.0 ± 6.4, BPD: 27.1 ± 5.6, t=0.9, p=.927) and education (HC: 12.2 ± 1.4, BPD: 11.7 ± 1.5, t=1.4, p=.176). There were no differences between groups in IQ (Raven Progressive Matrices, Raven; 1976; HC: 54.8 ± 3.8, BPD: 53.3 ± 4.7, t=1.6, p=.104).

Recruitment was done by the central project of the KFO 256, a Clinical Research Unit funded by the German Research Foundation dedicated to investigating mechanisms of disturbed emotion processing in BPD (Schmahl et al., 2014). The data presented in this article were collected within a larger individual project of the KFO. The study followed the Declaration of Helsinki and was approved by the Research Ethics Board of the University of Heidelberg. Participants provided written informed consent prior to study participation. General exclusion criteria included a lifetime history of psychotic or bipolar I disorder, current substance abuse, current pregnancy, history of organic brain disease,

skull or brain damage, or severe neurological illness. Additional exclusion criteria for the HCs were any lifetime psychiatric diagnoses.

The diagnosis of BPD according to DSM–IV was assessed by experienced clinical psychologists or psychiatrists who were trained in conducting interviews using the International Personality Disorder Examination (IPDE; Loranger, 1999). Patients met at least five of the nine DSM–IV criteria for BPD. Comorbid Axis I disorders were assessed using the German version of the Structured Clinical Interview for DSM–IV (First, Spitzer, Gibbon, Williams, & Benjamin, 1997). Twenty percent of the patients met criteria for a current comorbid major depressive episode, 22.5% for an eating disorder, 26.3% for an anxiety disorder, and 27.5% for PTSD. None of the patients had been on psychotropic medication for at least 4 weeks before the time of testing.

BPD symptom severity was measured by the short version of the BSL (Bohus et al., 2009) and the Zanarini Rating Scale for BPD (ZAN-BPD; Zanarini, 2003). The BSL-23 is a self-report measure that assesses symptom severity of borderline-specific symptomatology during the last week and contains 23 items rated on a 5-point Likert scale. The ZAN-BPD is a clinician-based diagnostic interview that assesses the severity of BPD symptoms in nine items during the last week. Its total score ranges from 0 (no BPD symptoms) to 36 (severe symptoms). Internal consistency was comparably high for both assessments (BSL-23: Cronbach's alpha = .98; ZAN-BPD: Cronbach's alpha = .91). Both methods confirmed higher BPD symptom severity in BPD patients compared to HCs (BSL-23: HC: 0.11 ± 0.15, BPD: 2.16 ± 0.66, t=18.2, p<.001; ZAN-BPD: HC: 0.4 ± 1.4, BPD: 11.9 ± 5.1, t=13.7, p<.001).

Analyses of three diagnostic interviews taped on video indicated high interrater reliability with respect to both the number of BPD criteria (IPDE) and the dimensional score (ZAN-BPD) for DSM–IV borderline psychopathology, with intraclass coefficients of 0.99 and 0.91, respectively.

2.3.2 Measurements

Loneliness. Loneliness was assessed using a German version of the UCLA Loneliness Scale (D. Russell, Peplau, & Ferguson, 1978). The UCLA Loneliness Scale has become the most frequently and widely used instrument for the assessment of loneliness (Vassar & Crosby, 2008). It consists of 20 items (e.g., "How often do you feel part of a group of friends?") examining the frequency and intensity of loneliness-related experiences. For the construction of the original version of the UCLA Loneliness Scale, lonely individuals' statements that described their feelings of loneliness were used (D. Russell et al., 1978). The terms lonely or loneliness were eliminated from all of the items to avoid response bias. Participants evaluate their personal agreement on how well the 20 statements apply to themselves using a 5-point Likert scale ranging from 1 (not at all) to 5 (totally). Hence, the total score ranges from 20 to 100 with higher scores representing more intense feelings of loneliness. In the

present study internal consistency for the UCLA Loneliness Scale was high (BPD: Cronbach's alpha=.95; HC: Cronbach's alpha=.90).

Social network features. Social network features were assessed using a German version of the Social Network Index (SNI; S. Cohen, Doyle, Skoner, Rabin, & Gwaltney, 1997). The SNI consists of 12 items assessing 12 different types of social relationships: Spouse, parents, parents-in-law, children, other close family members, close neighbors, friends, workmates, schoolmates, fellow volunteers, and members of groups with and without religious affiliations. For each type of relationship, the participant is asked how many people she knows and talks to at least once every two weeks. These questions can be answered with a number between 0 to 6 or "7 or more", except for parents and parents-in-law, who are naturally restricted to 2, and for the items on romantic partnership, where only a yes or no answer is permitted.

As social network characteristics, the SNI quantifies the size (SNI-size) and the diversity (SNI-diversity) of social networks as well as the number of embedded subnetworks (SNI-EN) within three subscales. The size of the social network is defined as the total number of people with whom the respondent speaks at least once every two weeks and serves as a measure of social isolation/being alone. Social network diversity quantifies the number of social roles. It is calculated as the number of domains of social relationships in which the respondent has regular contact with at least one person. The number of embedded networks is a measurement reflecting the number of different network domains in which the participant is active. Activity in the different domains is defined by having at least four high-contact people within each domain. High scores indicate large size, diversity, or high number of embedded networks.

Social functioning. Social functioning was assessed using the Social Functioning Scale (SFS; Birchwood et al., 1990; German version J. R. Iffland et al., 2015). The SFS is a self-report questionnaire that allows for a fine-grained assessment of social functioning. Based on 79 items, it measures the frequency of key social skills and behaviors in seven different domains of social functioning, i.e., in regard to social engagement (time spent alone, initiation of conversations, social avoidance), interpersonal communication (number of friends, quality of communication), prosocial behavior (engagement in a range of common social activities, e.g., sports), recreational activities (engagement in a range of common hobbies, interests, pastimes, etc.), independence (measured separately by both the ability to perform skills necessary for independent living and the actual performance of skills necessary for independent living), and occupation (engagement in productive employment or structured program of daily activity). Different response formats are used for the different items. Therefore, comparisons between different subscales and calculation of a total score of the SFS as a mean of the seven subscales require standardization of the distinct scores. Following the suggestion of

Birchwood et al. (1990) all scores were transformed to a mean of 100 and a standard deviation of 15 before calculating the mean as a total score. Higher scores on each subscale, as well as on the total score, indicate higher levels of functioning in the specific domain. The SFS has been shown to be a reliable and valid measure of psychosocial functioning (Birchwood et al., 1990); see also for the German version (J. R. Iffland et al., 2015).

Global functioning. Global functioning was assessed using the GAF (American Psychiatric Association, 2013). The GAF is a well-established and widely used instrument for the assessment of global functioning. It is a clinician-administered measure that requires the assessment of the level of social functioning together with symptom severity as well as psychological and occupational functioning on a 1-item scale. The GAF score ranges from 0 to 100, with a higher score indicating higher levels of functioning.

2.3.3 Statistical Analysis

All analyses were performed using SPSS. The level of significance was set to α=5%. Differences in loneliness scores, social network features, and social functioning scores between BPD patients and HCs were analyzed using two-sided independent t-tests. Effect sizes were computed using Cohen's d and used to calculate the overlap between the distributions of loneliness scores between groups (Bortz & Döring, 2006).

To analyze the hypothesized covariations between loneliness, social network features, and social functioning, Pearson's correlation coefficients were computed. To assess whether higher loneliness in the BPD group can be solely explained by differences in social network features and social functioning, we compared loneliness scores between groups by using features of social networks and social functioning as covariates in a one-factorial analysis of variance (ANOVA).

2.4 Results

2.4.1 Loneliness

BPD patients reported higher levels of loneliness than HCs; see Figure 1a and Table 1. Effect size indicated an overlap of loneliness score distributions of 0.6% for HCs and BPD patients (see Figure 1b; Cohen's *d*=2.728).

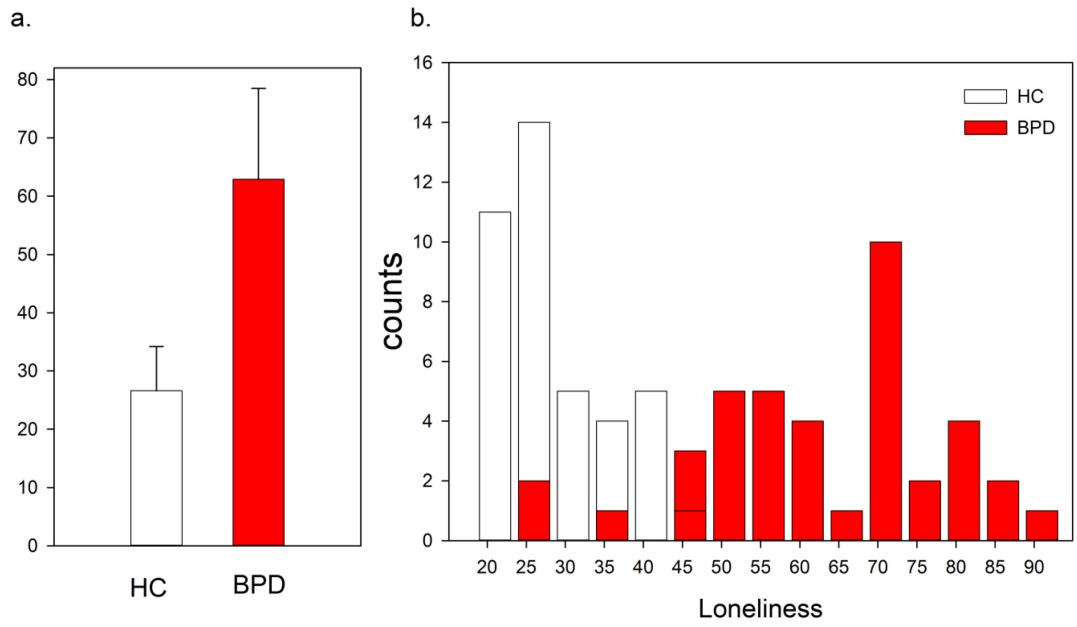


Figure 1. Group differences in loneliness between BPD patients and HCs: (a) Means and standard deviations and (b) frequency distributions.

2.4.2 Social Network Features

Size and diversity of social networks were reduced in BPD. There was no difference between groups in the number of embedded networks (see Table 1). The percentage of participants living alone was higher in BPD patients than in the HC group (BPD: 35%, HC: 15%, χ^2=4.267, p=.039).

Table 1. Means (AM) and standard deviations (SD) together with the results of the independent t-tests for BPD patients and HCs in UCLA Loneliness Scale, SNI, GAF, and SFS

	HC		BPD				
	AM	SD	AM	SD	*t*	*p*	*d*
UCLA-Loneliness	28.6 ±	7.6	62.9 ±	15.6	-12.5	<.001	2.728
SNI-Size	16.2 ±	9.8	8.3 ±	6.5	4.2	<.001	0.939
SNI-Diversity	5.1 ±	2.0	3.8 ±	1.9	3.0	.002	0.671
SNI-EN	1.8 ±	1.5	2.1 ±	3.9	-0.4	.706	0.085
GAF	89.4 ±	6.2	53.3 ±	9.0	20.9	<.001	4.673
SFS-total	108.7 ±	3.8	91.3 ±	9.1	11.2	<.001	2.504
SFS-SE	111.3 ±	6.8	88.7 ±	12.2	10.2	<.001	2.281
SFS-IC	109.0 ±	6.7	91.0 ±	15.6	6.7	<.001	1.498
SFS-IN-P	108.4 ±	5.4	91.6 ±	16.8	6.0	<.001	1.342
SFS-IN-C	108.6 ±	1.6	91.4 ±	17.4	6.2	<.001	1.386
SFS-PRO	110.1 ±	12.1	89.9 ±	10.1	8.1	<.001	1.811
SFS-REC	108.2 ±	11.1	91.8 ±	14.0	5.8	<.001	1.297
SFS-OCC	105.5 ±	8.1	94.5 ±	18.1	3.5	.001	0.783

Note. SNI = Social Network Index; EN = Embeddedness; GAF = Global Assessment of Functioning; SFS = Social Functioning Scale; SE = social engagement; IC = interpersonal communication; IN-P = independence performance; IN-C = independence competence; PRO = prosocial; REC = recreation, OCC = occupation. All group differences are also significant after correction for multiple testing, Bonferroni correction (i.e., $p<.003$).

2.4.3 Social and Global Functioning

The level of functioning was reduced in the BPD group compared to HCs for both the GAF and the SFS. Reduced social functioning was seen across all subscales of the SFS (see Table 1). Information retrieved from the SFS revealed that 35% of the BPD patients were unemployed, compared to only 5% of the HCs (χ^2=11.25, p=.001).

2.4.4 Covariation of Loneliness with Social Network Features and Social Functioning

Social networks. Loneliness correlated with social network size in both the BPD and the HC group: The fewer people there were in participants' social networks, the higher their loneliness (BPD: r=-.29, p=.037, HC: r=-.31, p=.026). In the BPD group, loneliness additionally correlated inversely with social network diversity: The lower the number of high-contact roles within the network, the higher the loneliness (BPD: r=-.38, p=.009, HC: r=-.07, p=.10; z=1.42, p=.078). The number of embedded networks was not linked to loneliness (both p>.10). In neither of the two groups was living alone correlated with loneliness (both ps>.10).

Social and global functioning. There was no significant correlation between loneliness and global functioning as assessed with the GAF (BPD: r=.07, p>.10, HC: r=.11, p>.10). In contrast, loneliness was negatively correlated with social functioning as assessed with the SFS (SFS total: BPD: r=-.38, p=.007; HC: r=-.31, p=.025). A more detailed analysis of subdomains of social functioning in the SFS revealed that higher loneliness was linked to lower social functioning in the domain of interpersonal communication in BPD patients (r=-.42, p<.001), but not in HCs (r=.18, p=.274; z=-3.38, p<.001). Irrespective of group, loneliness was higher with lower social functioning in the domains of social engagement (BPD: r=-.32, p=.044; HC: r=-.49, p<.001) and pro-social behavior (BPD: r=-.45, p=.003; HC: r=-.31, p=.048). Loneliness was not related to social functioning scores in the domains of independence performance, independence competence, recreation, and occupation in either the BPD or the HC groups (all ps>.10). In neither of the two groups was employment status correlated with loneliness (both ps>.134). An overview of all correlations can be found in Table 2 and Table 3.

Table 2. Intercorrelation matrix of GAF, UCLA, SFS, and SNI for BPD patients

	GAF	SFS-total	SFS-SE	SFS-IC	SFS-IN-P	SFS-IN-C	SFS-PRO	SFS-REC	SFS-OCC	SNI-Size	SNI-Diversity	SNI-EN
UCLA	.07 (.672)	-.38 (.014)	-.32 (.044)	-.54 (<.001)	-.13 (.429)	-.29 (.069)	-.45 (.003)	-.16 (.315)	.11 (.509)	-.29 (.074)	-.38 (.017)	-.21 (.192)
GAF		.27 (.089)	.15 (.352)	.24 (.132)	.24 (.131)	.14 (.387)	-.04 (.825)	-.03 (.867)	.33 (.040)	.14 (.376)	-.16 (.333)	-.16 (.316)
SFS-total			.63 (<.001)	.60 (<.001)	.84 (<.001)	.74 (<.001)	.64 (<.001)	.53 (<.001)	.32 (.045)	.40 (.011)	.06 (.700)	-.08 (.628)
SFS-SE				.35 (.026)	.45 (.004)	.29 (.066)	.36 (.022)	.31 (.049)	.10 (.530)	.40 (.011)	.13 (.427)	-.09 (.599)
SFS-IC					.29 (.067)	.36 (.021)	.40 (.010)	.23 (.145)	-.01 (.944)	.23 (.150)	.13 (.412)	.16 (.337)
SFS-IN-P						.69 (<.001)	.49 (.002)	.48 (.002)	.16 (.340)	.27 (.098)	-.15 (.373)	-.28 (.076)
SFS-IN-C							.31 (.050)	.30 (.063)	.07 (.673)	.04 (.810)	-.05 (.760)	.06 (.714)
SFS-PRO								.34 (.030)	.10 (.556)	.36 (.021)	.19 (.230)	-.13 (.409)
SFS-REC									-.26 (.100)	.23 (.156)	.05 (.768)	-.10 (.555)
SFS-OCC										.27 (.090)	.06 (.737)	.002 (.992)
SNI-Size											.28 (.076)	-.13 (.431)
SNI- Diversity												.54 (<.001)

Note. For abbreviations see page 42.

Table 3. Intercorrelation matrix of GAF, UCLA, SFS, and SNI for HCs

	GAF	SFS-total	SFS-SE	SFS-IC	SFS-IN-P	SFS-IN-C	SFS-PRO	SFS-REC	SFS-OCC	SNI-Size	SNI-Diversity	SNI-EN
UCLA	.11 (.502)	-.31 (.049)	-.49 (.001)	.18 (.274)	.16 (.328)	.08 (.636)	-.31 (.048)	-.17 (.289)	-.19 (.242)	-.31 (.052)	-.07 (.665)	-.23 (.159)
GAF		.19 (.250)	.13 (.442)	.14 (.374)	.19 (.248)	.27 (.099)	-.04 (.808)	.20 (.207)	-.002 (.989)	.14 (.393)	.06 (.694)	.06 (.734)
SFS-total			.55 (<.001)	.033 (.839)	.41 (.009)	.33 (.037)	.82 (<.001)	.65 (<.001)	.38 (.014)	.16 (.336)	.23 (.145)	.23 (.159)
SFS-SE				-.12 (.478)	-.01 (.959)	.16 (.322)	.42 (.007)	.33 (.039)	-.03 (.851)	.07 (.678)	.25 (.123)	-.01 (.975)
SFS-IC					-.06 (.718)	-.03 (.853)	-.12 (.451)	-.21 (.192)	-.11 (.517)	-.07 (.655)	.04 (.829)	-.19 (.234)
SFS-IN-P						.33 (.039)	.19 (.235)	.27 (.099)	.04 (.823)	-.27 (.090)	-.15 (.353)	-.15 (.363)
SFS-IN-C							.07 (.654)	.44 (.004)	-.14 (.393)	-.17 (.309)	-.16 (.313)	-.21 (.194)
SFS-PRO								.35 (.025)	.35 (.027)	.28 (.077)	.26 (.107)	.39 (.014)
SFS-REC									-.10 (.553)	.25 (.119)	.19 (.254)	.26 (.111)
SFS-OCC										-.03 (.861)	.04 (.829)	.13 (.422)
SNI-Size											.42 (.007)	.89 (<.001)
SNI- Diversity												.45 (.004)

Note. For abbreviations see page 42.

2.4.5 Contribution of Social Network Features and Social Functioning to Group Differences in Loneliness

To test whether group differences in loneliness are still present after controlling for social network features and social functioning, those social network features and social functioning domains that were linked to loneliness, i.e., social network size and diversity as well as social engagement, interpersonal communication, and pro-social behavior, were added to the ANOVA as covariates. Differences between groups in loneliness still remained significant, $F(1,73)=20.1$, $p<.001$, $d=1.015$, explaining 22% of the variance in loneliness compared to a 67% explanation of variance without controlling for social network features and social functioning. Interpersonal communication was a significant covariate, $F(1,73)=9.5$, $p=.003$, $d=0.698$, and explained 12% of the variance in loneliness scores. As a trend, prosocial behavior was also relevant, $F(1,73)=3.0$, $p=.089$, $d=0.392$, explaining 4% of the variance in loneliness. The other covariates did not significantly contribute to the group effect of loneliness (all ps>.121).

2.5 Discussion

The feeling of loneliness is often reported as a symptom in BPD and is well known to every clinician. The present study investigated loneliness in BPD and the relevance of social functioning and social isolation measured by features of social networks. Our findings confirmed that BPD patients report higher levels of loneliness. We found an overlap of only 0.6% in the distribution of loneliness between HCs and BPD patients, which is remarkably small. BPD patients reported smaller and less diverse social networks compared to HCs as well as lower social functioning across all domains of social skills and behaviors. Small network size and low functioning in the domains of social engagement and prosocial behavior were linked to increased loneliness in both healthy participants and BPD patients. The diversity of social networks and reduced interpersonal communication contributed to increased feelings of loneliness, particularly in BPD. However, after controlling for effects of social network features and social functioning, we still found increased loneliness scores in the BPD group, suggesting that further factors contribute to the painful experience in this clinical sample.

2.5.1 Loneliness and Being Alone

Loneliness describes perceived social isolation and is different from objective social isolation, i.e., a lack of interpersonal relations. Our findings revealed that BPD patients not only subjectively feel socially isolated, as their heightened levels of loneliness show, but are indeed more isolated as revealed by social network features. BPD patients report smaller networks, i.e., a smaller number of people with whom they have regular contact. This confirms past findings that suggest that the social contacts of BPD patients are restricted to a smaller number of different people compared to healthy

participants and patients without personality disorders (Stepp et al., 2011). Beyond network size, network diversity is reduced in BPD: The social roles of BPD patients within their networks are less diverse, i.e., BPD patients have regular contact with at least one person in a more restricted range of social domains.

Both network features that distinguish BPD patients from HCs are linked to loneliness. However, although smaller network size in general promotes stronger feelings of loneliness in both groups, a lower diversity of social roles within the network contributes to loneliness particularly in BPD. What comes to mind immediately when thinking about reduced network diversity is the influence of living alone or being unemployed, since both result in the complete loss of a single social domain. Routasalo, Savikko, Tilvis, Strandberg, and Pitkala (2006) found that higher levels of loneliness are associated with living alone. However, although in the present study BPD patients both lived alone and were unemployed more often than HCs, neither living alone nor employment status was related to loneliness, suggesting that these aspects are of minor relevance in healthy participants as well as in BPD patients. This agrees with our finding that the number of embedded networks has no effect on the level of loneliness. In regard to loneliness and social functioning it seems to be irrelevant whether someone has more or fewer embedded networks within the social network as a whole. Instead it is relevant to have regular contact with a high number of people and take different social roles in the social network, regardless of whether it can be subdivided into many smaller networks.

A recent study linked social network diversity to neuronal activation during the processing of nonverbal social signals. Dziura and Thompson (2014) asked participants to identify repeated presentations of human body movements depicted as point-light arrays. When contrasted with a control condition consisting of presentations of scrambled versions of the same movie clips, biological motions elicited activity in the right posterior superior temporal sulcus which was linked particularly with the participants' network diversity. Both the findings of Dziura and Thompson (2014) and our study underline the special relevance of diversity which is distinct from other network features such as network size. The relationship of network diversity with both brain activation and loneliness remained significant after controlling for effects of social network size (loneliness with diversity controlled for network size: r=-.24, p=.037). Although empirical data on the factors ensuring a network of high diversity are still sparse, the accurate perception and interpretation of social signals seems to contribute to a person's ability to take different social roles. Together with various findings on altered processing of social signals in BPD (see Lazarus et al., 2014; Mitchell, Dickens, & Picchioni, 2014), these results suggest that an attenuation of strong feelings of loneliness may be achieved by increasing network diversity via improving perception and interpretation of social signals.

2.5.2 Loneliness and Social Functioning

Confirming previous studies, our data revealed lower functioning in the BPD group. This held true both for the observer-based assessment with the GAF as well as for the self-report-based SFS. An analysis of different domains of social functioning suggests that social skills and behaviors are generally reduced in BPD. Regarding the link between loneliness and functioning, our study showed inconsistent findings. The GAF measure of global functioning was not correlated with loneliness, whereas the SFS total score measure of solely social functioning was. A finer grained analysis of different aspects of functioning revealed social engagement and prosocial activities as particularly important for the feeling of loneliness in all participants. Beyond these aspects, the level of interpersonal communication was linked to loneliness only in BPD. Interpersonal communication comprises the actual number of friends, having a romantic partner, how often one participates in a sensible or rational conversation, and how difficult one finds it to talk to people.

Impairments in social functioning likely lead to less frequent interactions with others, which in turn promotes smaller networks, being alone, and finally feelings of loneliness (Dykstra & van Tilburg, 2005; Pinquart & Sörensen, 2003). Thus, interpersonal communication may be linked to the number of interpersonal contacts, i.e., the size of the social network. However, additional analyses revealed no correlation between these factors in BPD patients (p=.150). Because larger network size and better social functioning in general (measured by the SFS total score) were positively correlated, this argues for the distinctness of interpersonal communication as a discrete aspect of social functioning. Having more people in the network as potential communication partners does not necessarily mean that an individual is able to carry out a sensible or rational conversation and finds it easy to talk to other people. The missing link suggests that deficits in interpersonal communication result from impaired communication skills rather than from a lack of potential conversational partners. This argues for the relevance of improving interpersonal communication skills in psychotherapy as an indirect path to improving feelings of loneliness in BPD.

We performed a post hoc analysis to explore causes underlying the divergent findings for the relationship between loneliness and functioning measured with the GAF and SFS. In BPD, the GAF score correlated at trend-level with the SFS total score, r=.27, p=.089. An analysis of covariance between the different domains of social functioning on the SFS revealed that the GAF mainly indicates occupation-related social functioning, as the only significant correlation was between the GAF and the subscale of the SFS that indicates employment, r=.33, p=.040. Besides a marginally significant correlation between the GAF score and the competence for living independently, r=.27, p=.099, all other areas of social functioning were not linked to the GAF score (all ps>.207). Moreover, the GAF score was not linked to features of social networks. The GAF is a well-established measure of general functioning and is therefore often used as an outcome measure in psychotherapy studies (Jørgensen

et al., 2013; Piersma & Boes, 1997; Salvi, Leese, & Slade, 2005). Our findings suggest that – in contrast to a measure which combines symptom severity with psychological, social, and occupational functioning, as the GAF does – a finer-grained assessment of social functioning in psychotherapy research may allow the beneficial effects of interventions in certain domains of functioning to be distinguished from insufficient effects in other domains. For example, shortcomings in regard to improving interpersonal communication may explain a failure of therapeutic approaches to beneficially affect loneliness in BPD (Bohus et al., 2007).

2.5.3 Limitations

Finally, some limitations of the present study have to be addressed. The main limitation is its merely correlational approach. Nonetheless, we found relevant links between the investigated concepts, which is a first step to the understanding of loneliness in BPD. Further studies should investigate causal relationships between specific impairments using longitudinal designs and experimental manipulations. Beyond that, our data rely on self-reports of both network features and social functioning. Because our data point to the relevance of impairments in social-cognitive functions regarding the perception and interpretation of complex social signals for increased feelings of loneliness, experimental tasks may help to identify these impairments and their relevance for loneliness. Thome et al. (2016) identified a lower self-confidence during the assessment of low intensity positive facial expressions as being linked to increased feelings of loneliness in BPD patients. This supports the relevance of alterations in social cognition for this psychopathological feature.

Because we did not include a clinical control group in the present study, the specificity of the observed alterations has to be investigated in future studies. Closely related is the question of whether different comorbidities contributed to our findings, because BPD patients may display differential patterns of impairment across distinct areas of social functioning and network features depending on the occurrence of specific patterns of concurrent disorders. The generalization of our findings to male BPD patients has to be investigated since we only included female participants.

Because the results of the present study show that social network features and social functioning contribute to severely increased feelings of loneliness in BPD, yet do not explain group differences completely, future research is necessary that investigates further potentially contributing factors, such as rejection sensitivity or rumination.

Moreover, loneliness has been shown to be predicted by neuroticism in healthy individuals (Flett, Goldstein, Pechenkov, Nepon, & Wekerle, 2016; Mund & Neyer, 2016; Stokes, 1985). BPD patients have been consistently described not only by high levels of neuroticism (according to the five-factor model; Trull & Brown, 2013) but also by extreme expressions of negative affectivity (according to the temperament model of BPD; Widiger, 2005). Because negative emotionality directly impacts

social functioning and development of social skills (Widiger, 2005), future research on loneliness in BPD may profit from taking contributions of personality traits such as neuroticism and negative affectivity into account.

2.5.4 Summary and Conclusions

Loneliness, i.e., the feeling of being alone, is markedly increased in BPD. Network features as well as skills and behaviors in specific domains of social functioning contribute to increased feelings of loneliness (see summary in Figure 2). In addition to factors that contribute to increased loneliness in general, we identified aspects with particular relevance for the emergence of loneliness in BPD. These seem to be related to deficits in social–cognitive functioning. However, the present study is only a first step to understanding loneliness in BPD, because social isolation and deficits in social functioning were not sufficient to explain the whole extent of the severe feelings of loneliness experienced by these patients. Nevertheless, our findings suggest starting points to determine an approach that may improve the persistent feelings of loneliness in this clinical sample.

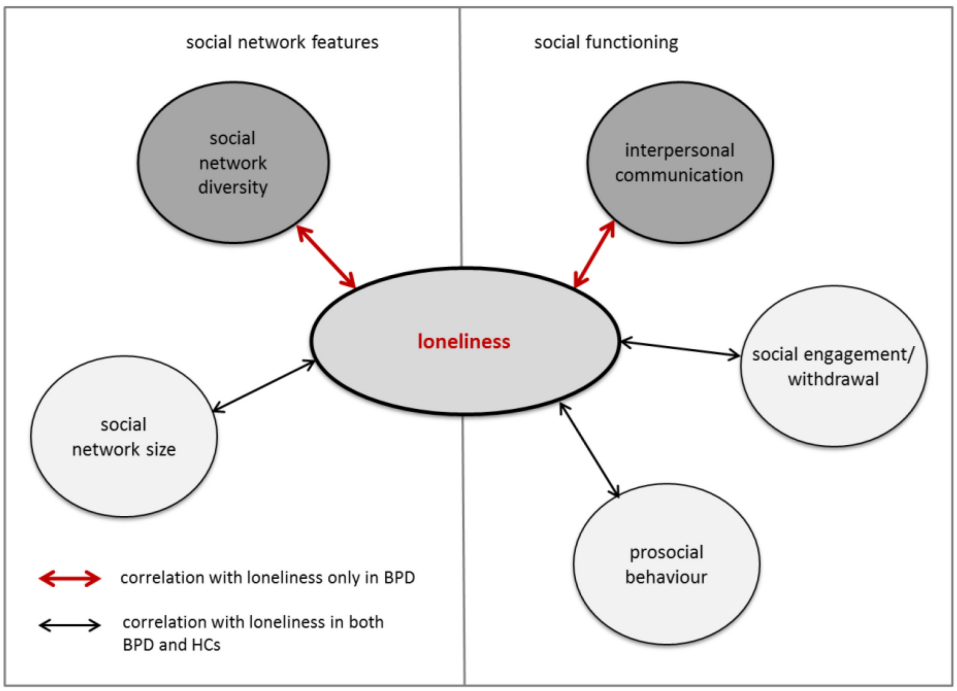


Figure 2. Illustration of the findings on the relations of loneliness with social network features and social functioning in BPD and HCs. Red arrows mark relations between domains observable only in the BPD group; Black arrows mark relations between domains observable in both the BPD and the HC group.

3 STUDY II: Expectations and Arousal in Healthy Individuals during Social Rejection based on the Mannheim Virtual Group Interaction Paradigm

Reactions to social rejection have been shown to be complex already in healthy individuals (see 1.4.2). Additionally, specific requirements for a paradigm to induce social acceptance and rejection suitable for our research agenda are not met completely by existing paradigms (see 1.4.1 and 1.5). Hence, this Chapter investigates healthy individuals' expectations of rejection or acceptance and their experienced arousal during social feedback, thereby introducing the newly developed MVGIP in detail. Later on, in Chapter 4, data from the same HC sample are compared to BPD patients.

3.1 Abstract

We developed the MVGIP to study the dynamic mechanisms of social rejection, while combining the advantages of mundane realism and high experimental control. Since social rejection is assumed to be particularly hurtful when people know those who reject them, we designed this new paradigm to investigate whether affiliation with future rejecters affects expectations of social rejection and arousal. The MVGIP consists of three phases: 1) A virtual reality (VR) interaction situation for becoming acquainted with six alleged other individuals, 2) an evaluation rating of the interaction partners measuring the degree of affiliation, and 3) an induction of social acceptance or rejection by social feedback. Fifty-six healthy female participants were randomly and double-blindly assigned to an acceptance or a rejection condition, while measuring adaptation of expectations as well as psychophysiological arousal to feedback. Participants adjusted their expectations to feedback quickly. After acceptance feedback, higher ratings of affiliation were linked to higher expectations of acceptance. After rejection feedback, affiliation was linked to opposing changes in arousal early in the feedback phase. Our findings emphasize affiliation with others as an important factor in the processing of social acceptance and rejection. Future research on social interaction may profit from using the MVGIP to manipulate features of social encounters with high experimental control while simultaneously inducing a real-life experience.

3.2 Introduction

Social rejection is frequently experienced in daily life (Williams et al., 2005). In a diary study, participants reported approximately one episode of rejection per day (Nezlek et al., 2012). Even among preschool children, social rejection is a daily occurrence. In a naturalistic observational study of 42 children examined for about 30 minutes each, Fanger et al. (2012) noted 206 incidents of social re-

jection. Not only is social rejection a frequent occurrence, but it is an experience which deeply impacts human life. It is particularly threatening because it ignores the fundamental need for belonging, which forms the basis for self-esteem and self-actualization (Baumeister & Leary, 1995; Kenrick, Griskevicius, Neuberg, & Schaller, 2010; Maslow, 1943). Leary (2005) suggest that it is especially hurtful when the persons being rejected are familiar with the people who are rejecting them, however, to date, empirical data are lacking to confirm this view.

The frequent peer-based social rejection, exclusion, and re-coaxing of childhood serves as an important training ground for the development of adaptive and assimilative social behaviors to cope with experiences of social rejection. When there are disturbances in this repetitive rejection–coaxing process during childhood and adolescence, it is possible that instead of adaptive coping methods individuals may develop persisting alterations in social cognitions and behavior, resulting in increased susceptibility to psychiatric disorders like BPD (Bungert, Koppe, et al., 2015; Bungert, Liebke, et al., 2015; Fonagy, Speranza, et al., 2015; Schmahl et al., 2014). E.g., it has recently been shown that frequent or repetitive experiences of social rejection (bullying) predict self-harm in adolescents (Fisher et al., 2012). Thus, it is important to elucidate the psychological mechanisms underlying the perception and processing of social rejection in order to understand not only functional but also dysfunctional social behaviors related to social rejection.

One of the major determinants of social interaction is expectation. The expectation of being excluded from or included in a group has been shown to affect the experience of rejection such as the extent of perceived discrimination (Liao et al., 2015). Moreover, expectations are shaped by former experiences of rejection. For example, dismissingly attached children display a stronger tendency toward persistent expectations of rejection (White et al., 2013) and intense peer rejection predicts an increase in anxious and angry expectations of future social rejection (London et al., 2007). Early experiences of intense rejection have been proposed to be crucial to the development of rejection sensitivity (Downey & Feldman, 1996; Downey, Feldman, Khuri, & Friedman, 1994; McLachlan, Zimer-Gembeck, & McGregor, 2012), a cognitive-affective disposition to “anxiously expect, readily perceive, and overreact to rejection“ (Downey & Feldman, 1996, p. 1327). While these findings support the idea of a relationship between expectations and a previous history of rejection, little is known about how fast subjects adjust their expectations while actually experiencing social acceptance or rejection, or about how rejection sensitivity may influence this adjustment. One may hypothesize that expectations depend on the degree of perceived affiliation to the group (e.g., Leary, 2005). However, to our knowledge, no studies have investigated how affiliation affects the expectations of rejection or acceptance and the adjustment to the experience of actually being accepted or rejected by the group.

Some studies suggest that social expectations influence the strength of emotional distress from social rejection. Rejection sensitivity has been found to predict behavioral responses to rejection, including distress and hostility (Ayduk, Downey, Testa, Yen, & Shoda, 1999). A recent study by Gunther Moor et al. (2010) revealed that heart-rate is a parameter of psychophysiological arousal that is particularly affected by unexpected rejection. Thus, inter-subject variability in expectations as well as personality dispositions such as rejection sensitivity may contribute to the inconsistent relationships noted between social rejection and psychophysiological arousal in the past (see meta-analysis by Gerber & Wheeler, 2009; Gunther Moor et al., 2010; see also B. Iffland et al., 2014; Mooren & van Minnen, 2014; Murray-Close, 2011).

The aim of the present study is to investigate how healthy people adjust their expectations of social acceptance or rejection after a group situation. In particular, we were interested in understanding the effects of rejection sensitivity and degree of affiliation with the rejecting persons on expectations, the adjustment of expectations, and psychophysiological arousal. To answer these questions, we designed a social rejection paradigm that allows for i) becoming acquainted and thus the creation and assessment of emotional affiliation between participants, and ii) the measurement of expectations and adjustment thereof while manipulating the participant's acceptance or rejection from the group.

Existing social rejection paradigms can be separated into those that induce the fear of being rejected at some point in the future and those that create the experience of rejection in real time. An example of the former, the life-alone prognosis paradigm, induces the anticipation of social rejection in later life by manipulating the feedback of the results of a personality questionnaire (e.g., Baumeister et al., 2002; Twenge et al., 2001). Examples of the latter are interaction-related paradigms which create the experience of social rejection by having real or virtual others ignore the participants in the experiments. They comprise the well-established Cyberball paradigm, a virtual ball-tossing game (Kassner et al., 2012; Williams et al., 2000; Williams & Jarvis, 2006), and O-Cam, a recently developed paradigm that simulates a web conference during which the experimental participant is ignored by two other individuals (Goodacre & Zadro, 2010). So far, only few studies aimed at inducing social rejection through manipulations representing rejection situations that similarly occur in everyday life, like getting acquainted and subsequently ostensibly rejected by real other people (e.g., Maner, DeWall, Baumeister, & Schaller, 2007; Nezlek et al., 1997; Twenge et al., 2001). Since rejection may be especially hurtful when it comes from people of whom an individual has previously experienced acceptance (Leary, 2005), instead of rejection by total strangers like in the O-Cam paradigm, we also wanted to deploy such a paradigm that allows for preceding affiliation. Already Nezlek et al. (1997) designed a paradigm where participants became acquainted, showing that depression and low self-esteem predisposes individuals to react more strongly to social rejection.

Using virtual others as executors of acceptance or rejection, instead of groups of real participants or experimental confederates, we aimed at combining the approach of a become acquainted paradigm with the advantages of paradigms using computer-controlled co-players such as the Cyberball paradigm or O-Cam: It allows for experimental control of the social encounter, including subtle social signals such as mimicking reactions or intonation, and the content of verbal messages. Moreover, existing paradigms create experiences of social rejection as single isolated events and thus do not allow for studying the dynamics of the adjustment of social expectations. Consequently, we developed the MVGIP. This new VR paradigm consists of three distinct phases. In phase I, the participant becomes acquainted with the group, and forms an affiliation with the other virtual members. In phase II, the intensity of these affiliations is assessed via an evaluation rating. Finally, in phase III, social expectations of the participants are assessed and a subsequent experience of acceptance or rejection is generated via repeated explicit social feedback of acceptance or rejection. This feedback is interrupted by assessments which allow for the measurement of the relationship between perceived social rejection or acceptance and adjustments of social expectations. The MVGIP paradigm is described in more detail in the methods section below and in Figure 3. It was designed to combine the two great advantages of immersive virtual environments: Experimental control and mundane realism. Virtual environments enable the investigation of social behavior in a context which people perceive as real while simultaneously allowing for a high degree of control of the experimental social environment (i.e., the behavior of interaction partners). For a detailed discussion of the advantages of using VR environments in general psychological research, please see the writings of Blascovich et al. (2002) and Loomis (1999), and for a discussion of their relevance to investigations of social rejection in particular, see Kassner et al. (2012).

We hypothesized that in healthy populations 1) the expectations of social acceptance are adapted to situations of acceptance or rejection, 2) the experience of social rejection alters self-reported as well as psychophysiological arousal, and that 3) the expectation of social rejection and arousal reactions as well as their adjustments after social feedback are linked to the degree of affiliation with the executors of acceptance or rejection as well as to the personality trait of rejection sensitivity.

3.3 Methods

3.3.1 Participants and Design

A total of 56 healthy female subjects participated in the study. Exclusion criteria were a current or lifetime history of psychiatric disorders, history of organic brain disease, skull or brain damage, and severe neurological illness. The study was approved by the Research Ethics Board of the University of Heidelberg. Subjects provided written informed consent prior to study participation. Recruitment

was performed via the Central Project of the KFO-256, a Centre Grant dedicated to investigating mechanisms of disturbed emotion processing in BPD (Schmahl et al., 2014), funded by the German Research Foundation (DFG; KFO 256). The data presented in this article were collected within a larger study on the processing of social rejection in BPD.

The study followed a double-blind procedure where subjects were randomly assigned to a condition of either social acceptance or rejection. Subjects in both groups did not differ in age (acceptance: 26.9 ± 5.5; rejection: 27.6 ± 5.7; $t(54)=0.47$, $p=.637$), years of education (acceptance: 12.0 ± 1.5; rejection: 12.3 ± 1.3; $t(54)=0.66$, $p=.510$), intelligence based on their Raven Progressive Matrices scores (Raven, 1976; acceptance: 53.7 ± 3.8; rejection: 55.0 ± 3.1; $t(54)=-1.38$, $p=.174$) or rejection sensitivity (acceptance: 5.2 ± 3.2; rejection: 4.8 ± 2.6; $t(54)=-0.56$, $p=.580$).

3.3.2 Experimental Procedure

We developed the MVGIP to study the dynamics of social rejection and acceptance, while combining the advantages of immersive virtual environments, i.e., mundane realism, and high experimental control (Blascovich et al., 2002; Kassner et al., 2012; Loomis, 1999). Participants are told that the aim of the study is to test a newly developed virtual communication program. While they are led to believe that the other participants of the meeting are real participants, modelled by avatars, the avatars' behavior is computer-controlled to ensure a comparable social setting for all participants. It is important to note, that interacting with a human-like avatar has been shown to accurately reflect verbal behavior in interactions with a real human (Heyselaar, Hagoort, & Segaert, 2017). The experimental procedure consists of a sequence of different paradigms (see Figure 3): In phase I, we used a virtual environment to give participants the opportunity to become acquainted with what they believe are real other participants (see Figure 3a). In phase II, they evaluated their liking of every member of this virtual group (see Figure 3b). In phase III, participants received feedback about the evaluation by the others in six feedback rounds with feedback signaling either social acceptance or social rejection depending on the random and double-blind assignment of each subject to one of these two experimental conditions. Within each round, participants were asked about their expectations of the next round of feedback before it was given.

MVGIP phase I: VR become acquainted. During the become acquainted phase, participants meet six avatars of alleged other participants in a VR meeting (see Figure 3a). It allows the participant to get to know the other alleged participants and affiliate with them. They wear an nVisor ST50 head-mounted display (Engineering Systems Technologies GmbH & Co. KG), with two monitors that display stereoscopic images to the left and right eyes, thereby creating a three-dimensional VR environment. The participant's view within this environment creates the illusion of being seated at a table in a virtual room with other individuals. Head movements allow for a three-dimensional viewing of the

room and the members of the meeting. To create the six avatars, middle-aged individuals (three male and three female) were recruited, their responses to standardized questions were audiotaped and their pictures were transformed into avatars using 3D Studio Max (Kinetix).

As a cover story, participants as well as every alleged group member, introduce themselves according to a standardized protocol: They answer 6 questions adapted from the relationship closeness induction task (Sedikides, Campbell, Reeder, & Elliot, 1999): 1) „Please tell us your name, age, where you are from and what your profession is.“ 2) „What are your hobbies?“ 3) „Tell us something you have always wanted to do, but probably never will be able to do.“ 4) „If you could travel anywhere in the world, where would you go and why?“ 5) „If you could have one wish granted, what wish would that be?“ 6) „Please name us one or two persons or things that are important for you.“ All avatars also provide responses to these questions, fixed by the experimenters. Speaking order is marked by a speech bubble appearing above the currently selected speaker (see Figure 3a), and continued from the left to the right seating positions. The verbal responses of the virtual co-players as well as changes of their emotional facial expressions and gaze directions are pre-programmed and similar for each participant. Avatars always looked at the person who was talking; their facial emotional expressions were happy and surprised in 33.3% of the cases, and critical and neutral in 16.7% of the cases. Emotional expressions were pseudo-randomized such that the same percentage of each emotion was displayed towards each other avatar as well as the subject throughout the become acquainted phase. The onset of the emotion in response to a particular avatar depended on the duration of its answer and was initiated within +/-25% of half the duration. To ensure ecological validity, each of the individuals who were the models for the six avatars had been asked to answer the six become acquainted questions as they would if they were actually participating in the study. These audio-recordings were played back during the experiment. To further enhance the validity of the experiment, it was necessary to make the participant believe that she was represented as an avatar in the meeting, like the six other avatars she sees on the screen. For this purpose, the participants were pseudo-photographed and -video-taped in the beginning of the study while displaying each later used emotion and head movement such that the photos and videos could have been used to create their personal avatar. For each of the responses of each avatar in each question round, participants were asked to choose the emotional facial expression their own avatar should wear, to best reflect their emotional response to a given answer, selecting either a happy, critical, surprised, or neutral facial expression (see Figure 3a) by pressing keys on a control device. The dependent variable was the number of button presses for each emotional expression, indicating the degree to which subjects signaled willingness to affiliate (Heerdink, van Kleef, Homan, & Fischer, 2015).

MVGIP phase II: evaluation of the co-players. Following the become acquainted phase, participants were asked to evaluate the six other virtual participants. This evaluation rating functions as a measure of the degree of affiliation towards the interaction partners (affiliation defined as "willingness to socialize with the target", see Honey & Coulombe, 2009, p. 451). This task simultaneously served as the cover story for the subsequent feedback of acceptance or rejection they receive in the next phase. Affiliation towards the alleged other participants was assessed by responses to a set of 12 standardized evaluation questions regarding each of the six participants (e.g., regarding Anna: "Do you like Anna?", "Would you like to meet Anna again?", "Do you think Anna is intelligent?", "Do you think Anna is interesting?", "Do you think Anna is likeable?", "Do you feel close to Anna?", "Could you imagine working together with Anna?", "Do you think Anna is quite like you?", "Do you think Anna is attractive?", "Could you imagine spending your free time with Anna?", "Do you think Anna is an approachable person?", "Could you imagine being friends with Anna?"). As dependent variable, subjects estimated their own affiliation to each of the six co-players on a 6-point Likert scale (see Figure 3b). Mean rating scores for each avatar were transformed into percentages ranging from 0 to 100 with higher scores indicating more positive evaluations, i.e., higher affiliation.

MVGIP phase III: feedback phase. The induction of social acceptance or rejection is implemented outside the VR meeting to enable preceding assessment of how participants evaluated their co-players. The multi-round feedback phase comprises assessment of expectations and the induction of social acceptance or rejection. It consists of six rounds. During each round subjects are first asked to rate their expectations by estimating how many of their co-players evaluated them positively or negatively. A subset of six questions out of the 12 questions of the preceding evaluation rating was used (e.g., "What do you expect? How many would like to meet you again?", see Figure 3c). The dependent variable was the expectation rating given on a 7-point scale ranging from 0 ("nobody") to 6 ("everybody"). Subsequent to each expectation rating, subjects received bogus feedback about how the other participants of the VR meeting had actually evaluated them. Participants were told that the feedback was based on the ratings of their co-players, while in reality it was manipulated according to the subject's assignment to the acceptance or rejection condition. After each expectation rating, feedback was provided by the presentation of six schematic faces (see Figure 3c). In the acceptance condition, feedback varied between 4-6 positive (mean 5) happy faces and 0-2 negative faces (mean 1) per round, while the reverse ratios held true for the rejection condition. We chose not to simulate acceptance or rejection from all six co-players in each round, in order to increase credibility of the cover story. The first question for expectations serves as a baseline measure of expectation of social acceptance, since no feedback had been provided before. Adjustment of expectations according to social acceptance or rejection is measured by the following five expectation assessments.

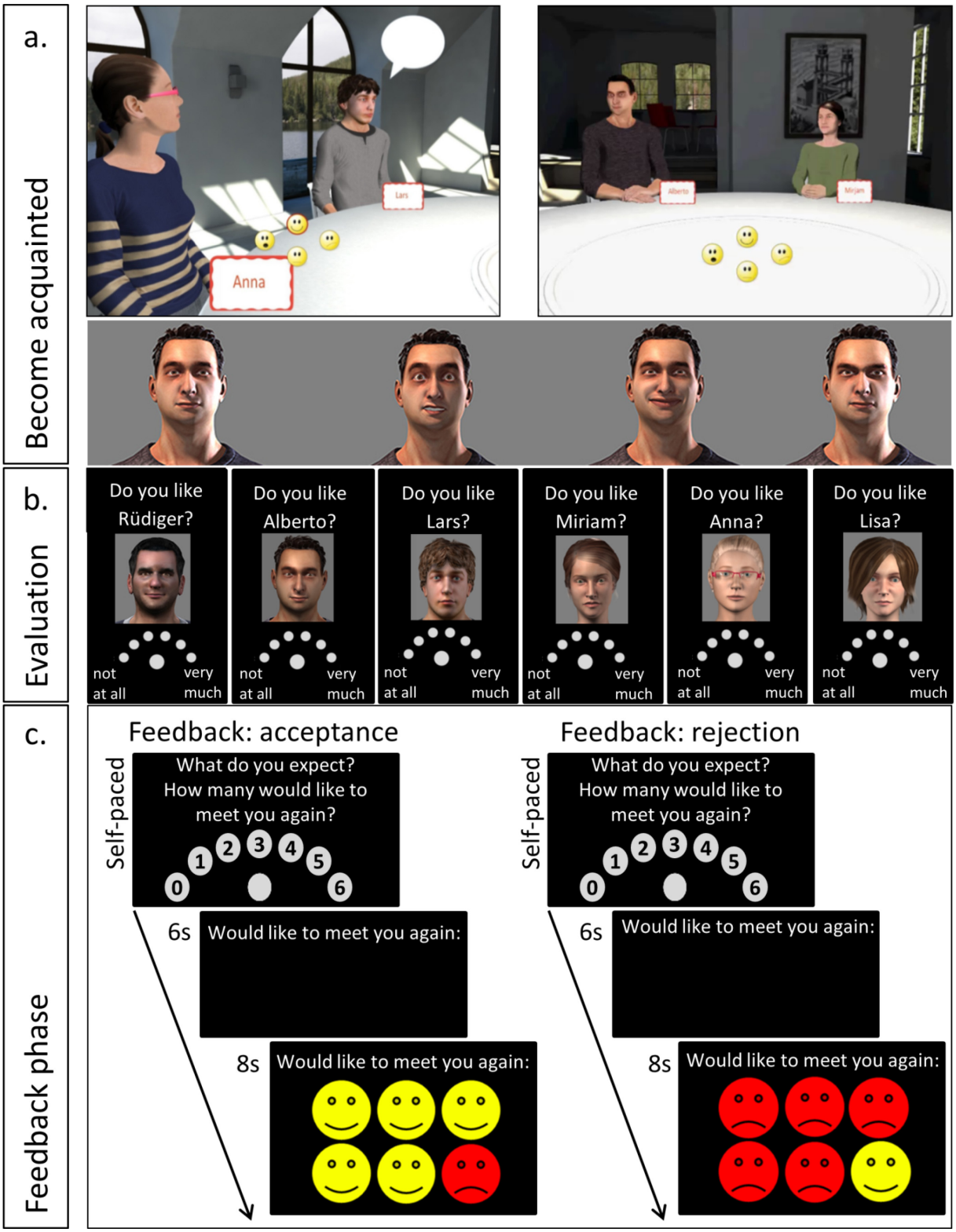


Figure 3.[1] Schematic illustration of the applied experimental settings of the MVGIP. (a.) Virtual reality environment become acquainted phase with an example of the variation of an avatar's emotional expression, (b.) Evaluation rating (avatars with one example of the ratings), and (c.) Example of one of the six rounds of the feedback phase for the acceptance and rejection condition.

[1] This figure is included in Liebke et al. (2018), see page 68.

3.3.3 Additional Measurements

Rejection sensitivity. Rejection sensitivity was measured using a German version of the Rejection Sensitivity Questionnaire (RSQ) for adults (Berenson et al., 2009; Bungert, Liebke, et al., 2015). The RSQ consists of nine items describing interpersonal scenarios that have to be rated on the expectation of and anxiety about being rejected. Rejection sensitivity scores range from 1 to 36, with higher scores signaling higher sensitivity.

Subjective arousal. Subjective Arousal was measured before and after the feedback phase. Participants rated their degree of arousal on a 9-point scale using the Self-Assessment Manikin (SAM; Lang, Bradley, & Cuthbert, 1990).

Physiological arousal. Physiological arousal was measured via HR during the feedback phase based on electrocardiography (ECG) recordings using a Biosemi Active Two system (Biosemi, Amsterdam, Netherlands, sampling rate 1024Hz, ActiView software; the Netherlands: http://www.biosemi.com). ECG signals were visually inspected for artefacts. Based on the RR-interval series of the ECG, HR was calculated for eight distinct intervals: A baseline interval before any feedback was provided, an interval for each round of the feedback phase (see Figure 3c), and an interval at the end of the task when subjects reported their degree of arousal. Due to technical problems during registration, seven subjects had missing HR data (acceptance condition n=4, rejection condition n=3).

Validity of the MVGIP. To evaluate the ecological validity of the MVGIP we assessed presence in VR and the subjects' wish to become acquainted to the alleged co-players in real life. Presence in VR is defined as the subjective experience of being physically present in a VR (Schuemie, van der Straaten, Krijn, & van der Mast, 2001) and thereby is rooted in "a psychological state in which the virtuality of experience is unnoticed" (Lee, 2004, p. 32). It was measured with the MEC-Spatial Presence Questionnaire (MEC-SPQ; Vorderer et al., 2004). This sense of being in a real environment is essential for VR approaches, as it is a prerequisite for reactions comparable to those that would be observed in a real environment (Schuemie et al., 2001). The MEC-SPQ measures five dimensions of presence in VR using 20 items. Every item is answered on a 5-point Likert scale (1 = "I do not agree at all" to 5 = "I fully agree"), and means are calculated for each subscale, ranging from 1 to 5. These five dimensions of spatial presence contain three process factors, i.e., factors that are necessary to experiencing spatial presence. These factors are Attention Allocation (being attentive to the mediated space), Possible Actions (holding assumptions of which actions are possible in the mediated space), and Spatial Presence (the conviction of being located in a mediated environment; see Wirth et al., 2007). The other two dimensions of spatial presence relate to states and actions. Spatial presence increases with Higher Cognitive Involvement (when recipients are interested in thinking about and processing information related to the virtual environment) and the Suspension of Disbelief (when recipients stop

thinking about whether what they perceive makes sense, and do not pay attention to possible irrationalities). Normative MEC-SPQ data was reported by Vorderer et al. (2004) and used in the present study to evaluate the strength of the VR experience.

Additionally, at the end of the session participants were asked whether or not they would like to get to know their co-players, whom they had met in VR, in real life. This question functions as a conclusive measure of affiliation, i.e., "willingness to socialize with the target" (Honey & Coulombe, 2009, p. 451), after feedback has been received (as compared to the degree of affiliation assessed through the evaluation rating preceding the feedback phase).

3.3.4 Statistical Analysis

All dependent variables of the MVGIP were analyzed using variance analytical designs (ANOVAs) with "feedback" as the between-subjects factor (acceptance versus rejection). The design was extended by task-specific within-subject factors. During the VR become acquainted phase, the choice of emotional facial expressions was analyzed using a 2x4 repeated measures ANOVA with the within-subject factor "emotion" (happy, critical, surprised, neutral). Affiliation scores of the evaluation rating were analyzed using a 2x6 repeated measures ANOVA with the within-subject factor "avatar" (for the 6 alleged co-players represented by avatars in the VR). Feedback expectations retrieved from the feedback phase were analyzed using a 2x6 repeated measures ANOVA with the within-subject factor "rounds" (round 1 to 6 of the feedback phase). SAM-arousal ratings were analyzed with a 2x2 repeated measures ANOVA with the within-subject factor "time" (before versus after the feedback phase). HR was analyzed with a 2x8 repeated measures ANOVA with the within-subject factor "time" for the eight intervals (1: baseline, 2-7: rounds 1 to 6 of the feedback phase, 8: post-feedback phase). To detect effects of medium size with a power of at least .95 in all of these designs, a power analysis using G*Power (Faul, Erdfelder, Lang, & Buchner, 2007) revealed that 54 participants are needed.

Pearson's correlation coefficients were computed to analyze co-variations between dependent variables in the experimental tasks with the strength of affiliations and with rejection sensitivity. The experience of spatial presence during the VR become acquainted phase was analyzed using a 2x5 repeated measures ANOVA (within-subject factor "subscale") including the 5 dimensions of presence assessed by the MEC-SPQ. All analyses were performed using SPSS (IBM SPSS Statistics for Windows, Version 20.0). Effect sizes were computed and reported as Cohen's d (J. Cohen, 1988).

3.4 Results

3.4.1 Phase I: VR Become Acquainted Phase

Selection of the avatar's emotional expressions. Participants chose the four emotions for the facial expressions of their avatars with different frequencies ($F(3,162)=192.02$, $p<.001$, $d=3.771$; see Figure 4a). Post-hoc tests revealed that subjects most often chose happy facial expressions (71.2%, 22.71 ± 7.98), less often neutral facial expressions (16.1%, 5.14 ± 5.31), and least often critical (6.5%, 2.07 ± 2.01), or surprised (6.2%, 1.98 ± 2.29) expressions. This resulted in the order happy > neutral > critical ≈ surprised. In 24% of trials participants did not select an emotional expression at all (22% acceptance, 26% rejection; $t=1.13$, $p=.265$). Choices of facial emotional expressions did not differ between the two feedback conditions ($F(1,54)=1.27$, $p=.265$) and there was no feedback x emotion interaction ($F(3,162)=1.65$, $p=.181$).

3.4.2 Phase II: Evaluation of the Co-Players

On average, subjects rated their affiliation with the members of the VR-meeting as moderately positive (59.7%). Mean ratings of affiliation towards the six alleged co-players of the VR meeting did not differ between feedback groups ($F(1,54)=1.02$, $p=.318$) and there was no feedback x avatar interaction ($F(5,270)=0.66$, $p=.657$). Yet, there was a main effect for avatar ($F(5,270)=2.72$, $p=.020$, $d=0.449$), suggesting that subjects differentiated between the six co-players (see Figure 4b).

To explore whether the behavior during the become acquainted phase was linked to the subsequently reported strength of affiliation we calculated correlations between the frequency of selected facial expressions and the evaluation rating scores. Analyses revealed a relation only for the selection of critical expressions. The higher the percentage of critical facial expressions selected, the lower subjects rated their affiliation towards the co-players ($r=-.45$, $p<.001$, all other $ps>.123$; see Figure 4c).

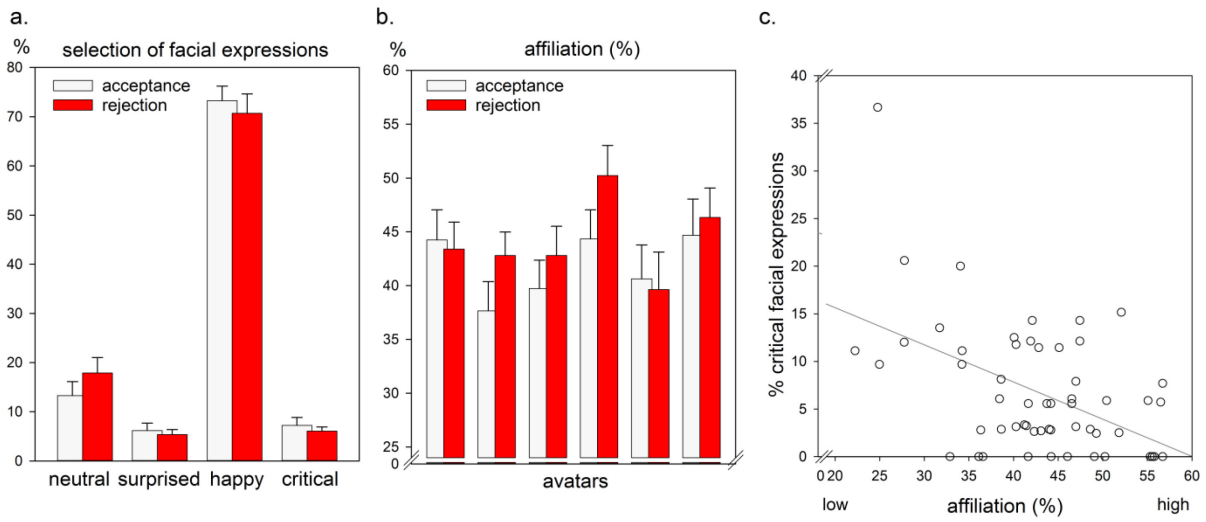


Figure 4. (a.) Percentages of emotional expressions selected for the avatars during the VR become acquainted phase. (b.) Evaluation rating of affiliations with the six virtual co-players. (c.) Relation of the degree of affiliation reported in the evaluation rating and the percentage of selected critical expressions during the VR become acquainted phase. Error bars represent standard errors.

3.4.3 Phase III: Feedback Phase: Assessment of Expectations and Arousal

Effects of feedback on expectations of social acceptance. Expectations of social acceptance differed between the acceptance and rejection groups depending on whether they had already received feedback (interaction feedback x round $F(5,54)=8.96$, $p<.001$, $d=0.815$, see Figure 5a). Post-hoc tests revealed no difference between the acceptance and rejection group at baseline before any feedback was given (round 1, $p=.495$). However, after feedback, subjects in the rejection condition expected significantly less social acceptance from the members of the VR meeting than subjects in the acceptance condition. This difference held through all subsequent rounds (see Figure 5a, all *p*s<.001).

At the beginning of the feedback phase, both groups expected to be accepted by 47% of their co-players. Following rejection feedback, subjects expected less positive feedback compared to their baseline expectation (all *p*s<.001). After acceptance feedback, subjects adjusted their expectations of social acceptance by expecting acceptance from a slightly higher number of participants compared to their baseline expectations (all *p*s<.05, round 2 and 6 $p<.1$). At the end of the feedback phase (round 6), the expectations of both groups differed from the feedback actually given. Subjects in the rejection group expected social acceptance by a higher number of participants than the average acceptance they were given (expected feedback: 32.7% ± 22.0, actual feedback: 16.7%; $t=7.88$, $p<.001$). In contrast, subjects of the acceptance group expected social acceptance by a lower number of par-

ticipants than their average five participants (expected feedback: 54.2% ± 25.1, actual feedback: 83.3%; *t*=- 2.64, *p*=.014).

Correlation between affiliation and expectation of social acceptance. Expectation of social acceptance at baseline before feedback in phase III correlated on a marginally significant level with evaluation ratings of affiliation in phase II (*r*=.25, *p*=.064, see Figure 5b). The more the participants felt affiliated with their alleged co-players, the more positive feedback they expected. Moreover, expectations of social acceptance at the end of the phase III (feedback phase) correlated with evaluation ratings of affiliation, when accepted (*r*=.43, *p*=.022, see Figure 5c), but not when rejected (*r*=.08, *p*=.690, see Figure 5c). As such, the more the participants felt affiliated with their alleged co-players, the more positive feedback they expected from them when they received acceptance feedback.

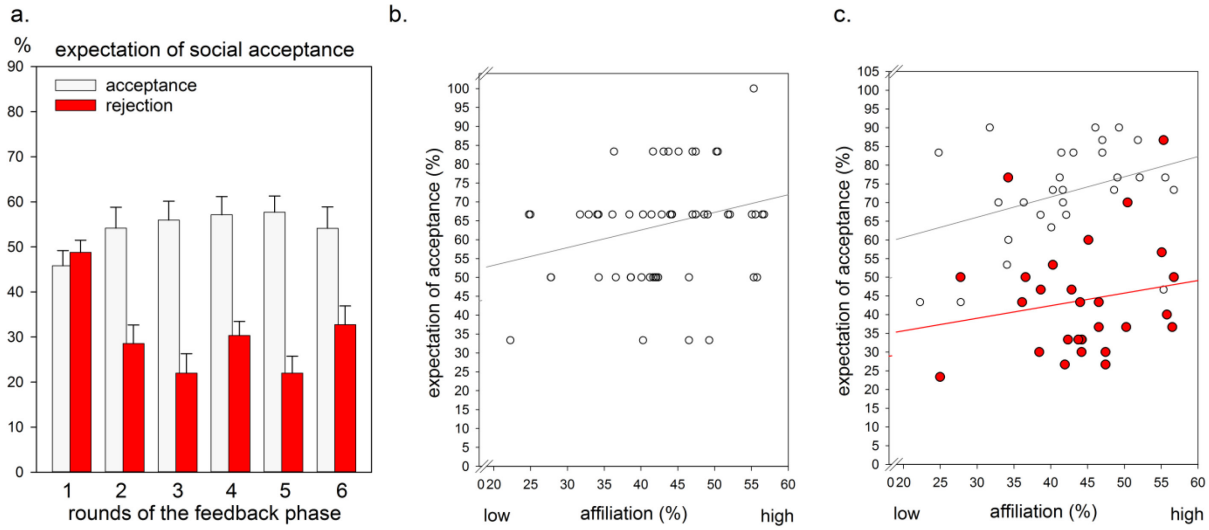


Figure 5. Expectations of social acceptance and covariation with affiliation. (a.) Expectations over the course of the feedback phase for the acceptance and rejection groups. (b.) Correlation between evaluation rating of affiliations and expectation of acceptance in round 1 before any feedback was given and (c.) at the end of the feedback phase. Error bars represent standard errors.

Effects of feedback on subjective and physiological arousal. Analysis of SAM-scores before and after the feedback phase revealed a trend toward changes in subjective arousal in the acceptance and rejection conditions (time x feedback interaction, *F*(1,54)=3.52, *p*=.066, *d*=0.511). While mean SAM-scores increased after rejection, they decreased after acceptance (see Figure 6a). However, neither the increase nor decrease was statistically significant.

Analysis of HR during the feedback phase revealed a decrease of HR over the course of the feedback phase (main effect of time, *F*(7,329)=4.31, *p*<.001, *d*=0.606). However, this decrease was

not influenced by the feedback conditions (time x feedback interaction, $F(7,329)=0.98$, $p=.446$) and HR did not differ between feedback groups ($F(1,47)=0.05$, $p=.818$; see Figure 6b).

Correlation between affiliation and arousal. Neither self-reported arousal nor HR showed a correlation with evaluation rating of affiliations (both *p*s>.1). However, an analysis of the relationship between the degree of affiliation and change in HR during the feedback phase was significant in the rejection group. The more subjects affiliated with their alleged co-players, the higher their HR compared to baseline during early rounds of rejection feedback (round 1: $r=.50$, $p=.011$; round 2: $r=.40$, $p=.045$; round 3: $r=.42$, $p=.035$, for representative data see Figure 6c). Covariations were not observed in later feedback rounds, or in the acceptance group (all *p*s>.1).

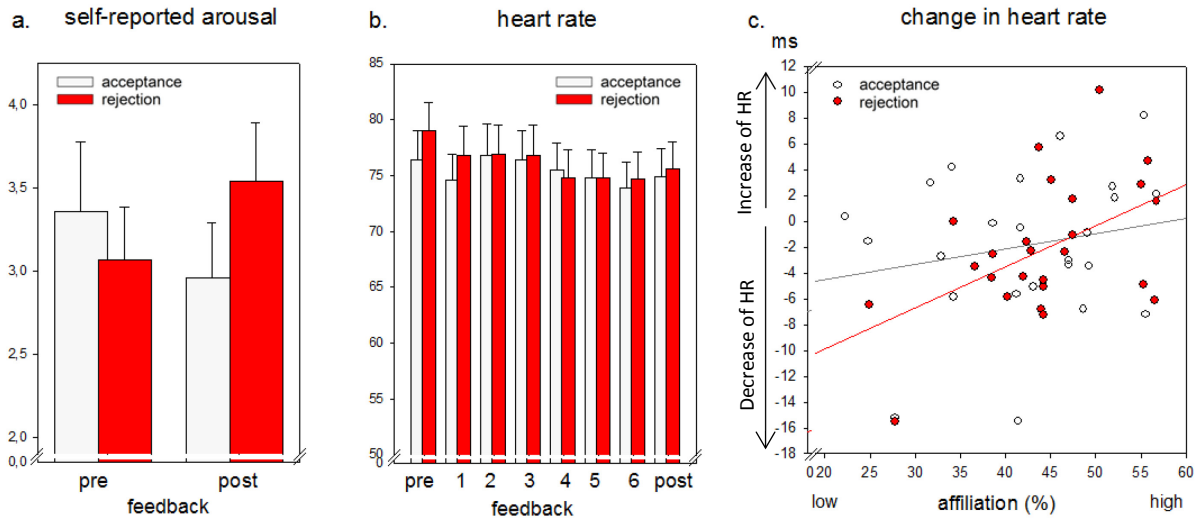


Figure 6. Arousal in the acceptance and rejection conditions. (a.) SAM-arousal ratings before and at the end of the feedback phase; (b.) HR in beats per minute; (c.) correlation between the level of affiliation with the co-players and change in HR during the first feedback round from baseline. Error bars represent standard errors.

3.4.5 Influence of Rejection Sensitivity

Rejection sensitivity was not correlated with any of the experimental variables except with HR during the feedback phase. The more rejection sensitive participants were, the higher their HR ($r=.32$, $p=.024$).

3.4.6 Ecological Validity of the MVGIP

Spatial presence in VR. Spatial presence ratings differed between subscales of the MEC-SPQ ($F(4,216)=21.88$, $p<.001$, $d=1.272$)**.** Compared to the MEC-SPQ normative sample data, participants reported higher scores of Spatial Presence, Possible Actions, and Suspension of Disbelief, and lower scores for Higher Cognitive Involvement. There were no differences in Attention Allocation between our participants and the normative sample. There were no differences in any of the subscales of spatial presence in VR between both feedback conditions ($F(1,54)=0.05$, $p=.830$) and no feedback x subscale interaction ($F(1,216)=0.45$, $p=.773$).

Wish to meet in real life. When asking participants whether or not they would like to meet their co-players in real life, 68% of the participants in the acceptance condition said they wanted to get to know them, versus only 25% of the participants in the rejection condition ($\chi^2=4.791$, $p=.029$, $d=0.612$). Moreover, after acceptance, those who wanted to meet the alleged other participants had previously reported significantly higher degrees of affiliation with the co-players ($t=4.87$, $p<.001$). This was not the case when rejected ($t=1.12$, $p=.275$). After acceptance, those who wished to meet in real life also had expected more positive feedback (mean of rounds 2-6, $t=2.41$, $p=.023$). This was true on a marginally significant level after receiving rejection feedback (mean of rounds 2-6, $t=1.76$, $p=.090$).

3.5 Discussion

The present study investigated the effects of social acceptance and rejection on expectations of social acceptance and arousal. We were particularly interested in whether the degree of affiliation with social partners would affect the degree and the adjustment of expectations of social acceptance and the adjustment of arousal over the course of repeated experiences of acceptance or rejection. We used the MVGIP, a newly developed rejection paradigm designed to study the dynamic mechanisms of social rejection and acceptance. Our findings revealed that expectations of social acceptance change very quickly after experiences of acceptance or rejection. Furthermore, expectations are linked with affiliation particularly in case of being accepted. However, the adjustment of expectations after rejection is not affected by the degree of affiliation. In contrast, subjects with higher affiliation responded to social rejection with stronger psychophysiological arousal, particularly during initial rejection feedback.

Expectations of being rejected influence how people experience social encounters (Downey & Feldman, 1996; Liao et al., 2015). Our data revealed that during the signaling of social acceptance or rejection by others, expectations change very quickly, right after a first feedback. Subjects decreased their expectations in case of rejection and increased it in case of acceptance. However, neither a predisposition to expect rejection (rejection sensitivity) nor degree of affiliation influenced expecta-

tions during a social encounter. Although our data suggests a link between stronger affiliations and higher expectations of acceptance, this relationship explained only 6% of the variance in expectations before any feedback was provided. In contrast to expectations after rejection, subjects who affiliated more strongly with their co-players expected greater acceptance at the end of an acceptance feedback phase. Thus, our data confirm the relevance of affiliations to expectations after positively valenced encounters, but not after negative ones. This fits with recent findings indicating that becoming part of a group and avoiding rejection constitute distinct domains of affiliation (Neel, Kenrick, White, & Neuberg, 2016). These conclusions are relevant to interpersonal experiences with new or casual acquaintances. Our findings cannot necessarily be generalized to interactions with close friends, family members, or romantic partners. Nevertheless, the selection of emotional expressions for their avatars in response to the other members suggests that participants were willing to affiliate with their alleged co-players during the become acquainted phase. In particular, smiling is a sign of willingness to initiate social contact and reflects social affiliation (Schultz, Ambike, Buckingham-Howes, & Cheah, 2008). Participants chose to display happy facial expressions much more often than any other emotional expression. In line, subjects who reported lower affiliation with their virtual co-players had displayed more critical facial expressions during the become acquainted phase. The influence of the degree of affiliation seems to transfer into the building of new social contacts in the context of social acceptance, suggesting that the MVGIP is ecologically valid. The wish of participants for further contact with the alleged co-players was particularly frequent in those who were previously accepted and showed stronger affiliation previous to receiving feedback. Whereas, affiliation, i.e., the wish to further socialize with the interaction partners, changes through rejection: In subjects who received rejection feedback, the wish to affiliate expressed at the end of the session was independent from the rating of affiliation before the rejection encounter.

Social rejection is a distressing experience (Eisenberger, Lieberman, & Williams, 2003; van Beest & Williams, 2004), yet attempts to link effects of social rejection to psychophysiological responses such as changes in HR have revealed inconsistent findings in the past (Gerber & Wheeler, 2009; Gunther Moor et al., 2010; B. Iffland et al., 2014; Mooren & van Minnen, 2014; Murray-Close, 2011). Our data suggest that the psychophysiological response to social rejection depends on the degree of affiliation with rejecters. Subjects, who reported a higher level of affiliation with the others, responded to social rejection with a stronger increase of HR, while HR dropped in subjects with lower affiliation to the rejecters. It seems important to note that these changes occur very quickly and are very short-lived. Beyond that, HR decreased over the course of the feedback phase in both rejected as well as accepted subjects. Being liked by others is of high importance to oneself (Srivastava & Beer, 2005) and anticipation of being evaluated by others is also arousing in and of itself (see e.g., Cottrell, Wack, Sekerak, & Rittle, 1968). The general level of arousal was the only pa-

rameter which was linked to rejection sensitivity. Subjects who more anxiously expected social rejection showed higher HR throughout the feedback phase, suggesting that evaluation situations are especially arousing for rejection sensitive individuals.

In sum, our data suggest that psychophysiological arousal is determined by different factors, i.e., a personality disposition to anxiously expect rejection which contributes to inter-subject variability of HR during social situations, the degree of affiliation with interaction partners which particularly influences the response to social rejection, and the time course of social rejection since the influence of affiliation seems to fade over the course of repeated experiences of rejection. Disentangling these factors in studies on social rejection may help to clarify the heterogeneity of previous findings on the influence of rejection on HR. However, it requires the use of paradigms that allow for the measurement of affiliation with the rejecters and effects of social rejection with a time resolution sufficient to differentiate phasic and tonic responses of HR to rejection events. Finally, limitations of the present study are that the findings are restricted to new acquaintances and may differ when studying participants who have established deeper bonds over a longer time. However, this limitation is common to most of the presently available experimental paradigms in research on social rejection. Furthermore, rejection sensitivity was rather low in our sample and variance was small which may explain why rejection sensitivity does not play as big of a role as might be expected. Thus, further studies are necessary to investigate whether the findings actually hold true when the sample includes subjects with a higher level of this cognitive-affective personality disposition accompanied by a higher variability of rejection sensitivity between subjects. Moreover, our sample included only female participants. Further studies are needed to determine whether our findings generalize to male subjects.

In conclusion, expectations of being accepted or rejected are adjusted very quickly after feedback. The degree of affiliation affects expectations during positive social encounters, as well as the psychophysiological responses after social rejection. Our findings emphasize the need to use rejection paradigms that include an affiliation phase during which participants get to know the future executors of rejection or acceptance. The use of a VR approach to allow people to become acquainted seems to be a promising approach. Subjects signaled willingness to affiliate during this task and reported a high virtual presence, i.e., sense of being in a real environment. Further refinements of this approach such as experimentally manipulating the degree of affiliation with alleged co-players or creating an experience of social rejection via VR by for example manipulating eye-contact (Kleinke, 1986; Mason, Tatkow, & Macrae, 2005) may allow for deeper investigation of interpersonal relations and interactions not only as regards social rejection but also affiliation. The use of VR offers the great advantage of inducing an experience in a virtual environment that is perceived as the real world while simultaneously allowing for a high degree of control of the features of this social environment.

4 STUDY III: Difficulties with being Socially Accepted: An Experimental Study in Borderline Personality Disorder

An adapted version of this Chapter has been accepted for publication as "Liebke, L., Koppe, G., Bungert, M., Thome, J., Hauschild, S., Defiebre, N., Izurieta Hidalgo, N. A., Schmahl, C., Bohus, M., & Lis, S. (2018). Difficulties with being socially accepted: An experimental study in borderline personality disorder. *Journal of Abnormal Psychology, 127*(7), 670-682. doi:10.1037/abn0000373*"*.

4.1 Abstract

Anxious preoccupation with real or imagined abandonment is a key feature of borderline personality disorder (BPD). Recent experimental research suggests that patients with BPD do not simply show emotional over-reactivity to rejection. Instead, they experience reduced connectedness with others in situations of social inclusion. Resulting consequences of these features on social behavior are not investigated yet. The aim of the present study was to investigate the differential impact of social acceptance and rejection on social expectations and subsequent social behavior in BPD. To this end, we developed the Mannheim Virtual Group Interaction Paradigm in which participants interacted with a group of computer-controlled avatars. They were led to believe that these represented real human co-players. During these interactions, participants introduced themselves, evaluated their co-players, assessed their social expectations and received feedback signaling either acceptance or rejection by the alleged other participants. Subsequently, participants played a modified trust game, which measured cooperative and aggressive behavior. Fifty-six non-medicated BPD patients and 56 healthy control participants were randomly and double-blindly assigned to either the group-acceptance or group-rejection condition. BPD patients showed lower initial expectations of being socially accepted than healthy controls. After repeated presentation of social feedback, they adjusted their expectations in response to negative, but not to positive feedback. After the experience of social acceptance, BPD patients behaved less cooperatively. These experimental findings point to a clinically relevant issue in BPD: Altered cognitive and behavioral responses to social acceptance may hamper the forming of stable cooperative relationships and negatively affect future interpersonal relationships.

4.2 Introduction

Anxious preoccupation with real or imagined abandonment constitutes a key feature of dysfunctional interpersonal behavior in borderline personality disorder (BPD; American Psychiatric Association, 2013). Initially, the experimental research on this symptom domain in BPD was primarily focused on stronger negative emotional reactions to actually occurring social rejection (Berenson et al., 2011;

e.g., Lawrence et al., 2011; see also Schmahl et al., 2003). In line with more recent studies (Beeney, Levy, Gatzke-Kopp, & Hallquist, 2014; Dixon-Gordon et al., 2013), most of these studies revealed an overall stronger negative affect in BPD, but not a stronger responsiveness toward rejection compared with healthy individuals (for exception see Chapman, Dixon-Gordon, Butler, & Walters, 2015; Chapman et al., 2014, compared with a non-social evaluation task; ; Staebler, Renneberg, et al., 2011, for other-focused negative emotions). Recent experimental studies further challenged the assumption that patients with BPD simply show emotional over-reactivity when being rejected by others: By extending experimental paradigms with conditions during which participants experience acceptance in social interactions, studies revealed that patients with BPD experience a lower sense of belonging mainly when being included by their co-players (De Panfilis et al., 2015; Domsalla et al., 2014; Gutz et al., 2015; Renneberg et al., 2012; Staebler, Renneberg, et al., 2011; see also Ruocco et al., 2010). This reduced sense of connectedness with others was even observed when the exchange was based on predefined rules (i.e., not determined by the intentions of the co-players; Domsalla et al., 2014) or the patients were over-included at the cost of fair play for their co-players (De Panfilis et al., 2015). This bias in evaluating situations of social acceptance aligns with a study by Lobbestael and McNally (2016) that reveals a rejection-related interpretation bias in ambiguous social situations in individuals with marked BPD traits. Put in a broader theoretical framework, these findings can be regarded as examples of alterations in cognitive empathy, i.e., in the ability to correctly infer the mental states of others. Since people adjust their interpersonal behavior based on their interpretation of the intentions and behaviors of a social partner, i.e., since they take both the role of a perceiver as well as a sender of social signals during interactions, biased evaluations may underlie interpersonal behavioral problems (Roepke, Vater, Preissler, Heekeren, & Dziobek, 2013). Findings of studies on social inclusion and rejection suggest that these biases are particularly prominent in positive instead of negatively valenced social situations.

4.2.1 Sense of Belonging and Expectations of Social Acceptance in BPD

The reduced sense of belonging has indirectly been linked to altered cognitive processing. Amplitudes of the P300 component of the event-related potential were increased in BPD, particularly in response to being socially included, suggesting a violation of the patients' expectations of the behavior of social partners (Gutz et al., 2015). This is in line with many studies that found that anxious expectations of being rejected characterize these patients (e.g., Ayduk et al., 1999; Bungert, Liebke, et al., 2015; Staebler, Helbing, et al., 2011). However, the assumption of altered expectations in patients with BPD relies exclusively on either self-reports in hypothetical social scenarios as assessed with questionnaires (e.g., the RSQ; Berenson et al., 2009; Bungert, Liebke, et al., 2015) or indirect measures, such as the P300 during social interactions (Gutz et al., 2015). Studies on whether patients

with BPD explicitly expect social rejection more than healthy controls do when experiencing the same social cues are missing. Moreover, it is unclear whether patients with BPD adjust their social expectations based on feedback of either acceptance or rejection.

4.2.2 Effects of Social Acceptance and Rejection on Social Behavior

In social psychology, it is well known that social behaviors, such as cooperation and trustfulness, are shaped by an individual's preceding experiences with others (Glanville & Paxton, 2007). Studies on social behavior following social acceptance and rejection in BPD are sparse. A diary study linked anti-social behavior in BPD, such as extreme rage, to feelings of being rejected (Berenson et al., 2011). Therefore, it suggested impaired abilities in coping with social rejection as one underlying cause of reactive aggression, which constitutes an important part of BPD psychopathology (e.g., Mancke, Herpertz, & Bertsch, 2015). Diary studies are assumed to have high ecological validity. However, the link between social rejection and aggressive behavior relies upon the patients' evaluation of a social situation, in this case on the assessment of being rejected during the situation preceding the experience of extreme rage. Due to the described cognitive bias towards feeling rejected even in situations of inclusion in BPD, the behavior of these patients may depend less on actual social rejection, but on an evaluation bias, namely a reduced experience of social connectedness. So far, experimental studies on the effects of social acceptance on social behavior are missing in BPD. However, several studies applied exchange games from behavioral economy to directly measure cooperative behavior in BPD during interactions with unknown others. Although these studies revealed inconsistent findings, ranging from more cooperative to less cooperative behavior in BPD (for reviews, see Jeung et al., 2016; Lis & Bohus, 2013; Lis & Kirsch, 2016), patients with BPD seem to react less cooperatively in cases of unfair behavior of co-players (e.g., King-Casas et al., 2008; Thielmann et al., 2014). In conclusion, these findings suggest that reduced feelings of being accepted may intensify alterations in social interaction behavior in individuals with BPD.

The aim of the present study was to investigate the social expectations of patients with BPD after a standardized social encounter and the expectations' adjustment following experiences of social acceptance or rejection. We hypothesized that patients with BPD would show 1) lower expectations of being accepted by others compared with healthy controls, even if they received the same social cues. We also hypothesized that patients with BPD would 2) fail to adjust these expectations to positive social feedback. In addition, we were interested in learning whether social acceptance and rejection affect subsequent social behavior in patients with BPD and healthy participants differently. We hypothesized that 3) patients with BPD would behave less cooperatively and more aggressively compared with healthy controls. Patients with BPD have a negative evaluation bias during social encounters, i.e., they feel more rejected when socially accepted. Therefore, we hypothesized that these

differences in social behavior between patients with BPD and healthy controls would be stronger following acceptance than following rejection. To explore the underlying mechanism, we additionally investigated whether patients with BPD differ from healthy controls in the strength of the negative affect induced by the feedback of acceptance or rejection. We hypothesized that 4) social rejection increases the negative affect in patients with BPD and healthy controls alike while social acceptance increases the negative affect only in patients with BPD.

4.3 Methods

4.3.1 Sample

The patient group consisted of 56 female patients with BPD. A group of 56 age- and education-matched female HCs served as control group. BPD was diagnosed according to the Diagnostic and Statistical Manual of Mental Disorders IV (DSM-IV; American Psychiatric Association, 2000). Patients met at least five of the nine DSM-IV criteria for BPD which was assessed by trained clinical psychologists using the International Personality Disorder Examination (IPDE; Loranger, 1999). Inter-rater reliability established for three randomly selected video-taped diagnostic interviews was “excellent” (see Cicchetti, 1994, p.28), with intraclass correlations of .978 for the number of BPD criteria.

Comorbid axis I disorders were assessed using the German version of the Structured Interview for DSM-IV (SCID-I; First et al., 1997; inter-rater reliability according to Lobbestael, Leurgans, & Arntz, 2011: kappa = .71; range .61 - .83 for different diagnoses). Criteria for comorbid disorders were met in 37.5 % of the patients for affective disorder, in 37.5% for eating disorders, in 50.0% for anxiety disorder, in 32.1% for posttraumatic stress disorder, and in 3.6% for obsessive compulsive disorder.

General exclusion criteria were any psychopharmacological treatment at the time of testing, a lifetime history of psychotic or bipolar I disorder, current pregnancy or substance dependence, history of organic brain disease, skull or brain damage, or severe neurological illness. Additional exclusion criteria for HCs were all lifetime or current psychiatric diagnoses.

We assessed BPD symptom severity with the BSL-23 (Bohus et al., 2009) and severity of depressive symptomatology with the Beck Depression Inventory (BDI; Beck, Ward, Mendelson, Mock, & Erbaugh, 1961). Rejection sensitivity, i.e., the predisposition to anxiously expect social rejection, was measured with the German version of the RSQ for adults (Berenson et al., 2009; internal consistency in our sample: BPD: Cronbach’s α = .74, HC: Cronbach’s α = .77; Bungert, Liebke, et al., 2015).

Since HCs and patients with BPD were either assigned to an acceptance or rejection condition, sample characteristics for HCs and patients with BPD were reported separately for the acceptance and rejection samples (see Table 4; n=28 for each of the four groups). None of the frequencies of co-diagnoses differed significantly between the two BPD feedback groups (all ps>.155).

Recruitment was carried out by the central project of the KFO 256, which is a clinical research unit funded by the German Research Foundation (DFG). It is dedicated to investigating mechanisms of disturbed emotion processing in BPD (Schmahl et al., 2014). The study was approved by the Research Ethics Board of the Medical Faculty/Heidelberg University (protocol number: 2011-221N-MA). Participants provided written informed consent prior to study participation. The study was conducted according to the Declaration of Helsinki.

4.3.2 Experimental Procedure

The MVGIP is a paradigm which consists of three different phases: Phase I acquaintance with the alleged other participants in the VR environment (see Figure 3a), phase II an evaluation rating (see Figure 3b), and phase III a feedback phase (see Figure 3c). For a more detailed description of the MVGIP see 3.3.2. Subsequently to the MVGIP, subjects played a modified trust game which assessed cooperative and aggressive behavior.

MVGIP phase I: VR become acquainted. During the become acquainted phase, subjects participate in a VR meeting with six alleged other participants represented as avatars. They introduce themselves according to a standardized protocol, adapted from the relationship closeness induction task (Sedikides et al., 1999). Simultaneously, participants are asked to choose the emotional facial expression their own avatar should wear, to best reflect their emotional response to a given answer (happy, critical, surprised, or neutral). The dependent variable is the amount of each emotional expression, indicating the degree to which the subjects signaled willingness to affiliate (Heerdink et al., 2015). Thus, we used the number of button presses for each emotional expression as a control to explore whether differences in the degree to which the participants signaled willingness to affiliate (indicated by the frequency of smiling) might constitute an explanation for differences in expectations of social acceptance between groups.

MVGIP phase II: Evaluation of the co-players. Following the become acquainted phase, participants evaluated the six other virtual participants by answering standardized questions (e.g., “Do you like Anna?”). This task was applied to control the level of liking that participants perceived during the VR paradigm. Based on research on reciprocity of liking (see e.g., Montoya & Insko, 2008), a lower level of liking of the other members of the meeting may predict expectations of lower social acceptance. Thus, we used this task as a control to explore whether reduced expectations of social acceptance in the patients with BPD could be due to a reduced liking of the others, i.e., to alterations in the mechanism of reciprocity of liking. Beyond this theoretical relevance, the task was part of the cover story for the subsequent feedback presentation during which alleged feedback of the other members of the VR meeting was given. The dependent variable was the number of alleged co-players that were evaluated as positive (mean evaluation rating of >3.5, ranging from 0 to 6).

MVGIP phase III: Feedback phase. The induction of social acceptance or rejection was implemented in the feedback phase outside the VR meeting to enable a preceding assessment of how participants evaluated their co-players. Expectations of social acceptance were assessed in six rounds in alternating order with induction of social acceptance or rejection via presentation of feedback. Participants were told that the feedback was based on the evaluation ratings by their co-players, while in reality it was determined according to the participant's assignment to the acceptance or rejection condition. In each of the six rounds, participants were asked about their expectations first (e.g., "What do you expect? How many of the others said they like you?"). Participants answered these questions by means of a 7-point scale ranging from 0 ("nobody") to 6 ("everybody"). After each expectation rating, feedback was provided by the presentation of six schematic faces. The dependent variable was the expectation rating. The first rating served as a baseline measure of expectations of social acceptance before any feedback was provided. Adjustment of expectations based on feedback was measured with the five expectation ratings that followed.

To assess the influence of acceptance and rejection feedback on the emotional states of the participants, arousal and anger were measured before and after the feedback phase (arousal: SAM, Lang, 1980, ranging from 1 to 9; anger: state subscale of the State Trait Anger Expression Inventory, Spielberger, Krassner, & Soloman, 1988, ranging from 10 to 40).

Multi-round trust game. After the MVGIP, participants played a modified multi-round trust game (adapted from Berg et al., 1995) in the role of the investor with two co-players, i.e., a trustee and a provocateur. Participants were told that those co-players had not participated in the present study thus far, thus were not known from the MVGIP. By choosing strangers as co-players, we changed the context of social behavior, since the transfer of interpersonal experiences to different social encounters is particularly important for interpersonal functioning when social problems in one social situation affect other domains of social life. The social behavior of both co-players was computer-controlled and designed to induce specific social situations. The simulation of an interaction required the virtual trustee to respond to the participant's actions. Since previous studies on social behavior in BPD suggest that behavioral alterations are not ubiquitous, but rather restricted to specific features of the partner's behavior (such as to strong unfairness as revealed in a finer grainer analysis e.g., in the supporting online material by King-Casas et al., 2008), we designed the co-players' behavior in a manner that simulated different types of social behavior shown to be of importance in BPD in previous studies. These included phases of cooperative behavior, ruptures in cooperation, and attempts to repair ruptured cooperation (see Lis & Kirsch, 2016). The provocateur was introduced to induce anti-social behavior. Aggression has been reported as one possible response when individuals feel rejected reflecting a lack of regulation of negative emotions (e.g., Leary et al., 2006; Twenge et al.,

2001) and has been linked to feeling rejected in BPD (Berenson et al., 2011). Before the trust game, participants performed an emotion recognition task (data not shown here).

Cooperative behavior in the trust game toward the trustee. In each of the 21 rounds, the participant (investor) was endowed with 20 MUs. She could transfer between 2 and 20 MUs of this account to the trustee. During this transfer, the investment was tripled. The trustee returned an amount according to experimentally determined portions. In each round, the participant earned the sum of the part of her endowment that she did not transfer plus the amount that was repaid by the trustee. When the trustee repaid less than a third of the tripled investment, the investor's initial endowment was reduced, i.e., she lost. When the trustee repaid more than a third, the repayment exceeded the investment and the gain for the investor increased with the amount of the investment. If the participant trusted the trustee to behave fairly, larger investments would result in the greatest gain. Feedback about the amount of the returned sum was displayed on the screen after each round. Prior to playing the game, participants were informed that they would receive their winnings with each MU corresponding to 0.5 Euro cents. We varied the repayment ratios of the trustee to simulate phases of cooperative behavior (five consecutive rounds of at least 50% repayment ratio, respectively; presented twice during the exchange), ruptures of cooperation (the trustee repaid nothing following fair behavior, presented three times during the exchange), and the trustee's attempts to repair such breaks of co-operation (the trustee shows cooperative behavior following a rupture of cooperation, presented twice during the exchange). As dependent variable, cooperative behavior was measured by the amount of the participant's investment.

Aggressive behavior in the trust game toward the provocateur. The provocateur was adapted from the point subtraction aggression paradigm (Cherek, Moeller, Schnapp, & Dougherty, 1997; see Cackowski et al., 2017 and Geniole, MacDonell, & McCormick, 2017, for findings with this task in BPD). The provocateur subtracted 20 MUs from the participant's account at three times during the exchange. The participant could subtract 20 MUs from the account of the provocateur at the start of each round. Since participants did not profit from such a subtraction, but could only harm the provocateur, the amount of MU subtractions from the provocateur served as a measure of aggressive behavior (Cherek et al., 1997).

Table 4. Sample characteristics

	HC (n=56)				BPD (n=56)				Main effect Group		Main effect Feedback		Interaction	
	Feedback				Feedback									
	Acceptance (n=28)		Rejection (n=28)		Acceptance (n=28)		Rejection (n=28)							
	AM	SD	AM	SD	AM	SD	AM	SD	*F*	*p*	*F*	*p*	*F*	*p*
Age	26.9	± 5.5	27.6	± 5.7	27.9	± 6.4	26.1	± 6.4	0.06	.802	0.19	.661	1.14	.289
Education (years)	12.0	± 1.5	12.3	± 1.3	11.6	± 1.6	12.0	± 1.4	1.36	.245	1.68	.197	0.15	.698
BSL-23	0.12	± 0.14	0.10	± 0.15	2.10	± 0.74	2.14	± 0.62	451.05	<.001	0.02	.883	0.17	.685
RSQ	5.2	± 3.2	4.8	± 2.6	17.4	± 5.8	15.5	± 6.0	168.10	<.001	1.74	190	0.68	.411
BDI	3.5	± 3.4	2.4	± 2.7	26.0	± 8.4	25.5	± 8.4	364.4	<.001	0.47	.493	0.08	784

Note. AM = arithmetic mean; SD = standard deviation; BSL-23 = Borderline Symptom List; RSQ = Rejection Sensitivity Questionnaire; BDI = Beck Depression Inventory

4.3.3 Credibility of the Cover Story

At the end of the experiment, participants were asked how credible it had been for them that there had been real other co-players in the virtual meeting of the become acquainted phase of the MVGIP, as well as in the trust game. Answers to both questions were provided on an 11-point Likert scale ranging from 0 (not at all) to 10 (very much). Subsequently, patients were informed that the social responses were not based on the behavior of real co-players but driven through a computational algorithm.

4.3.4 Statistical Analysis

In the MVGIP-feedback phase, the dependent variable expectations was analyzed with a variance analytical design (2x2x2 repeated measures ANOVA) with the two between-subjects factors, group (HC vs. BPD) and feedback condition (acceptance vs. rejection), and the repeated measures factor time (expectations at baseline [round 1]; expectations after feedback [mean of round 2-6]). In the trust game, participants' investment behavior in the first round of the game, which reflected the effects of the preceding feedback conditions on trustful behavior independent of an interference by the co-players' behavior, was analyzed with a 2x2 ANOVA with the two between-subjects factors, group and feedback condition. Investment behavior depending on the trustee's behavior was analyzed with a 2x2x3 repeated measures multivariate ANOVA with the two between-subjects factors, group and feedback condition, and the repeated measures dependent variable trustee behavior. Herein, investments were collapsed across the rounds of the trust game separately for the three different types of trustee behavior, i.e., for cooperative behavior of the trustee (mean score of the 10 rounds during which the trustee behaved cooperatively), for ruptures in cooperation by the trustee (mean score of three changes of investments following the rupture), and for attempts to repair these ruptures (mean score of two changes of investments following the trustee's attempt to repair the break of cooperation). To further explore the nature of the effects, post hoc tests were done in separate ANOVAs for the three kinds of trustee behavior. Changes of investments following a provocation by the provocateur were analyzed with a 2x2x3 repeated measures ANOVA with the two between-subjects factors group and feedback, and the repeated measures factor phase (for the three occurrences of the provocations).

Degrees of freedom were corrected according to Greenhouse and Geisser. Effect sizes were interpreted according to conventions by J. Cohen (1988) and were reported as partial η^2 along with 90% confidence intervals (CI). CIs were calculated for significant results through bootstrapping (10.000 resamples) using the MATLAB effect size toolbox (see Hentschke & Stuttgen, 2011). Calculations of the effect sizes and CIs were based on reduced designs based on data collapsed across those factors not involved in the effect of interest. In case of significant interaction effects, we decomposed

the variance analytical designs into sub-designs and calculated pairwise comparisons (t-test, Bonferroni corrected for multiple comparisons) respectively to further describe the effects. The overall number of aggressive responses was analyzed using a Mann-Whitney U Test. All analyses were performed using SPSS (IBM SPSS Statistics for Windows, Version 23.0).

4.4 Results

4.4.1 MVGIP: Expectations of Social Acceptance

Expectations of social acceptance were measured during the feedback phase of the MVGIP. Expectations differed between BPD and HCs depending on whether the feedback was that of acceptance or rejection (time x group x feedback: $F(1,108)=7.1$, $p=.009$, $\eta_p^2=.062$, 90% CI [.012, .152]; see Figure 7a). Analyses of separate sub-designs for the two feedback conditions revealed differential changes in expectations between groups for feedback of social acceptance on marginally significant level (time x group $F(1,54)=2.9$, $p=.094$, $\eta_p^2=.051$, 90% CI [.002, .174]) and of social rejection (time x group $F(1,54)=4.2$, $p=.044$, $\eta_p^2=.073$, 90% CI [.005, .213]): Adjustments to feedback are stronger in HCs than in patients with BPD after both feedback conditions (see Figure 7a). Post hoc pairwise comparisons reveal that after acceptance, only HCs adjusted their expectations toward more positive feedback ($p=.002$), while expectations of patients with BPD did not change ($p=.280$). In contrast, both groups adjusted their expectations toward being rejected by more members of the virtual meeting after rejection feedback (both $ps<.001$). In addition, patients with BPD expected less positive feedback than HCs across all experimental conditions (group: $F(1,108)=56.5$, $p<.001$, $\eta_p^2=.350$, 90% CI [.247, .473]). The main effect of feedback and the interaction effect time x feedback are of restricted interpretability due to the higher-order interaction effect (feedback: $F(1,108)=13.9$, $p<.001$, $\eta_p^2=.114$; time x feedback: $F(1,108)=58.2$, $p<.001$, $\eta_p^2=.350$). Please note that these findings hold true when controlling for depressive symptoms (see Supplemental Table S4). Please see Supplemental Material for more details on the six rounds of the feedback phase (Table S5). In the BPD group, expectations were particularly low in those participants with high BPD symptom severity (BPD: $r=-.41$, $p=.002$; HC: $r=-.06$, $p=.642$; $z=-1.93$, $p=.054$) and high rejection sensitivity (BPD: $r=-.43$, $p=.001$; HC: $r=-.05$, $p=.729$; $z=-2.11$, $p=.035$).

4.4.2 MVGIP: Emotional Responses to Social Acceptance and Rejection

Patients with BPD reported higher anger than HCs, and anger increased following feedback in patients with BPD ($p<.001$) but not in HCs ($p=.760$; time x group: $F(1,107)=22.7$, $p<.001$, $\eta_p^2=.169$, 90% CI [.094, .267]; group: $F(1,107)=63.4$, $p<.001$, $\eta_p^2=.361$, 90% CI [.278, .458]; see Figure 7b). Arousal was influenced differentially by the different feedback conditions (feedback x time: $F(1,108)=7.9$, $p=.006$, $\eta_p^2=.068$, 90% CI [.019, .135]; see Figure 7c): While arousal decreased after being accepted

(p=.036), it increased after being rejected at a marginally significant level (*p*=.067). In contrast to anger, this adjustment was not distinguishable between groups (group x feedback: *F*(1,108)=0.1 *p*=.743, η_p^2=.001).

For more details on the MVGIP findings, see Supplemental Table S1-3, and Figure S1-3.

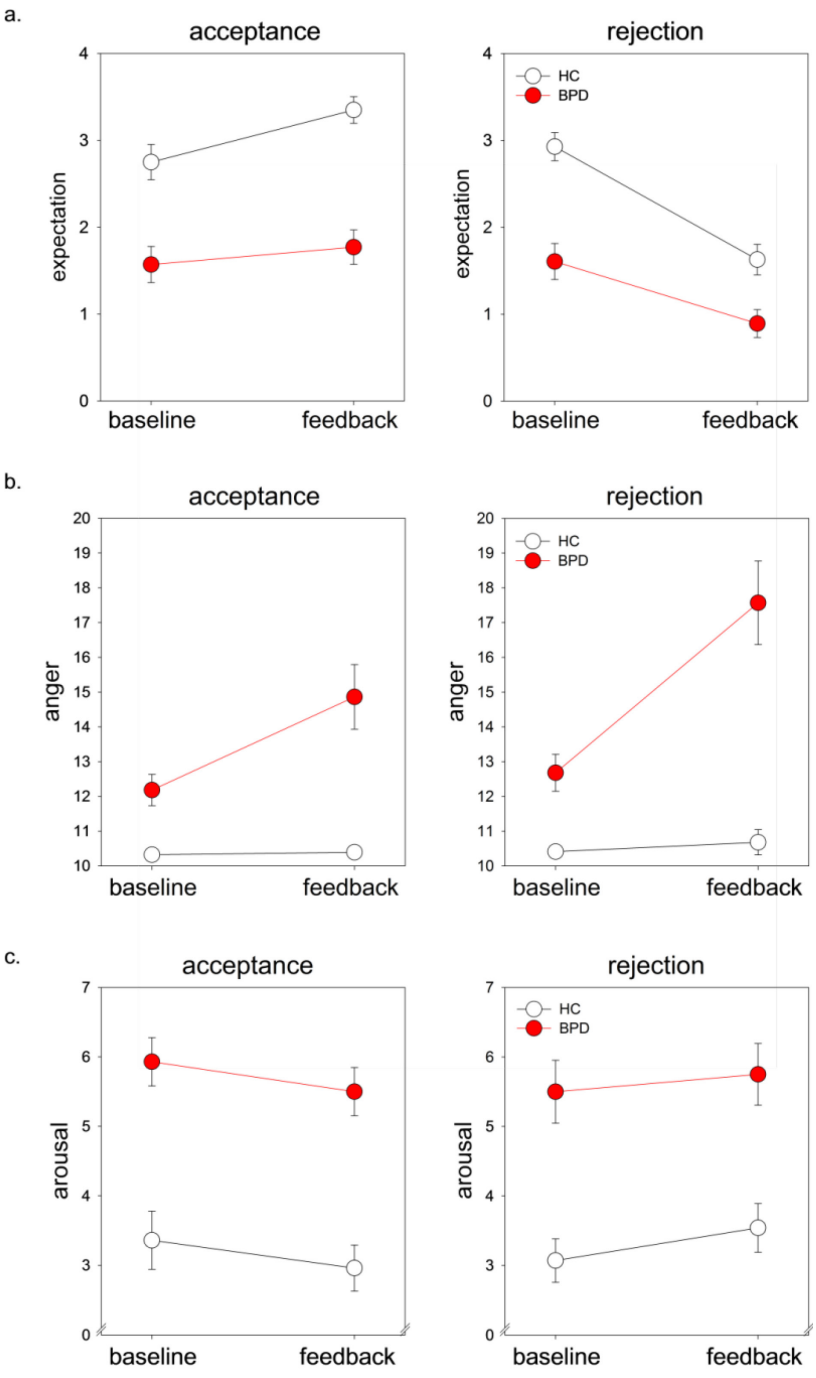


Figure 7. Effects of social acceptance and rejection in patients with BPD and HCs on (a.) expectations of social acceptance before (baseline) and after receiving feedback, (b.) state of anger preceding and following the feedback phase, and (c.) arousal preceding and following the feedback phase (n=28 for each of the four groups).

4.4.3 Multi-round Trust Game: Investment Behavior toward the Trustee

In the first round of the trust game, participants offered 48% (±24%) of their account to the trustee. This first investment did not differ between groups ($F(1,108)=1.1$, $p=.302$, $\eta_p^2=.010$) or feedback conditions ($F(1,108)=2.1$, $p=.154$, $\eta_p^2=.019$; group x feedback: $F(1,108)<0.1$, $p=.937$, $\eta_p^2<.001$).

In the course of the game, investment behavior differed between groups and feedback conditions depending on the trustee's behavior (group x feedback x trustee behavior: Wilks' Lambda=.943, $F(2,107)=3.2$, $p=.043$, $\eta_p^2=.057$). During phases of cooperative behavior of the trustee (see Figure 8a, see Supplemental Table S6), investments were lower in patients with BPD compared with HCs. However, this occurred only after the preceding feedback of social acceptance (group x feedback: $F(1,108)=4.6$, $p=.033$, $\eta_p^2=.041$, 90% CI [.003; .124]; HC vs BPD: acceptance: $p=.009$; rejection $p=.700$). Previously accepted patients with BPD offered less MUs than those previously rejected ($p=.010$), while in contrast, HCs' behavior did not depend on the preceding feedback condition ($p=.669$). Exploratory analyses revealed that the investment during cooperative phases of the trust game depended on the degree of discrepancy between expected and received feedback in BPD, but not in HCs. Investments were particularly low in those patients with BPD for whom the provided feedback was more positive than expected (see Figure 8b, BPD: $r=.382$, $p=.004$; HC: $r=-.006$, $p=.963$, $z=2.10$, $p=.036$, see also Supplemental Figure S4 for HCs). Please note that these findings hold true when controlling for depressive symptoms (see Supplemental Table S7). Investments did not differ between groups or feedback conditions in response to ruptures in cooperation by the trustee or to the trustee's attempts to repair ruptured cooperation (all ps>.258, for further details, see Supplemental Figure S5, Supplemental Table S8).

Investments following MU subtraction by the provocateur did not differ between groups or feedback conditions (all ps>.296, Supplemental Table S8).

4.4.4 Multi-round Trust Game: Aggressive Behavior toward the Provocateur

The frequency of aggressive responses toward the provocateur was low and did not differ between patients with BPD and HCs (BPD: 2.37 ±2.21, HC: 1.80, ±1.77; Mann-Whitney U=1320.0, $p=.137$).

For a round-by-round visualization of investment behavior toward the trustee and aggressive responses toward the provocateur, see Supplemental Figure S6.

4.4.5 Credibility of the Cover Story

There were no differences in credibility of the cover story between any of the groups, for both the MVGIP (M=6.0±3.3) and the trust game (M=3.9±3.0; all Fs(1,107)<1.2, all ps>.271, all $\eta_p^2<.011$).

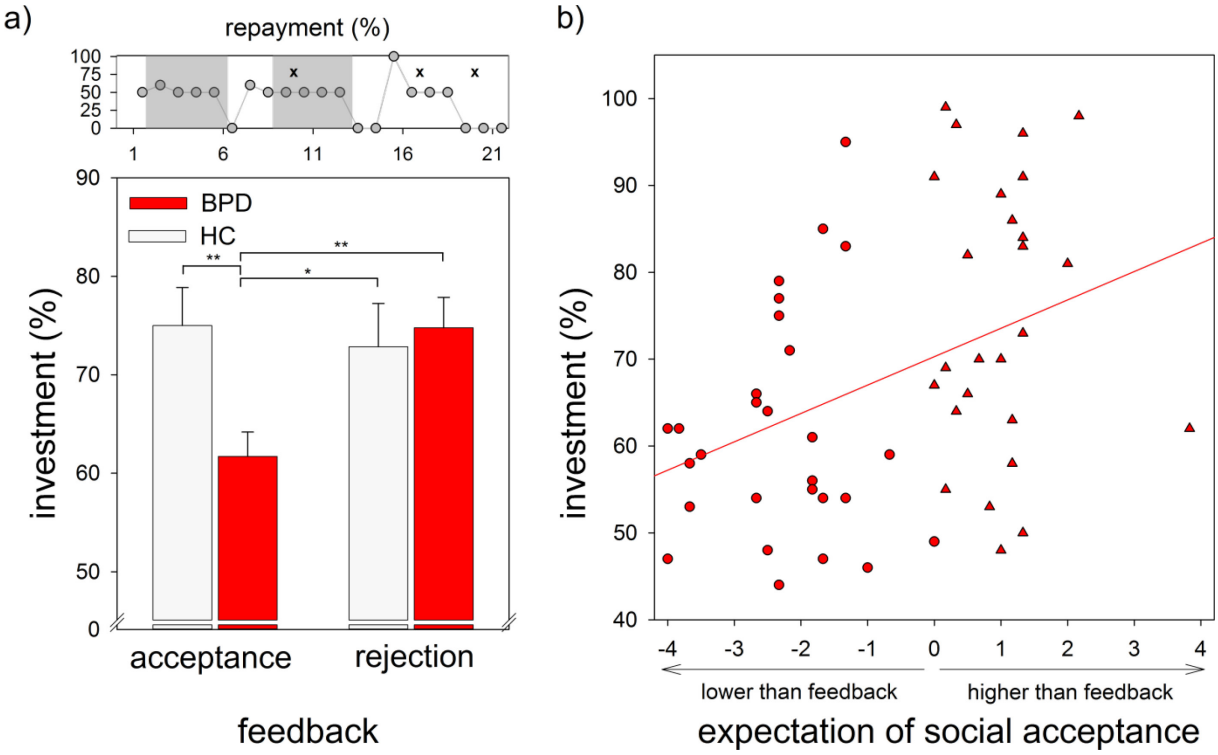


Figure 8. Investments during the cooperative phases of the trust game. a) Investments after feedback of social acceptance and rejection for patients with BPD and HCs along with the repayment ratios of the trustee (o) and provocations of the provocateur (x) across the 21 rounds of the trust game (n=28 for each of the four groups). Grey areas mark the intervals included in the analyses. b) Correlation between the discrepancy between expected and feedback actually given and the investments during phases of cooperation for the patients with BPD (circles: participants of the acceptance condition, n=28; triangles: participants of the rejection condition, n=28).

4.5 Discussion

In the present study, we investigated explicit expectations of social acceptance in BPD after a standardized social encounter. We were interested in whether expectations of acceptance were lower in patients with BPD compared with healthy controls. Moreover, we were interested in whether patients with BPD differed from healthy controls in how experimentally induced social acceptance and rejection affected these expectations and social behavior in a different social context. Our findings support reduced expectations of social acceptance in patients with BPD. Most importantly, they extend our understanding of BPD in clearly revealing a particular role of positive social feedback in BPD: The patients did not only fail to adjust their expectations to positive feedback, but were less cooperative toward social partners in a different social context after feedback of social acceptance.

4.5.1 Expectations of Social Acceptance

Compared with healthy controls, patients with BPD expected less positive feedback following a virtual meeting with alleged other participants. Additional exploratory analyses revealed that the level of expectation was linked to the severity of BPD psychopathology and the level of rejection sensitivity in BPD. This confirms that stronger anxious expectations of rejection, which were assessed by self-report questionnaires in many studies in BPD (e.g., Bungert, Liebke, et al., 2015; Staebler, Helbing, et al., 2011), are indeed linked to expectations during actual social encounters. Effect sizes show that this group difference is large, which is also in line with Bungert, Liebke, et al. (2015) and Staebler, Helbing, et al. (2011). Our results extend previous findings in that they revealed that poor social expectations in BPD cannot merely be attributed to more frequent or stronger negative social signals that patients with BPD may receive from social partners during everyday life. In the present study, all participants received the same social cues from their alleged co-players during a standardized VR situation from which participants had to deduce their social expectations of acceptance. Our findings of reduced social expectations were based on explicit judgments. They agree with those based on implicit measures, such as alterations in psychophysiological brain measures indicating a violation of expectations in BPD when being included by others (Gutz et al., 2015).

4.5.2 Adaptation of Expectations to Social Feedback

Beyond the lower level of expectations of social acceptance, our data reveal a medium effect size for a differential adjustment of expectations in the BPD and HC group. Healthy participants increased their expectations after acceptance and reduced their expectations after rejection. Both of these adjustments were less pronounced in the BPD group. Regarding adjustments to rejection feedback, both groups lower their expectations. This adjustment is stronger in healthy participants, who reported markedly higher expectation at baseline than patients with BPD. Although BPD patients' expectations were already low before any feedback was given, they nonetheless further reduced their expectations after rejection. On the other hand, in the case of positive feedback we did not observe an increase of expectations towards the actually signaled acceptance in BPD. Although this difference between groups could statistically only be observed on marginally significant level when analyzing sub-designs of the main variance analytical design, this finding seems to be important due to the markedly different baseline levels in both groups. The healthy participant expected acceptance to a degree rather similar to the actually provided feedback. Although this suggests a ceiling effect which may have prevented a stronger adjustment, the healthy subject corrected their expectation towards stronger acceptance. In contrast in the BPD group, the baseline expectations were far below the actual feedback. Nevertheless, the patients did not increase their expectations of acceptance. This is in line with the assumption of impairments in appraising positive signals as suggested by De Panfilis et

al. (2015) and revealed by studies on emotion recognition: These studies confirmed deficits in the detection and assessment, as well as a misinterpretation of low intensity, positive facial expressions signaling willingness to affiliate (Domes et al., 2008; Hagenhoff et al., 2013; Izurieta Hidalgo et al., 2016; Thome et al., 2016). It is well known that patients with BPD experience a high extent of social rejection during their lives: Many studies suggest a high incidence of emotional and physical neglect and abuse during childhood and adolescence (e.g., Infurna et al., 2016). Similarly, social networks of adult patients with BPD show an increased number of relationship break-ups (Clifton et al., 2007; Lazarus et al., 2014). While such experiences may contribute to the low expectations of social acceptance in BPD, our findings clearly reveal that a lack of adaptation of expectations in case of positive cues may contribute to the persistence of this negative view. Neither the low expectations in general, nor the lack of their adaptation to positive feedback can be explained by anticipated reciprocity or by differential willingness to affiliate. We did not find any differences in the assessment of interaction partners, which rules out that alterations in the formation of expectations can be traced to the diminished liking of others (please see Supplemental Table S2-5). Moreover, HCs and patients with BPD did not differ in their signaling of affiliation motives during the become acquainted phase as indicated by the number of happy facial expressions participants chose for their avatars (see Heerdink et al., 2015; please see Supplemental Table S2).

Our findings suggest a failure of learning from positive outcomes, which can be regarded as an alteration in reward-based processes. The failure to learn from positive social feedback is in line with impairments of epistemic trust, namely openness to the reception of social communications (Fonagy, Luyten, Allison, & Campbell, 2017). A lack of epistemic trust has been suggested to characterize patients with BPD, leading to an inability of learning through interpersonal experiences (Fonagy, Luyten, & Allison, 2015; Fonagy, Luyten, et al., 2017). Our findings suggest that this may be particularly true in cases of positive experiences.

4.5.3 Transfer of Social Acceptance and Rejection onto Strangers

With help of a trust game, we investigated whether the experiences of social acceptance and rejection affect subsequent social encounters in patients with BPD differently from healthy controls. Our data suggest that investment behavior differs between groups depending on the preceding feedback condition and the trustee's behavior.

Effects of social acceptance on cooperative behavior and reactive aggression. Effect size revealed a small differential impact of preceding positive feedback in BPD and healthy controls. Patients with BPD showed less cooperative behavior after having been accepted by others, during phases of repeated cooperative behavior of the trustee, i.e., when the trustee shared at least half of his account with the participant across several rounds. This was true in comparison to all other groups (i.e., re-

jected patients with BPD and both rejected and accepted healthy controls), suggesting a disadvantageous effect of positive social encounters on subsequent social interactions in BPD, even in a different social context with strangers. The investment was particularly low when feedback was more positive in relation to the social expectation. One may speculate whether unexpected, positive social experiences might lead to sensitization toward the fairness of others. In line with the assumption of a need for stronger positive social signals, one may question whether patients with BPD experienced a 50% repayment ratio as fair. This interpretation is supported by De Panfilis et al. (2015) who suggested altered social norms in BPD. In line, participants with higher BPD features required higher offers by their co-players in an ultimatum game to accept the offer (Thielmann et al., 2014). This interpretation agrees not only with theoretical models postulating that justice is of high importance for those with BPD (Bateman & Krawitz, 2013; Gunderson & Links, 2008), but also with a recent study revealing that higher BPD features are linked to a higher sensitivity to injustice (Lis et al., 2018). Nevertheless, a study by Franzen et al. (2011) found no differences between patients with BPD and healthy controls in judgements of fairness for individual repayments during a trust game. The data of the present study suggest that these evaluation processes might be influenced by the valence of preceding social encounters.

In contrast to behavior during phases of cooperation, neither the responses to trustee's breaks of cooperation, attempts to repair the relation subsequently, nor the effects of provocations by an additional co-player differed between patients with BPD and healthy controls or between the preceding feedback manipulations. This suggests that patients with BPD are well able to forgive their social partner for disruptions in cooperation and re-establish cooperative behavior over a course of multiple interactions when the first step is made by the patients' interaction partner (see reviews by Jeung et al., 2016; Lis & Kirsch, 2016). However, further independent replications are required to investigate whether the described findings of a preceding experience of social acceptance are indeed specific for phases of cooperative behavior of an interaction partner. These studies may choose an experimental design which enables the direct comparison of investments by carefully manipulating the trustee's behavior in independent groups.

Effects of social rejection on cooperative behavior and reactive aggression. It is noteworthy that rejection did not result in a drop in cooperative behavior or an increase in reactive aggression toward a provocateur, neither in the healthy nor in the BPD group. This may reflect the participants' efforts to re-establish social relations and satisfy the need to belong after being socially rejected. Such behaviors have been shown in previous studies in healthy individuals, particularly for social encounters with strangers (see e.g., Baumeister & Leary, 1995; Cheung et al., 2015; Gerber & Wheeler, 2009). Future studies are needed to assess whether comparable behavior would be observed when interacting with those co-players who had rejected the participant. If so, this may reflect clinically signifi-

cant behaviors in BPD, i.e., attempts to seek reconciliation with someone who has rejected or otherwise hurt them, even when such behavior might be unreasonable.

4.5.4 Limitations

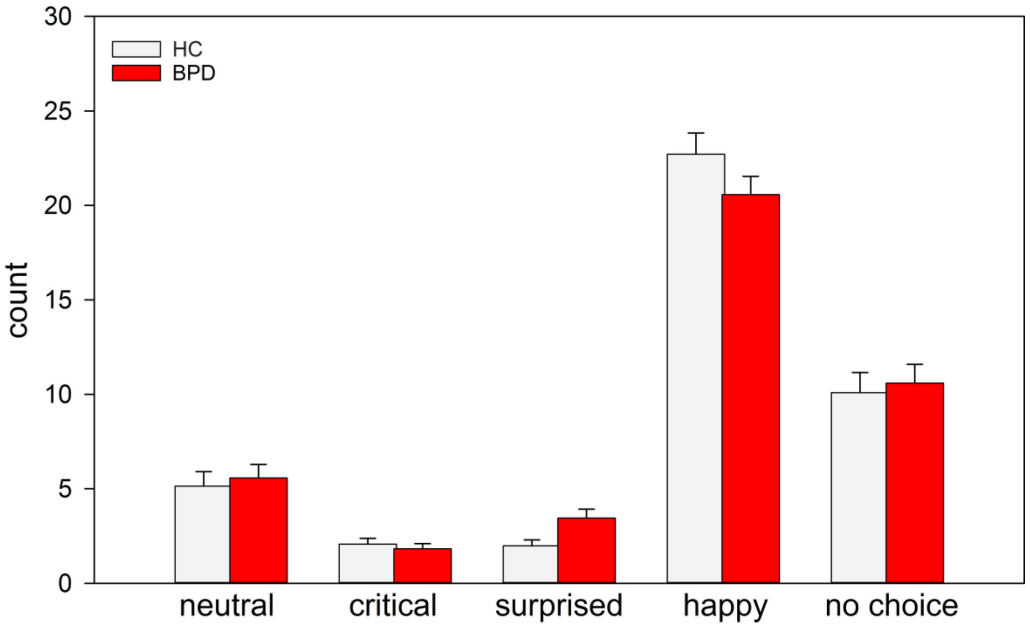
The current study faces some limitations, one of them being restricted generalizability due to the inclusion of solely female participants. Depressive symptoms did not explain our findings. Nevertheless, the extent to which our findings are influenced by comorbid disorders has to be investigated in further studies with larger sample sizes. Moreover, it has to be mentioned that the current sample size is rather small and the current results have to be replicated by independent research groups and larger sample sizes.

Another issue is rooted in general difficulties with investigating complex interpersonal social behavior. Social interactions are dynamic sequences of actions, each of which influences future anticipations of the partner's behavior and future adaptations of their own behavior. Based on our findings, further studies are required to deepen our understanding of the determinants of altered behavior. These involve studies that experimentally disentangle the different facets of complex interaction behavior and their interplay, while taking the diversity of social partners in regard to e.g., age, sex, or ethnicity, as well as their emotional signals into account. Moreover, altered social behavior has to be linked to real-life interactions to ensure the external validity of our findings. Additionally, non-social control tasks should be used to differentiate effects specific for social rejection from those of a negative evaluation (Chapman et al., 2015; Chapman et al., 2014).

4.5.5 Conclusions

Our findings extend previous findings on reduced expectations of social acceptance in BPD by revealing that these expectations are also evident when the nature of the social encounter is standardized, i.e., when all individuals receive the same social cues. Moreover, patients with BPD do not use positive social feedback to adjust these low expectations, suggesting deficits in the appraisal and integration of signals of social acceptance. Most importantly, alterations during the processing of positive social cues disadvantageously affect social encounters in independent social situations in BPD. Interpersonal problems may arise if a social partner behaves fairly, and the patients were previously confronted with social acceptance of others that violated the patients' expectations. Our findings suggest mechanisms that may explain an aggravation of interpersonal problems with a spreading of interpersonal problems throughout different social domains. The mismatch of expectations and experiences of social acceptance constitutes a promising target for psychosocial interventions.

4.6 Supplemental Material

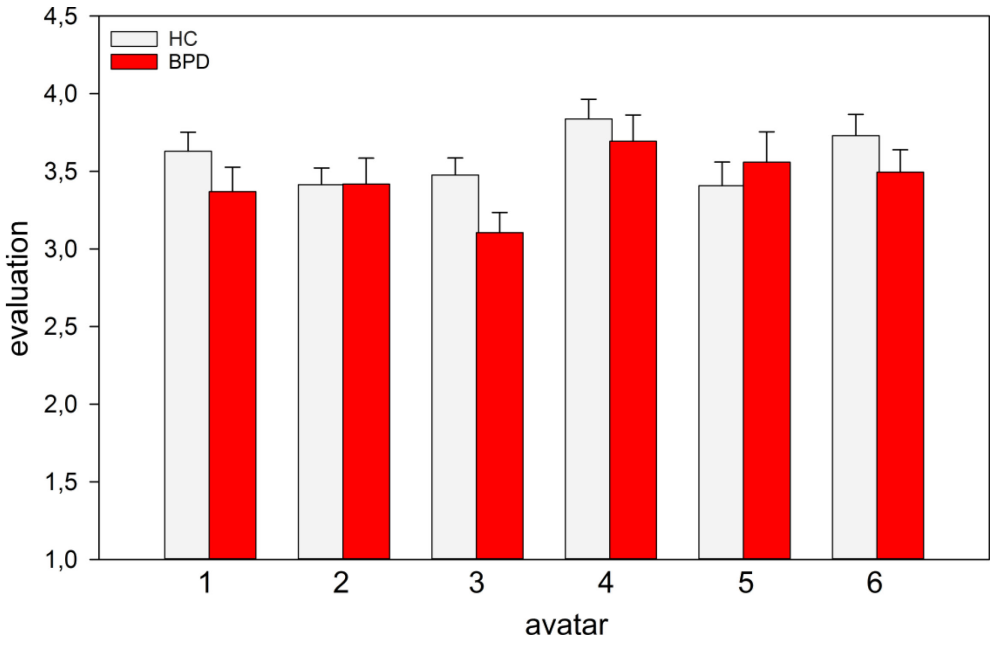


Supplemental Figure S1. MVGIP Phase I become acquainted: Number of facial emotional expressions during the VR meeting. None of the groups differed regarding the chosen emotional expressions. Participants chose emotions for the facial expressions of their avatars with different frequencies: happy>neutral>surprised>critical, all *p*s<.015. In 24.6% of trials participants did not select an emotional expression at all (25.2% BPD, 24.0% HC; *t*=0.37, *p*=.711). For further details see ANOVA, Table S1. Error bars represent standard errors.

Supplemental Table S1. MVGIP Phase I become acquainted: Choice of facial emotional expressions during the VR meeting: Results of the 2x2x4 repeated measures ANOVA with the two between-subjects factors, group (HC vs. BPD) and feedback condition (acceptance vs. rejection), and the repeated-measurement factor emotional expression (happy, critical, surprised, neutral)

	F	df*	*p*	η_p^2
Group	0.1	1, 108	.712	.001
Feedback	0.8	1, 108	.385	.007
Group x Feedback	0.6	1,108	.430	.006
Emotion	354.9	1.7, 182.3	<.001	.767
Emotion x Group	2.4	1.7, 182.3	.104	.022
Emotion x Feedback	3.2	1.7, 182.3	.051	.029
Emotion x Group x Feedback	0.5	1.7, 182.3	.598	.004

**degrees of freedom are Greenhouse-Geisser corrected if appropriate*

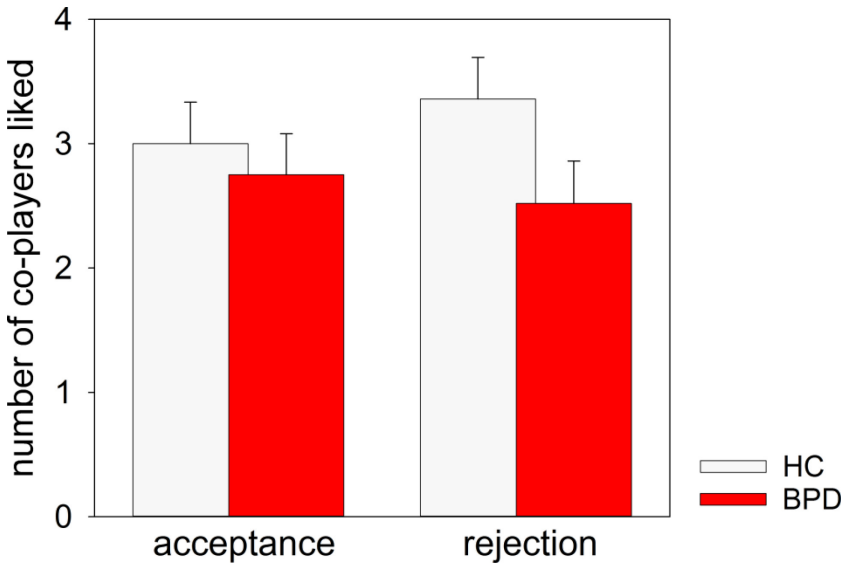


Supplemental Figure S2. MVGIP Phase II evaluation of the co-players: Mean evaluation of the co-players per group. None of the groups differed regarding the evaluation of the alleged members of the virtual meeting. For further details see ANOVA, Table S4. Error bars represent standard errors.

Supplemental Table S2. MVGIP Phase II evaluation of the co-players: Mean evaluation of the co-players: Results of the 2x2x6 repeated measures ANOVA with the two between-subjects factors, group (HC vs. BPD) and feedback condition (acceptance vs. rejection), and the repeated-measurement factor avatar (for the six alleged co-players represented by avatars in the virtual environment)

	F	df*	*p*	η_p^2
Group	1.6	1, 107	.209	.015
Feedback	0.1	1, 107	.731	.001
Group x Feedback	2.4	1, 107	.121	.022
Avatar	3.7	4.3, 461.6	.004	.034
Avatar x Group	1.3	4.3, 461.6	.280	.012
Avatar x Feedback	0.6	4.3, 461.6	.646	.006
Avatar x Group x Feedback	1.3	4.3, 461.6	.253	.012

**degrees of freedom are Greenhouse-Geisser corrected if appropriate*



Supplemental Figure S3. MVGIP Phase II evaluation of the co-players: Number of co-players liked (rating>3.5). Error bars represent standard errors.

Supplemental Table S3. MVGIP Phase II evaluation of the co-players: Number of co-players liked (rating>3.5): Results of the ANOVA

	F	df	*p*	η_p^2
Group	2.6	1, 107	.108	.024
Feedback	<0.1	1, 107	.852	<.001
Group x Feedback	0.8	1, 107	.383	.007

Supplemental Table S4. MVGIP Phase III feedback phase: Results of the ANCOVA for feedback expectations with depressive symptomatology (BDI) as covariate

	F	df	*p*	η_p^2
BDI	4.9	1, 107	.029	.044
Group	4.1	1, 107	.089	.027
Feedback	15.4	1, 107	<.001	.126
Group x Feedback	1.4	1, 107	.244	.013
Time	7.6	1, 107	.007	.066
Time x BDI	2.4	1, 107	.121	.022
Time x Group	1.3	1, 107	.261	.012
Time x Feedback	57.2	1, 107	<.001	.348
Time x Group x Feedback	7.0	1, 107	.009	.062

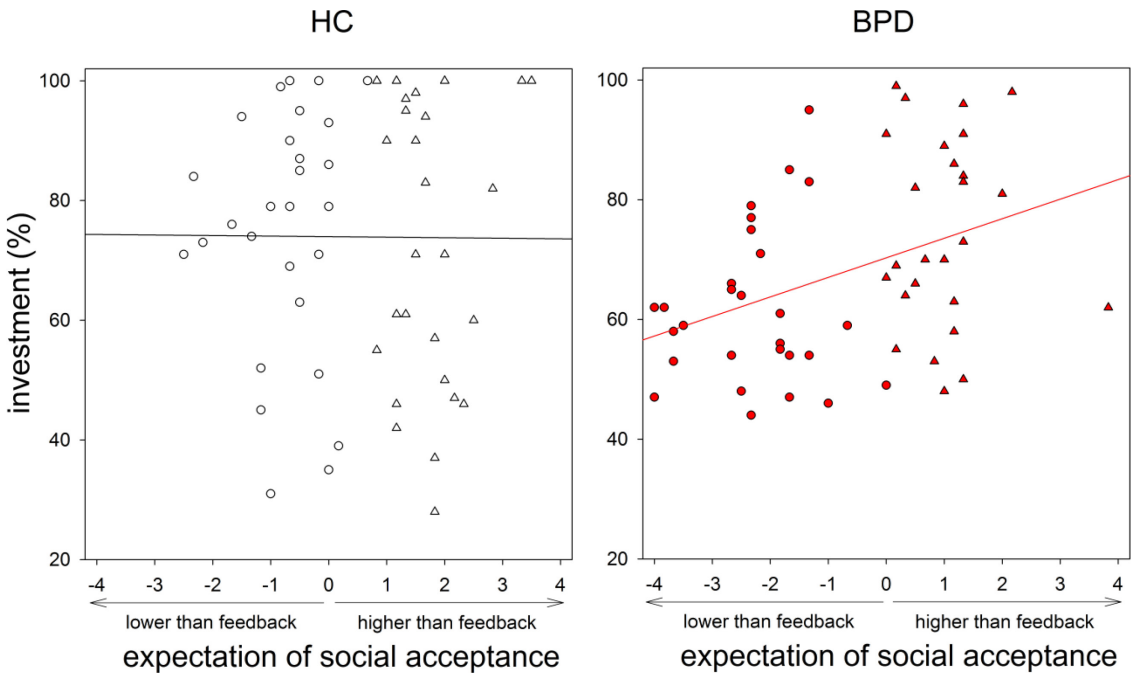
Supplemental Table S5. MVGIP Phase III feedback phase: Mean expectation ratings (AM) and standard deviations (SD) for each of the six rounds, by group and feedback condition

	HC				BPD			
	Acceptance		Rejection		Acceptance		Rejection	
Round	AM	SD	AM	SD	AM	SD	AM	SD
1	3.8	1.1	3.9	0.9	2.6	1.1	2.6	1.1
2	4.3	1.5	2.7	1.3	3.1	1.5	2.1	1.1
3	4.4	1.3	2.3	1.4	2.8	1.2	1.7	0.9
4	4.4	1.3	2.8	1.0	2.6	1.2	2.0	1.3
5	4.5	1.1	2.3	1.2	2.6	1.4	1.9	1.3
6	4.3	1.5	3.0	1.3	2.7	1.3	1.8	1.3

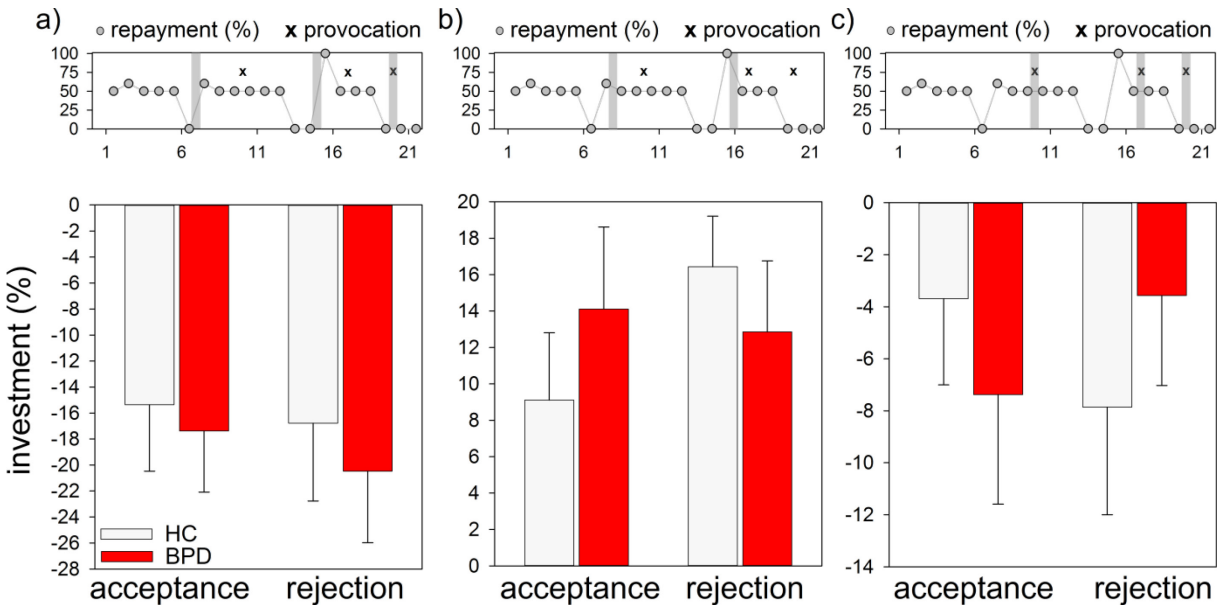
Supplemental Table S6. Trust game: Results of the ANOVA for investments during phases of trustee's cooperation

	F	df*	*p*	η_p^2
Group	2.6	1, 108	.111	.023
Feedback	2.4	1, 108	.125	.022
Group x Feedback	4.6	1, 108	.033	.041
Phase	2.4	1.0, 108.0	.126	.022
Phase x Group	1.1	1.0, 108.0	.297	.010
Phase x Feedback	1.7	1.0, 108.0	.198	.015
Phase x Group x Feedback	0.1	1.0, 108.0	.727	.001
Time	10.5	3.8, 407.0	<.001	.089
Time x Group	0.3	3.8, 407.0	.850	.003
Time x Feedback	0.1	3.8, 407.0	.975	.001
Time x Group x Feedback	1.8	3.8, 407.0	.141	.016
Phase x Time	2.8	3.5, 376.3	.032	.025
Phase x Time x Group	0.1	3.5, 376.3	.961	.001
Phase x Time x Feedback	0.2	3.5, 376.3	.914	.002
Phase x Time x Group x Feedback	1.4	3.5, 376.3	.237	.013

**degrees of freedom are Greenhouse-Geisser corrected if appropriate*



Supplemental Figure S4. Correlation between the discrepancy between expected and actually given feedback and the investments during phases of cooperation for HCs and BPD patients (circles: participants of the acceptance condition; triangles: participants of the rejection condition).



Supplemental Figure S5. Trust game: Changes in investments in response to a) the trustee's ruptures of cooperation, b) the trustee's attempts to repair ruptured cooperation, and c) to provocations by the second co-player (provocateur). Grey areas mark the intervals included in the analyses. Error bars represent standard errors.

Supplemental Table S7. Trust game: Results of the ANCOVA for investments during phases of trustee's cooperation with depressive symptomatology (BDI) as covariate

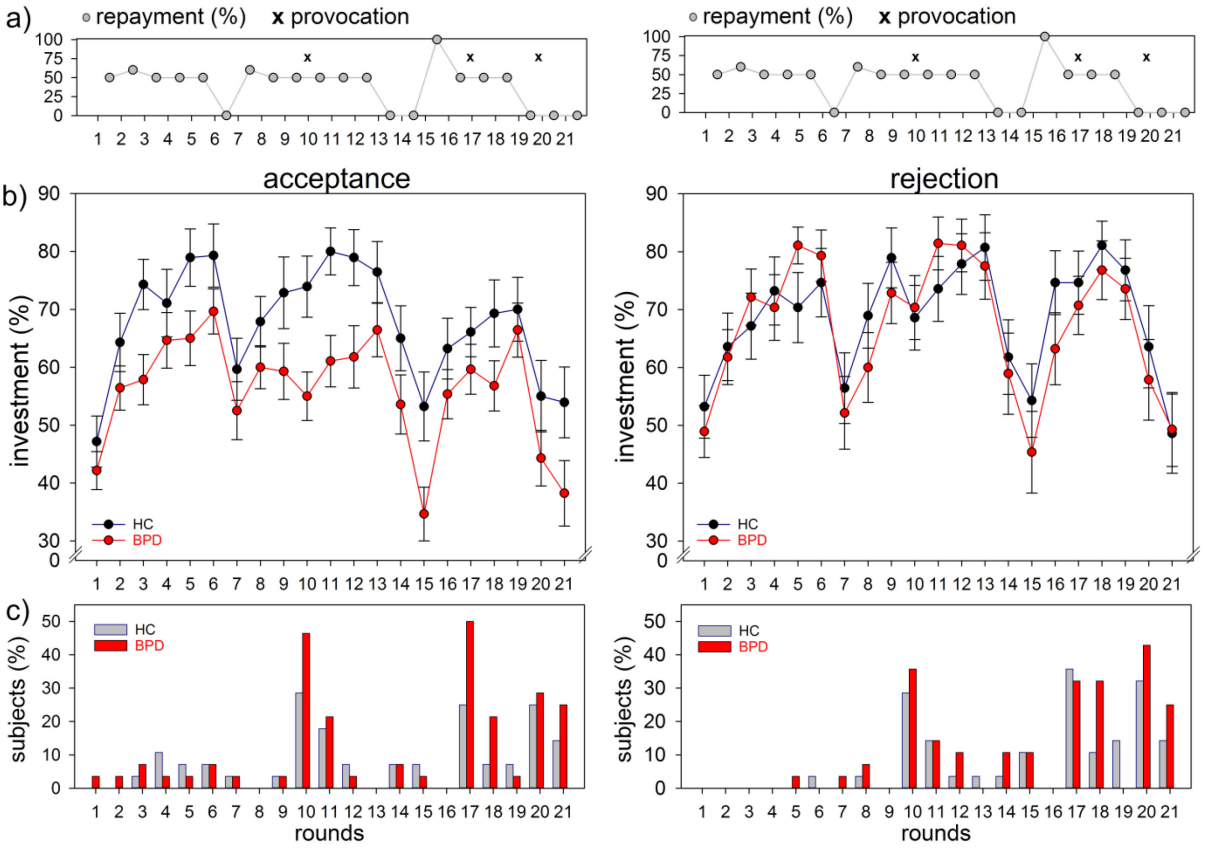
	F	df*	*p*	η_p^2
BDI	0.1	1, 107	.700	.001
Group	0.2	1, 107	.670	.002
Feedback	2.3	1, 107	.133	.021
Group x Feedback	4.6	1, 107	.033	.042
Phase	14.5	1, 107	<.001	.119
Phase x BDI	11.9	1, 107	.001	.100
Phase x Group	6.3	1, 107	.014	.055
Phase x Feedback	1.3	1, 107	.262	.012
Phase x Group x Feedback	0.2	1, 107	.648	.002
Time	3.3	3.8, 403.4	.010	.030
Time x BDI	1.5	3.8, 403.4	.197	.014
Time x Group	1.3	3.8, 403.4	.276	.012
Time x Feedback	0.2	3.8, 403.4	.954	.001
Time x Group x Feedback	1.8	3.8, 403.4	.127	.017
Phase x Time	0.9	3.5, 373.2	.431	.009
Phase x Time x BDI	0.4	3.5, 373.2	.780	.004
Phase x Time x Group	0.3	3.5, 373.2	.848	.003
Phase x Time x Feedback	0.2	3.5, 373.2	.911	.002
Phase x Time x Group x Feedback	1.4	3.5, 373.2	.240	.013

**degrees of freedom are Greenhouse-Geisser corrected if appropriate*

Supplemental Table S8. Trust game: Results of the ANOVA for changes in investments in response to a) the trustee's ruptures of cooperation, b) the trustee's attempts to repair ruptured cooperation, and c) to provocations by the second co-player (provocateur)

	F	df*	*p*	η_p^2
a) Trustee's ruptures in cooperation:				
Group	0.3	1, 108	.594	.003
Feedback	0.2	1, 108	.673	.002
Group x Feedback	<0.1	1, 108	.876	<.001
Phase	0.7	2.0, 214.5	.492	.007
Phase x Group	0.1	2.0, 214.5	.890	.001
Phase x Feedback	0.8	2.0, 214.5	.458	.007
Phase x Group x Feedback	0.5	2.0, 214.5	.635	.004
b) Trustee's attempts to repair cooperation:				
Group	<0.1	1, 108	.850	<.001
Feedback	0.6	1, 108	.423	.006
Group x Feedback	1.3	1, 108	.258	.012
Phase	4.4	1.0, 108.0	.038	.039
Phase x Group	0.8	1.0, 108.0	.387	.007
Phase x Feedback	<0.1	1.0, 108.0	.855	<.001
Phase x Group x Feedback	0.4	1.0, 108.0	.553	.003
c) Provocations by the provocateur:				
Group	<0.1	1, 108	.938	<.001
Feedback	<0.1	1, 108	.963	<.001
Group x Feedback	1.1	1, 108	.296	.010
Phase	11.6	1.7, 180.0	<.001	.097
Phase x Group	0.6	1.7, 180.0	.510	.006
Phase x Feedback	0.6	1.7, 180.0	.541	.005
Phase x Group x Feedback	0.1	1.7, 180.0	.825	.001

**degrees of freedom are Greenhouse-Geisser corrected if appropriate*



Supplemental Figure S6. Trust game visualized for the single 21 rounds. a) repayment ratios of the trustee (o) and provocations by the provocateur (x), b) investments towards the trustee, c) percentages of subjects with aggressive responses towards the second co-player (provocateur). Error bars represent standard errors.

5 GENERAL DISCUSSION

The overall aim of the present thesis was to examine two aspects of interpersonal relatedness in BPD: First, the role of loneliness as an important facet of the severe psychological burden of these patients, and second, the experience of social rejection and acceptance as interaction situations that are especially challenging for this patient group.

BPD patients' frequent and strong feelings of loneliness are well known to clinicians, yet have not been focused on in empirical research so far. Study I of the present thesis provides an empirical basis for these observations and puts it in reference to related concepts. BPD patients indeed reported tremendously increased levels of loneliness when compared to HCs, along with smaller and less diverse social networks, and reduced social functioning. Especially reduced network diversity and diminished functioning in the domains of social engagement, prosocial behavior, and interpersonal communication were linked to increased feelings of loneliness in BPD. Fitting into this picture of BPD-characteristic severe alterations throughout various domains relevant for social life, the present thesis also provides evidence for impaired processing of social cues in social encounters: In study III, BPD patients expected less positive feedback from interaction partners than HCs and even failed to update these expectations particularly in case of positive feedback. Study II provided basis for this investigation by approving suitability of the applied experimental paradigm and by showing that healthy individuals adjust their expectations to actual feedback very quickly, and tailor their expectations of acceptance to their level of affiliation with interaction partners after having received acceptance feedback. Although BPD patients do not differ from HCs in their evaluation of interaction partners, they do not expect to be evaluated equally positive by them, not even after having been told that they indeed are being liked (Study III). Even on the contrary, this kind of feedback increased their feelings of anger just as much as negative feedback. On top of that, acceptance feedback reduced BPD patients' cooperative behavior in subsequent interactions with cooperating partners.

In the following paragraphs the herein summarized findings of the studies provided in Chapters 2-4 are discussed in light of previous research. Limitations and future directions for research on alterations in interpersonal relations in BPD are outlined as well as practical implications of the conclusions that can be drawn from the present findings.

5.1 Integration into Previous Research and Future Directions

As a whole this thesis adds to the literature by examining interpersonal relatedness in BPD, which has been proposed to be an important characteristic for this severe disorder (Gunderson, 2007). The phenomena of loneliness, social rejection, and belonging are highlighted, since clinical observations as well as previous research suggest that they constitute key areas of BPD specific alterations in so-

cial experiencing and interaction. In the following paragraphs, potential interpretations of the studies I-III of this thesis are discussed in detail in the light of previous research findings. Along with potential explanations and implications, proposals for future research directions are made from a content-related as well as a methodological point of view.

5.1.1 Loneliness, Social Networks, and Social Functioning

Our investigation of loneliness in study I revealed that BPD patients report remarkably increased levels of loneliness, smaller and less diverse social networks, and reduced social functioning across a variety of social skills and behaviors, as well as an interconnection between these variables. Specifically, deficiencies in the domains of social engagement, prosocial behavior, and interpersonal communication were linked to heightened loneliness. Given the enormous effects of loneliness on health and well-being that have been outlined in 1.3, these are important findings, since they provide possible starting points for interventions to reduce loneliness and thereby increase patients' quality of life; yet, these findings constitute only a first step to understand the emergence and burden of loneliness in BPD and thus hopefully stimulate further empirical investigations. Hence, the following discussion regarding this topic focusses mainly on providing suggestions for future research in this area.

In study I, social functioning in BPD was reduced throughout all domains. Pagano et al. (2004) were able to show that stressful life events, especially when they are interpersonal, predict reduced social functioning (including e.g., interpersonal relations with family and friends) over time. Since experiencing stressful interpersonal life events is more typical for BPD patients than for HCs or patients with other psychiatric disorders (be it e.g., childhood maltreatment, see Battle et al., 2004; or social rejection, see Berenson et al., 2011; Bungert, Liebke, et al., 2015; Renneberg et al., 2012; Staebler, Helbing, et al., 2011), this experiencing could contribute to reduced social functioning. Following up on the finding of increased loneliness in BPD, future research should examine situations where BPD patients might feel particularly lonely. E.g., it would be plausible that BPD patients feel lonely even when in company. Since according to Baumeister and Leary (1995) the need to belong is a need for "regular social contact with those to whom one feels connected" (p. 501), social contact alone – as reflected e.g., by a large social network – is not sufficient to prevent loneliness. Rather, it requires meaningful intimate relatedness with social network members. Consequently, feeling lonely while being in groups could be due to reduced feelings of really being part of this group, i.e., reduced ability to develop belonging (see 5.1.6).

It remains to be investigated, whether increased loneliness in BPD is due to similar desires that are just not as much fulfilled in BPD patients as they are in HCs or due to even increased desires in BPD patients, as findings by De Panfilis et al. (2015) lead to expect. In our investigation of the relationship between social networks and loneliness, we considered size, i.e., the number of people in a

social network, and diversity, i.e., the number of high-contact roles one holds within one's network. Following the cognitive discrepancy model of loneliness (Peplau & Perlman, 1982), loneliness does not necessarily occur when the social network is small, but rather due to perception of a discrepancy between ideal and actual social relationships. Therefore, future studies should aim at measuring the desired amount of friendships to compare not only actual social networks but ideal social networks as well as the discrepancy between actual and ideal social networks between BPD patients and HCs. Do BPD patients differ from healthy individuals in their desired network sizes and the number of high-contact social roles they want to play in their networks? Furthermore, while investigating whether the cognitive discrepancy model can explain severe increases in loneliness in BPD, a distinction between ideal standards and good-enough standards (see Andrews & Whitey, 1976) should also be considered: How many friends would one like to have ideally versus how many friends would one perceive as sufficient or acceptable considering all constraints? This way, it could be disentangled whether BPD patients only exhibit extreme ideal-typical ideas of social connectedness or whether they indeed express a need for having such extreme social networks in order to be satisfied. Moreover, we investigated purely quantitative measures of social networks; however, qualitative aspects like closeness of relationships should also be taken into account. Although the SNI to some extent factors closeness in – e.g., by asking for the number of close friends (defining close friends as persons one feels close to, talks to about private issues and can ask for help) – it quantitatively measures these qualitative factors by merely asking for the number and not asking for the different aspects of closeness that might be important in regard to loneliness. Hence, different assessment tools are needed in order to disentangle quantitative and qualitative aspects of social relatedness and their particular contribution to the experience of loneliness. In terms of ideal-typical ideas it would be interesting to learn more about enhanced desired closeness in BPD (which Fonagy, 1998, reports; see 5.1.6 for details) and its discrepancy to perceived closeness in actual relationships.

Beyond perception of their own social networks, it would be highly interesting to assess BPD patients' perceptions of the social networks of others around them. Do they perceive others' networks to be larger than their own? And if so, can such perception be traced back to the amount of actual discrepancies or do they even overestimate the actual discrepancies between BPD patients' and HCs' networks that we found in study I? Social comparison (Festinger, 1954) has been shown to be a huge factor in life satisfaction and well-being (e.g., Ben-Zur, 2016; Huang, 2014), with upward social comparison being linked to negative outcomes in various contexts (e.g., Ben-Zur & Michael, 2009; Vogel, Rose, Roberts, & Eckles, 2014). Hence, if someone constantly feels that other people have larger social networks than oneself, it might likely lead to dissatisfaction with their own social network size and thus to feelings of loneliness. This might especially be the case in comparison with peers, since comparing oneself to individuals with a similar background according to the to-be-

compared domain is perceived as most informative (see e.g., C. T. Miller, 1982; Wheeler, Martin, & Suls, 1997). Simultaneously, other types of comparison standards can be considered: Temporal comparison to ones' own past (e.g., how large was my social network a certain number of years ago compared to now) or comparison to social norms (i.e., cognitive concepts of how large social networks should generally be).

In the end, after controlling for effects of social network features and social functioning, loneliness was still increased in BPD patients, suggesting that further factors contribute to this painful experience. Potential candidates might be e.g., rejection sensitivity, self-esteem, and the need to belong. Increased rejection sensitivity could cause loneliness, since it has been argued that amongst other cognitive mechanisms rejection sensitivity explains development of emotional maladjustment (Downey, Bonica, & Rincon, 1999). Moreover, loneliness has been linked to rejection sensitivity in adolescents (Zimmer-Gembeck, Trevaskis, Nesdale, & Downey, 2014). According to sociometer-theory (Leary, Tambor, Terdal, & Downs, 1995) self-esteem functions as a monitor of the degree of being accepted by others. Consequently, low self-esteem constitutes a warning signal when we are rejected, in order to make us change our behavior in a way that reassures acceptance. Hence, BPD patients' low self-esteem signals low acceptance by others and thus could explain aggravated loneliness in these patients. Moreover, an extreme need to belong with simultaneous difficulties in the development of the feeling of belonging, which is characteristic for BPD patients (see 5.1.6), might constitute a predicament predestining loneliness.

5.1.2 Social Expectations of Acceptance or Rejection

It becomes evident in study III that BPD patients exhibit negative social expectations: Not only do they expect significantly fewer acceptances than HCs from interaction partners, whom they just came to know. These initial expectations also stay on their low level when incongruent (i.e., positive) feedback is provided (for a detailed discussion of this incapacity to adjust expectations towards the positive, see 5.1.3). Diminished social expectations in BPD in our study are perfectly in line with literature on heightened expectations of rejection in BPD based upon the evaluation of hypothetical scenarios (Bungert, Liebke, et al., 2015; Staebler, Helbing, et al., 2011) and with an EEG-study using Cyberball by Gutz et al. (2015) implying that being included violates the patients' expectations.

What are the consequences of expectations in social relationships? That expectations play a huge role in guiding our experiences has been frequently shown by many psychologists. As Greenberg, Constantino, and Bruce (2006) put it: "There is a tendency to distort objective interpersonal encounters to conform to prior expectations" (p. 658). This phenomenon can be explained by cognitive dissonance, an aversive cognitive state caused by conflicting cognitions, that people aim at reducing through changing opinions or behavior (Festinger, 1962). Negative consequences of expec-

tations have been frequently shown in rejection sensitivity research, e.g., expectations of rejection evoke actual rejection via self-fulfilling prophecies (Downey et al., 1998). Concordantly, positive consequences can be observed when expectations are positive: In different studies, positive expectations about the outcome of a health treatment have been shown to be beneficial, e.g., in terms of clinically significant reduction in depressive symptomatology, and global improvement (Beard et al., 2016; for a review on how expectations can influence course and outcome of psychotherapy, see Greenberg et al., 2006). In a longitudinal study, such beneficial effects have also been shown in BPD patients, who improved in depressive symptomatology and the number of BPD criteria met when expecting such improvement (Wenzel, Jeglic, Levy-Mack, Beck, & Brown, 2008). These findings implicate that reduced social expectations in BPD are potentially problematic for success of their social interaction and their well-being.

It remains inconclusive why BPD patients show such negative expectations. Interestingly, expectations differed between groups despite of similar behavior during the become acquainted meeting in phase I of the MVGIP and similar evaluations of the interaction partners in phase II. Hence, we can rule out the objection that negative social expectations could be due to more negative evaluation of others, since BPD patients did not differ from HCs in evaluations of their interaction partners and nonetheless expected fewer acceptances by them. This shows that reduced expectations of acceptance are not due to expected reciprocity because of own diminished wish to affiliate or reduced liking of the interaction partners; whereas in healthy participants expected reciprocity indeed seems to be a relevant factor, since the more positive they had evaluated the others in the evaluation rating the more positive feedback they expected from them in the acceptance condition in study II. In BPD patients, however, these reduced expectations of acceptance could rather be due to negative self-images and low self-esteem that have been shown to be highly associated with BPD (Abela, Payne, & Moussaly, 2003; American Psychiatric Association, 2013; Kanter, 2001). It seems likely that someone who has a very negative view of him-/herself does not expect to be liked and accepted by others as much as someone who has a high stable self-esteem. Confirming this connection, low self-esteem and high rejection sensitivity have been shown to be linked in HCs as well as in BPD patients (Bungert, Liebke, et al., 2015). In addition, development of low social expectations could be explained by learning theory: In a longitudinal study, BPD patients reported having experienced more negative life events in the past than patients with any other personality disorder or major depressive disorder (Pagano et al., 2004). Such negative experiences are likely to influence assumptions about the future. Critchfield, Levy, Clarkin, and Kernberg (2008) found that especially BPD patients with fearful forms of attachment expect more aggression and hostility from others. It is also conceivable that negative expectations function as a protective mechanism: Making extremely negative predictions in the first place, per se reduces the negative prediction error. A promising approach for future

research would be to manipulate expectations by announcement of what follows and simultaneously measuring neuronal responses via functional magnetic resonance imaging. By doing so, potentially underlying neuronal deficits contributing to reduced social expectations in BPD could be uncovered.

Having found social cognitive differences between BPD patients and HCs always entails the question whether these differences are indeed specific for social cognition or can be observed in non-social cognition as well. Likewise, in case of the present findings, specificity for social relations needs to be verified. Are negative expectations in BPD particularly present in social situations or due to a general pessimism? There are a few studies which suggest that also in other contexts negative expectations are generally present in BPD patients. Korn, La Rosee, Heekeren, and Roepke (2016) asked their participants to estimate the probability that they themselves will experience certain negative life events (i.e., accidents, thefts, and diseases, like e.g., bone fracture, car stolen, gallbladder stones). BPD patients' initial estimates were significantly higher than those of HCs (mean of 35.2% compared to 29.9%). Vega et al. (2013) investigated a different kind of expectancy, nonetheless their findings point in the same direction: Using EEG they found negative reward expectations in BPD. Since social signals of acceptance are usually rewarding (see Bhanji & Delgado, 2014) negative reward expectations in general could underlie negative social expectations in our study. Further studies on expectations in BPD are still missing. It would be desirable to substantiate previous findings by replicating negative expectations in different social contexts. Moreover, the precise effects of such social cognitive mechanisms should be investigated. However, it cannot be ruled out that the negative social expectations of BPD patients that we found in study III are part of a generally negative world view that is not specific to social encounters. The herein summarized findings on expectations in BPD paint a picture of an unspecific more pessimistic foresight, be it according to thefts, accidents and illnesses (Korn et al., 2016), to receiving a reward (Vega et al., 2013), or to receiving interpersonal feedback of rejection or acceptance (study III of this thesis). This is supported by studies pointing to a generally more negative world view of BPD patients (e.g., Giesen-Bloo & Arntz, 2005).

There are only those few studies specifically addressing altered expectations in BPD, however, the picture is consistent so far. Assuming that they are right in their statement that expectations are more negative in BPD patients, the question arises whether or how these expectations can be adjusted through actual social events or social feedback, and is discussed in the following paragraph.

5.1.3 Adjustment of Social Expectations according to Feedback

After these initially less positive social expectations of BPD patients, all subjects were provided with feedback of either rejection or acceptance. In general, expectations of social acceptance change very quickly after experiences of acceptance or rejection, as becomes evident in study II, where the first presentation of feedback is sufficient to evoke updating of the participants' social expectations in

healthy individuals. In study III, these adjustments of expectations to feedback were stronger in HCs than in BPD patients after both kinds of feedback. Taking baseline expectations into account, it is not surprising that HCs show stronger adjustment to rejection feedback than BPD patients, since they start from a score well above the actual feedback. However, although BPD patients show low expectations from the beginning, they still lower them even further after feedback that is rather consistent with their baseline expectations. Hence, baseline differences might account for this stronger adjustment to rejection feedback in HCs. Moreover, despite HCs' stronger adjustment to rejection feedback, in the end their expectations are still significantly higher than those of the patient group after rejection feedback. In contrast, after acceptance feedback, adjustment is not only stronger in HCs, but also not at all significant in BPD patients.

Taken together, while HCs updated their expectations according to the valence of the provided feedback in both cases, BPD patients also lowered their expectations after rejection feedback (even if not as strongly as HCs); however, they did not adjust their expectations towards the positive in case of acceptance feedback, as healthy individuals did. It remains unclear whether this reflects a general deficit in integrating positive feedback or a reduced reward value of such feedback. A potential explanation could be that the unexpected high acceptance responses of the interaction partners induced mistrust in BPD patients (for a detailed discussion on how mistrust could explain findings of study III, see 5.1.5). Nevertheless, in contrast to reactive anger, the level of self-reported arousal decreased in both BPD patients and HCs after acceptance feedback. These opposing effects of positive feedback on arousal and anger might indicate conflicting evaluations of social acceptance in BPD: On the one hand, their arousal is reduced; on the other hand, they seem to have difficulties to handle these experiences as reflected by increased anger and non-adaptation of expectations. These findings suggest that being accepted is not as pleasant an experience for BPD patients as it is for HCs (for further discussion see 5.1.6).

Our findings of altered feedback processing in BPD are in line with a very recent study that described alterations in using feedback to update the self-image (Korn, La Rosee, Heekeren, & Roepke, 2015). However, Korn et al. (2015) found inconsistent processing of self-related information in BPD: Patients integrated both desirable as well as undesirable feedback into their self-image and one may speculate whether these – in principle incompatible – adjustments might underlie the unstable self-image in BPD patients. While Korn et al. (2015) targeted the subjects' evaluation processes of themselves, our approach focused on how people expect to be evaluated by others. Taking these findings together implies that BPD patients try to adjust their evaluation of themselves based on heterogeneous feedback of others, but refuse to change their expectations of how they are perceived by others in case of positive feedback. This suggests that BPD patients prefer self-verification in contrast to self-enhancement as a motive in the processing of social information (Leary, 2007; for a review see

Winter, 2016; see also Winter, Koplin, Schmahl, Bohus, & Lis, 2016). Based on reduced feelings of self-worth in BPD (Bungert, Liebke, et al., 2015; S. G. Miller, 1994; Rüsch et al., 2006), social acceptance, if received from someone whose view of us is more positively than our view of ourselves, feels precarious, because it bears the risk of disappointment. Such a "worrisome threat" (Leary, 2007, p. 326) may impede adjustment of social expectations and thus the formation of a positive self-image through self-enhancement strategies as they are applied by healthy individuals in the current study as well as in the study by Korn et al. (2015).

In an even more recently published study by Korn et al. (2016) the authors investigated expectations about experiencing negative life events. Although initial experiences were more negative in BPD patients as discussed above (see 5.1.2), after receiving feedback about the actual probability of such life events, BPD patients and HCs did not differ in their expectations anymore. BPD patients' updating in case of adverse events was even positively biased as was that of HCs. Thus, initial expectations are also more negative when they do not concern social evaluations. However, since those expectations are updated towards the positive after according feedback has been provided, the lack of adjustment of expectations to positive feedback seems to be specific for social evaluations. Hence, the authors conclusion that providing feedback helps BPD patients to establish a less pessimistic view (Korn et al., 2016) holds true for expectations of adverse events, but does not hold true for expectations of social acceptance (study III, this thesis). This specificity is highly interesting, since it again underlines the importance of altered social relatedness in BPD, and points to the fact that opportunities to help BPD patients "overcome their pessimism" (Korn et al., 2016, p. 1) according to social interaction have yet to be found. In our study, not even repeated presentations of positive feedback can incite BPD patients to adjust their social expectations. Future research should focus on potential long term effects of positive social feedback: Do BPD patients really not update their expectations according to positive feedback or could repeated presentations over a longer time course and across different social contexts and situations eventually cause adjustment of expectations?

5.1.4 Social Interaction with Significant Others versus with Unknown Others

As has been addressed in the theoretical background of this thesis, there is a distinction to be made between social interaction with significant others versus with unknown others. In the MVGIP, participants did not previously know their interaction partners. Hence, in phase I of the MVGIP, the become acquainted phase, social interaction with previously unknown others can be observed. Here we found no alterations in interaction behavior: Both groups chose same amounts of emotional facial expressions, with a high priority for smiling. Since this happy facial expression that has been chosen to be shown at far most by both groups signals a wish to affiliate (Heerdink et al., 2015), we conclude that BPD patients show just the same amount of signs of interest in bonding with their interaction

partners as HCs do (which would also justify using the term "rejection" according to Blackhart et al.'s, 2009, definition; see 1.4). In phase II of the MVGIP, we neither found any differences between groups in evaluation of the others one became acquainted with: BPD patients evaluated them just as HCs did (i.e., both groups evaluated them as rather neutral, in the middle of the continuum between both poles "positive" and "negative"), contradicting findings by e.g., Barnow et al. (2009), who showed that compared to HCs BPD patients evaluated others more negatively, less positively, and more aggressively. Our evaluation rating in study III differs from Barnow et al. (2009) in evaluation criteria as well as degree of acquaintance to the others to be evaluated. In the study by Barnow et al. (2009) participants could evaluate others on several adjectives, where BPD patients evaluated others as less serious and more mischievous, and tended to rate the persons as less nice and respectful than HCs. Those others were completely unknown to the participants and did not talk at all. Participants just saw them for 10 seconds, entering an empty room and taking place on a chair at a table, whereas, in the MVGIP participants evaluated others whom they had become acquainted to in a VR meeting before, where they had heard them talk about personal topics. Moreover, to evaluate the others in the MVGIP, ratings were not merely performed on adjectives, but rather on more profound measures, such as "Do you feel close to Anna?" and "Could you imagine being friends with Anna?" with behavioral implications such as "Would you like to meet Anna again?" and "Could you imagine spending your free time with Anna?". Hence, while findings by Barnow et al. (2009) support the idea of a generally more negative world view of BPD patients, our findings of study III imply that this does not hold true for evaluation of others whom patients got to know at least a little bit before. Should this assumption be proven through future research, it would provide promising approaches for therapeutic treatment, since it suggests that BPD patients' negatively biased evaluations can be overcome.

Later on, in the feedback phase (where assessment of expectations takes place along with the actual manipulation of social rejection and acceptance), the interaction partners are not completely unknown anymore, which constitutes one of the main differences between the MVGIP and Cyberball. We decided to design the paradigm like this, since social feedback on how much one is being liked by others or if others would like to meet one again, requires being known at least a little bit, for it to be attributable to one self's personal characteristics. Nevertheless, one might criticize study II and III for induction of social acceptance and rejection by individuals subjects were only very briefly acquainted to, proposing that rejection by (almost) strangers should lack relevance. However, this is most certainly not the case: Previous literature has extensively shown that rejection by strangers (or brief acquaintances – known for 15 minutes) does indeed hurt and elicit a wide range of neuronal, emotional, and behavioral reactions (e.g., Bourgeois & Leary, 2001; Chow, Tiedens, & Govan, 2008; Eisenberger et al., 2003; Maner et al., 2007; Twenge et al., 2001; Twenge et al., 2003; Warburton et

al., 2006; Williams et al., 2000). Nonetheless, even though rejection by unknown others is far from meaningless, it might be the case that individuals exhibit even stronger reactions to rejection by significant others. Tesser, Millar, and Moore (1988) found that the closeness of another person intensifies self-evaluation processes: The gain in self-evaluation is higher when a close other outperforms oneself in an irrelevant task than when a stranger does (this works through reflective processes, i.e., basking in reflected glory; see Cialdini, Borden, & Thorne, 1976). Conversely, when it comes to self-relevant tasks, the loss in self-evaluation is higher when one is outperformed by a close other than by a stranger (herein, comparison processes are at work). These findings suggest that social evaluation processes might have stronger impact in the context of significant others compared to unknown others. Hence, it would be interesting to use the MVGIP creating avatars representing the subjects' family members, romantic partners, and/or friends, to compare reactions to standardized social experiences from strangers (avatars without preceding become acquainted phase), brief acquaintances (avatars with preceding become acquainted phase; like in the MVGIP), and significant others (avatars of friends, family, or alike). BPD patients' cooperative behavior towards cooperating co-players in the trust game might be less reduced after acceptance feedback by significant others, since potentially positive feedback from friends or family should not be as unexpected to them as positive feedback from brief acquaintances. Such a finding would explain Linehan's (1993) observation that BPD patients who are in stable relationships seem to do relatively well.

Then again, in the end of study III, the trust game is played with complete strangers. Here, we found differences in cooperative behavior towards these unknown others between BPD patients and HCs, however, these differences are completely due to the preceding manipulation of social feedback in the MVGIP: Only after preceding acceptance feedback from interaction partners who, at the time of feedback, were not completely unknown to the participants anymore, BPD patients showed less cooperative behavior in the trust game, while after rejection, investments to the trustee were adjusted towards repayment of the trustee strikingly similar in both groups.

In summary, in phase I of the MVGIP as well as in the trust game, interaction partners are strangers, and BPD patients behave similarly to HCs. In phase III of the MVGIP, interaction partners are individuals to whom the participants became virtually acquainted, and there are differences in social expectations between BPD patients and HCs – although they do not differ in their evaluations of the others. Last but not least, the behavioral differences between groups actually occurring in cooperation phases of the trust game towards strangers are dependent on the preceding feedback of acquainted interaction partners. This pattern of results implies that BPD patients' interaction behavior might be problematically altered especially when it comes to positive social interaction and development of belonging. However, this conclusion requires further empirical basis: Future studies

should investigate different social contexts and e.g., provide various behavioral alternatives in phase I of the MVGIP.

Next to the experimental investigation in study III it is interesting to also consider the role of interaction with significant others versus with unknown others in increased levels of loneliness that have been shown in study I. It seems likely that loneliness is related to both: If significant relations are characterized by problematic behavioral and perceptional patterns and thus not experienced as satisfying, loneliness will eventually occur, as is supported by the link between social withdrawal and loneliness. Also, if dysfunctional interactions with unknown others inhibit further contact and thus development of significant others in the first place, because relations are frequently terminated as analysis of study I as well as previous studies (Beeney et al., 2018; Clifton et al., 2007) suggest, the resulting lack in size of the social network and closeness to the network members could also explain severe loneliness issues.

5.1.5 Cooperation and Trust in Social Interaction

In general our findings suggest that BPD patients are able to adapt their own behavior according to that of an interaction partner, as reflected in similar adjustments of investments in response to ruptures of the trustee's cooperation, the trustee's attempts to repair such ruptured cooperation and the provocations of the second co-player, as well as in the absence of differences in investments between BPD patients and HCs who have previously been rejected in the MVGIP. However, interpersonal problems may arise if an interaction partner behaves fair, and the patients were previously confronted with social acceptance of others that violated their expectations towards the evaluation of the own person by others.

Our findings suggest reduced trust (see 1.2.2 for an explanation why investments in the trust game require trust) in BPD patients towards a cooperative co-player after having received positive feedback of social acceptance by a group of different people. In the following, this finding will be discussed in light of the recently proposed epistemic trust theory (for a review see Bo, Sharp, Fonagy, & Kongerslev, 2017), an extension of the mentalization-based theory of BPD (Fonagy & Bateman, 2008; see also 1.1). Mentalization – which is also referred to as cognitive empathy – is defined as "the ability to understand others in terms of their thoughts, feelings, wishes, and desires" (Fonagy, Luyten, & Bateman, 2015, p. 380). Thus, it is an important mechanism for social functioning, since it is required to comprehend others' behavior and make predictions about their future behavior (Bateman & Fonagy, 2013). This higher-order cognitive ability has been proposed to be impaired in BPD: Throughout interpersonal interactions BPD patients frequently lose their capacity to mentalize accurately (e.g., Bateman & Fonagy, 2013; Fonagy, 1998). Sharp and Vanwoerden (2015) argue that BPD patients mainly show hypermentalizing, which means that they form complex theories to ex-

plain behaviors of their interaction partners which others find difficult to comprehend. Such altered mentalizing could lead BPD patients to expect that others will reject them, even though they have been accepted by them before, e.g., by dismissing others' positive feedback as dissimulation through hypermentalization of the others' reasons not to like them.

Mentalizing is a crucial ability for the development of epistemic trust, i.e., "trust in the authenticity and personal relevance of interpersonally transmitted knowledge about how the social environment works" (Fonagy, Campbell, & Bateman, 2017, p. 176): A caregiver must have the ability to mentalize his/her child in order to enable secure attachment which the development of trust depends on (Bo et al., 2017). Fonagy, Luyten, and Allison (2015) understand epistemic mistrust as a "specific underlying vulnerability" (p. 576) to BPD psychopathology. Moreover, rigidity which is defined as „loss of the capacity for change" that is common in BPD (Fonagy, Luyten, & Allison, 2015, p. 577), meaning that patients are unable to flexibly adjust to their changing environment, in our study occurs only in case of positive feedback: Being liked by others does not fit into their self-image. The lack of adjustment towards acceptance feedback can be understood as an expression of epistemic mistrust (which makes sense only after unexpected positive feedback which contradicts BPD patients' self-images; consequently, rejection feedback which is in line with BPD patients' self-images and thus also with their expectations does not elicit mistrust). Such mistrust towards positive social feedback, might take effect in subsequent positive interaction in the trust game when partners behave fair, implying that BPD patients are especially suspicious when treated decently. Sanfey (2009) showed that expectations can influence future behavior. Moreover, a study by Millar and Tesser (1988) implies that deceptive behavior is indeed linked to violated expectations. Several studies using trust games also point to an important role of expectations in the occurrence of trust (Bigoni, Bortolotti, Casari, & Gambetta, 2013; Coricelli, Gonzáles Morales, & Mahlstedt, 2006; Holm & Danielson, 2005; Yamagishi et al., 2013; see also Thielmann & Hilbig, 2015). In the current study III acceptance feedback exceeded BPD patients' expectations. Hence, reduced trust in the subsequent trust game, which is only present in previously accepted BPD patients, could be due not to positive feedback per se, but rather more specifically to expectancy violation in the MVGIP. This assumption is supported by a significant correlation of discrepancy between expectations and actual feedback with investments during cooperation-rounds in the trust game (see results of study III). The interpretation that the experience of social acceptance triggers mistrust in BPD patients since it violates their expectations is further supported by an increase of anger after positive feedback as well as by patients' comments during the debriefing at the end of the study: Some BPD patients reported that they believed the others' positive feedback to be untrustworthy because they believe to know that they themselves are not likable.

Although BPD patients have been shown to lack the ability to actively repair ruptured cooperation by coaxing their interaction partners (King-Casas et al., 2008), our findings indicate that they nonetheless allow repairment of cooperation by reacting to their co-players' fair offers after ruptures with increases of investments. Thus, BPD patient are not thwarting repair of cooperation when the first step towards a repair of the relation is made by their interaction partner. Findings by Thielmann et al. (2014) suggest that individuals with BPD features find it more difficult to forgive ruptures, when attempts to repair these build up more slowly over multiple rounds. Nevertheless, our findings agree with those of Thielmann et al. (2014) in the conclusion that BPD patients are not generally less cooperative than HCs.

Taken together, our findings of study III partly confirm "Beck's assertion that all personality pathology is characterized by the expectation that "others" are untrustworthy" (Fonagy, Luyten, & Allison, 2015, p. 577); "partly", because obviously from our investigation we can only draw conclusions on BPD pathology, and moreover, because we found specificity in terms of untrustworthiness particularly in situations characterized by positive social interaction. Therefore, the following paragraph focuses on potential implications of such disturbed processing that seems to be activated specifically in positive social encounters.

5.1.6 Processing of Positive Social Signals: The Formation of Social Belonging

Both tremendously increased experiences of loneliness (see study I) and reduced expectations of acceptance (see study III) point out that BPD patients might exhibit difficulties with feeling like they belong to other people. Results of study II show that after receiving positive feedback of social acceptance healthy individuals tailor their expectations to their level of affiliation towards the others, i.e., if they like others a lot and express willingness to socialize with them, they expect to be liked by them, which might be an important mechanism to establish close relationships with those whom one likes. That BPD patients do not expect to be liked by others even when they are told that they are (study III), might hamper such building of close relationships due to self-fulfilling prophecies (see Downey et al., 1998).

Taken together, all results of study III specifically point to altered processing of positive social signals: BPD patients exhibit problematic reactions particularly in response to positive social feedback by others. Subsequent to this positive feedback they act less cooperatively towards a different interaction partner, again only in cases where he/she shows positive cooperation behavior. Similar conclusions of alterations in the processing of positive social signals can be drawn from findings of emotion recognition tasks: BPD patients rated happy facial expressions as less happy than healthy individuals (Thome et al., 2016), but did not differ in evaluating angry faces. They also had more difficulties with correctly identifying positive or neutral facial expressions than with identifying negative

expressions (Fenske et al., 2015). Moreover, when confronted with ambiguous facial expressions, BPD patients have been shown to rather attribute anger than happiness to them (Daros, Uliaszek, & Ruocco, 2014; Domes et al., 2008; Izurieta Hidalgo et al., 2016). Note, however, that there has been disagreement regarding the interpretations of heterogeneous results throughout emotion recognition studies, with some authors arguing that BPD patients are specifically impaired in the ability to recognize negative emotions. For reasoning why this assumption could be due to methodological specifics see Thome et al. (2016).

Rejection feedback seems to be similarly painful for BPD patients as it is for HCs. However, acceptance feedback does not elicit positive changes of expectations, but rather higher levels of anger in BPD in our study III. This fits with findings by Gadassi et al. (2014) showing that affective reactions to social proximity are not consistently positive in BPD, but mixed with increased feelings of anger. Moreover, other authors also found that positive social participation is problematic (De Panfilis et al., 2015; Renneberg et al., 2012). In line, attenuated positive affect (Sadikaj et al., 2010) and greater negative impact (Bhatia, Davila, Eubanks-Carter, & Burckell, 2013) in response to positive social signals by interaction partners have been reported in BPD. A recent study found that BPD patients not only exhibit stronger negative emotional reactions to negative social interaction, but also less positive reactions (i.e., less pride, happiness, feelings of approval, and attraction/love) and more negative emotions (i.e., anger, anxiety, and embarrassment) in response to positive social interaction (Reichenberger et al., 2017). It can be suspected that such negative reactions to positive social signals – just as attenuated cooperation towards cooperative partners after preceding positive social feedback in study III – may even lead interaction partners to refrain from sending such positive signals in future interactions.

Taken together, this leads to the assumption that there is limited possibility for BPD patients to really gather positive social experiences. Applied to our study this means that there are the following options: BPD patients expect that almost nobody likes them, then they – option 1 – receive rejection feedback confirming these negative expectations which might lead to cognitive processing like “I knew it all along“ causing an increase in anger and arousal or – option 2 – receive acceptance feedback which contradicts their expectations eliciting mistrust and potentially thoughts like “They all lie to me“, which equally elicits anger (and potentially other negative emotions) as well as difficulties in subsequent cooperation. Hence, there is no option for BPD patients to be pleased or satisfied in situations comprising social evaluations. Rather, initial expectations of “others do not like me“ are inevitably confirmed in their own perception, no matter what kind of feedback they receive, explaining not only the non-existing adjustment of expectations to positive feedback, but also suggesting that creation of trust and formation of a feeling of belonging is dangerously impaired in BPD. This process

reflected in data of study III is aptly described by Fonagy, Luyten, and Allison (2015) in the context of children-caregiver-relationships:

> If the need for others cannot be satisfied even in the presence of the attachment figure because the individual feels deeply suspicious of the attachment figure's motives, while the intense need for separateness is consistently undermined by the intense desire to seek reassurance, the individual faces an insoluble interpersonal dilemma. His/her experiences will inevitably validate his/her perceptions, and the potential for change in the light of "new data" is minimal. […] Even a positive response from the attachment figure will be discounted by assumptions about his/her motives. (p. 578)

The need to belong is one of the most fundamental human needs (Baumeister & Leary, 1995) and its fulfilment is of outmost importance for health and well-being (see extensive literature on social rejection, summarized in 1.4.2, and loneliness, summarized in 1.3, for many negative consequences that are associated with a lack of belonging). Beyond this strong human need to belong, BPD patients seem to even more have a "terrifying wish for extreme closeness" (Fonagy, 1998) and "form inappropriately intense attachments to others" (Bateman & Fonagy, 2013, p. 597). In line, findings that domain disorganization (i.e., concretion between borders of different social domains like e.g., friendships and romantic partnerships) increases with BPD symptomatology (Hill et al., 2008), suggest that there might be an "inappropriate expression of attachment needs in relationships that are not equipped to meet them" (Hill et al., 2008, p. 144). Sadly, this heightened desire might make it even harder for BPD patients to achieve a feeling of closeness in their social relations that is perceived as satisfying. Combined with difficulties in positively experiencing social participation (De Panfilis et al., 2015; Gutz et al., 2015; Renneberg et al., 2012) or social feedback of acceptance by others (study III, this thesis), this is a disastrous combination. Figuring out how to overcome these difficulties and enable BPD patients to develop feelings of belonging should hence be purpose of future research. A meta-analysis by Blackhart et al. (2009) focusing on emotional reactions to rejection and acceptance in healthy individuals suggests that, compared to a neutral emotional state, rejection elicits clearly negative emotions, while acceptance evokes only slight differences toward the positive. The authors conclude that "the emotional impact of rejection was larger than that of acceptance" (Blackhart et al., 2009, p. 300). With this in mind, it gets all the more difficult as well as important to explore mechanisms that improve the processing of positive social signals and thus allow for BPD patients to experience at least these slightly positive effects of social acceptance.

5.2 Limitations and Methodological Aspects

As in every empirical study, studies I-III in the present thesis also face some limitations that have to be addressed in the following paragraphs in order to interpret the results properly. In samples consisting of BPD patients and healthy individuals we used self-report measures to investigate expression of loneliness and its relations to social networks and social functioning, an experimental approach to induce social rejection and acceptance and to investigate expectations, and an economic exchange game to study behavioral reactions to rejection and acceptance. These studies were first steps to elaborate the importance of loneliness in understanding emotional experiencing in BPD patients and to identify deficits in dealing with signals of being liked by others as one factor contributing to interpersonal dysfunction in BPD, hopefully clearing path for intensive future research. Hence, both sample characteristics and methods used are critically reflected in the following to provide notice for future directions.

5.2.1 Sample Characteristics

One major limitation of all three studies of this thesis is routed in our investigating only female participants. This is a common limitation in BPD research, since in clinical settings the prevalence of female BPD patients exceeds that of male by far (see e.g., Silberschmidt, Lee, Zanarini, & Schulz, 2015). Beyond clinical settings, there is a lack of clarity about gender prevalence discrepancies in the population. In the DSM-IV it is postulated that approximately 75% of all patients diagnosed with BPD are female (American Psychiatric Association, 2000). This discrepancy is suggested by some authors (Widiger & Trull, 1993), while others question the underlying mechanisms of such findings, arguing that gender prevalence discrepancies really are unknown (Skodol & Bender, 2003). Either way, it has to be mentioned that findings of the present studies are not necessarily generalizable to male individuals. Although in recent years, some studies found surprisingly few gender differences in BPD across a wide range of measures of symptomatology, comorbidities, and personality traits (Banzhaf & Ritter, 2012; Silberschmidt et al., 2015), it remains to be investigated how male and female BPD patients differ in terms of loneliness and expectations of as well as reactions to social acceptance and rejection.

BPD patients oftentimes are under strong, long-term, and diverse medical treatment (see e.g., Martinho, Fitzmaurice, Frankenburg, & Zanarini, 2014; Zanarini, Frankenburg, Bradford Reich, Harned, & Fitzmaurice, 2015). More than 75% of BPD patients take psychotropic medication on a regular basis (Silk, 2011). However, the specifics of suitability of pharmacological treatment for BPD patients are not yet fully understood (Silk, 2011). Hence, in this thesis, we focused on unmedicated BPD patients, since we were not interested in potential influences of psychotropic medication on alterations in interpersonal relatedness, but rather in an unbiased investigation of BPD-specific alter-

ations. Nevertheless, future research should consider potential influences of psychotropic medication on social cognition and interaction behavior and try to clarify them. Given the high rate of medical treatment, it is important to know about its effects on interaction behavior.

Furthermore, BPD is a very heterogeneous disorder. By definition, the DSM approach to diagnose BPD when at least 5 out of 9 criteria are met, results in 256 different criteria-variations that justify diagnosing someone with BPD. On top of that, BPD patients are known to suffer from a huge amount of comorbid psychiatric disorders (see e.g., Carpenter et al., 2016; Dell'Osso et al., 2010; Fornaro et al., 2016; Skodol et al., 2002; Tomko et al., 2013; Zanarini et al., 1998; Zanarini et al., 2004), increasing the heterogeneity even further. In the present studies I and III our BPD samples as well exhibit a lot of comorbidities, with affective disorders, PTSD, and eating disorders being most frequent. This constitutes a general difficulty in BPD research. Hence, future studies should include not only healthy but also clinical control groups (Axis I disorders and other personality disorders) to discover to which extend the present findings are specific to BPD. Moreover, sufficiently large sample sizes to allow for formation of subgroups according to comorbid symptomatology are desirable for future investigations. We performed additional analyses on data of study I (not published in study I due to small sample size) where we compared BPD patients with comorbid social anxiety disorder (SAD; n=13) to BPD patients without comorbid SAD (n=27). We found that BPD patients with comorbid SAD display significantly lower functioning in both competence and performance of independence. Furthermore we could find some evidence that social functioning in BPD with comorbid SAD is linked to social engagement and prosocial activities. This argues that BPD patients withdraw from social connections and activities even more if they are additionally burdened by social anxiety. Accordingly, it would be highly informative to realize a clinical control group consisting of SAD-only patients to clarify the actual relations between social functioning, consistency of social networks, and loneliness, to identify the portion of impairment that is specific to BPD versus SAD symptomatology or just contributes to overall psychological strain.

5.2.2 Methods of Study I: Self-report Data, Correlations

Study I of this thesis is based on self-report data and correlations. Participants filled out questionnaires that indicated their level of loneliness, size, and diversity of their social networks, as well as their social functioning in a variety of distinct domains of social skills. Using these questionnaires was a great opportunity to provide a first investigation of expression of these variables in BPD patients compared to HCs as well as the relationships of these concepts among each other and their differences between both groups. Nonetheless, for future studies it would be desirable to use more sophisticated methods: Experimental manipulation of loneliness (e.g., via priming) could provide valuable information on how subsequent social interaction (e.g., communication) is altered. Similar inves-

tigations have been done in healthy individuals (see e.g., Cacioppo et al., 2006; Hicks, Schlegel, & King, 2010), but equivalent studies on alterations in BPD are still missing. Such experimental investigations are necessary, since from our analysis via cross-sectional assessment and correlations, no conclusions about causality can be drawn. Do smaller and less diverse social networks really lead to increased loneliness? Or does it also work the other way around, with increased feelings of loneliness (and expression thereof to the social community) leading to reductions in social network size and diversity, and social functioning, e.g., via means of self-fulfilling prophecy as has been shown to be a relevant mechanism in rejection sensitivity (Downey et al., 1998)?

To measure loneliness, we relied on the most widely used measure of loneliness, the UCLA Loneliness Scale. Further research could deploy different questionnaires to disentangle different dimensions of loneliness, e.g., the Social and Emotional Loneliness Scale for Adults (DiTommaso & Spinner, 1993) or the Existential Loneliness Questionnaire (Mayers et al., 2002). This could be especially useful considering the finding that increased loneliness in BPD cannot be sufficiently explained by alterations in social functioning and social networks, which suggests that different aspects of loneliness, like existential aspects, might be missing in this investigation.

Future studies should also consider using methods to assess social networks even more precisely. To investigate further important variables, exceeding mere size of a social network (which no doubt is a relevant measure, but cannot explain everything), social network analysis has proven a valuable method in the past in HCs (see e.g., Borgatti et al., 2013) as well as in BPD patients (see e.g., Beeney et al., 2018; Clifton et al., 2007). For example, through social network analysis the density of a social network can be captured, i.e., direct ties between members of a network are counted and divided by the total number of ties possible, or the centrality of a person within a social network, i.e., a quantification of the importance of a particular person for the network (see Borgatti et al., 2013). Also, it would be very interesting to assess social networks not only from the perspective of the patients themselves, but also from the perspectives of significant others: Do others consistently report smaller and less diverse networks of BPD patients?

We assessed social functioning by means of a self-report questionnaire. Usually, as an outcome-measure, studies on psychotherapy use the GAF (see Jørgensen et al., 2013; Piersma & Boes, 1997; Salvi et al., 2005), which is a well-established instrument where clinical experts rate social functioning of participants in one global score. Yet, current data of study I suggest, that the GAF mainly indicates occupation-related social functioning, as the only significant correlation of the GAF was with the subscale of the SFS that indicates employment. Therefore, findings of study I agree with Grootenboer et al. (2012) who recommend to either use other scales instead or split the GAF up into distinct sub domains, like the MIRECC version of the GAF (Niv, Cohen, Sullivan, & Young, 2007) does. The authors reported poor interrater-reliability as well as poor discriminant validity of the GAF. In the

current study I, the GAF is not associated to any aspect of social functioning except from occupation/employment, nor is it linked to constitution of social networks, loneliness, or rejection sensitivity. The GAF's missing link to interpersonal communication in addition to the finding that interpersonal communication is an important aspect in the emergence of loneliness in BPD, furthermore points out that the GAF is not a sufficient indicator of social functioning for our purposes (although there are of course contexts in which use of the GAF is highly reasonable). Nonetheless, the trend level significant relationship between the number of people in the social network and social functioning in the area of employment suggests that occupation indeed is a relevant part of social functioning. Yet, it is far from being the only relevant part. While many subscales of the SFS are linked to rejection sensitivity, neither the GAF score nor the equivalent SFS subscale occupation/employment is. Rejection sensitivity being a highly relevant characteristic of BPD patients, argues for less significant impact of occupation based functioning. For future studies it would hence be desirable to be able to access a measure of social functioning that differentiates precisely between domains of functioning. Although the SFS was developed for schizophrenia in the first place, its use seems to be a first step in the right direction since present data show that subscales of the SFS distinct from employment status are linked to various aspects in this area relevant for BPD – like rejection sensitivity, loneliness and number of people in the social network – thus differentiating more accurately. Accurate differentiation is important in the area of social functioning, since regarding impairment of social functioning in BPD further knowledge is necessary for being able to impose specific therapeutic interventions. However, since the SFS relies solely on self-ratings, thus providing subjective measures of functioning, a similarly detailed assessment method would be desirable that is more objective, e.g., other-ratings by multiple observers who are blind to the diagnostic status of the participants.

Although we found significantly higher loneliness, and lower size and diversity of social networks, as well as lower social functioning in every domain measured in the BPD group compared to HCs, nonetheless, none of these concepts were linked to borderline symptom severity. Unlike a longitudinal study, which found that social functioning is strongly linked to BPD patients' symptomatic status (Zanarini et al., 2005), we could not verify this relation through correlational analyses of the present data, although we measured borderline symptom severity through self- as well as clinician-administered ratings. Since there was a significant high correlation between both measures of borderline symptom severity, which argues for satisfactory convergent validity, and nonetheless no links to social measures could be found, one might assume that this suggests a qualitative shift in the area of social functioning through diagnosis, without any linear relationship within the patients group.

5.2.3 Methods of Study II and III: Experimental Paradigm and Economic Game

The MVGIP used in studies II and III of this thesis to enable manipulation of rejection and acceptance, was designed to ensure mundane realism and experimental standardization: It allows for simulation of a real social environment while simultaneously ensuring high experimental control of even subtle social signals that could never be held constant in an interaction situation with real individuals, not even with trained confederates. Nonetheless, it is important to discuss whether the MVGIP proved suitable to address our research questions.

Both the degree of arousal with which healthy participants reacted to rejection, and updating of expectations of acceptance after acceptance feedback increased with strength of the previously reported affiliation towards those rejecters (study II). Hence, the become acquainted phase of the MVGIP, which differentiates this paradigm from prominent others (like Cyberball or O-Cam) proves important for certain investigations. Moreover, the spatial presence which subjects experience in the virtual environment (see study II) shows that it is indeed perceived as rather real, as does the finding, that healthy subjects prefer meeting the virtual others in real life when they have been accepted by them than when they have been rejected (study II). Behavioral opportunities in phase I of the MVGIP are rather restricted, since facial emotional expressions were the only variable parameter together with answers to the questions. The latter were not part of the analyses of study III, although it would no doubt be very interesting to investigate potential differences between BPD patients and HCs in verbal behavior. Future studies should examine whether BPD patients differ from HCs in the social signals they send via verbal communication. All the more, considering that social functioning in the domain of interpersonal communication has proven to be particularly and most strongly associated with loneliness in BPD in study I of this thesis. Augmenting the MVGIP with further opportunities to behave in the interaction situation in phase I could provide interesting information on how certain behaviors might influence subsequent expectations of acceptance. With regard to phase III of the MVGIP, the feedback phase, one can argue that it is not as realistic as is the become acquainted phase, since it happens outside of the virtual group meeting. Hence, future adaptations of the MVGIP could devolve from explicit acceptance or rejection feedback in form of presentation of slides after the social encounter to integrate feedback into the VR social encounter: Be it e.g., through avatars ignoring the subject while he/she speaks (which would be similar to the O-Cam paradigm, Goodacre & Zadro, 2010, but extending it to a larger group experience with previous development of affiliation) or through critical facial expressions and rejecting verbal statements versus friendly facial expressions and verbal statements signaling acceptance (see Heerdink et al., 2015). This could be done either in a between-subjects design with participants randomly receiving either positive or negative feedback by all members of the virtual group or in a within-subject design with half of the ava-

tars signaling acceptance and the other half signaling rejection through their verbal behavior and mimics.

Taken together, the MVGIP possesses some advantages tailored to important research questions, therefore being of value in addition to other paradigms such as Cyberball (see also 1.4.1). However, Cyberball is very well established in a huge variety of empirical investigations, while the MVGIP is much less intensively studied, frankly only in the herein reported studies so far. Therefore, future studies using the MVGIP or comparable paradigms are necessary to really draw conclusions from different findings between different paradigms. As became evident so far, the MVGIP is a paradigm that can be adapted in various ways, thus offering the possibility to study a variety of social processes. Moreover, the experimental setup can be easily modified to study influences of social acceptance and rejection not only on investment behavior in a trust game, but also on many other potentially altered social processes by replacing the trust game that we used subsequent to the MVGIP in study III of this thesis, with any other behavioral measure. E.g., it would be interesting to use other economic exchange games like the dictator game or the prisoner's dilemma (see 1.2.2 for details) to gain a deeper understanding of cooperative behavior after social acceptance and rejection, or even completely different measures to find out how e.g., risk taking behavior or decision making are influenced by preceding social feedback and whether this potential influence differs between BPD patients and HCs.

The trust game, used in study III to assess cooperative and aggressive behavior, just as the virtual group meeting of the MVGIP, also ensures high experimental control of even subtle social signals, which cannot be achieved in encounters between real people. Nonetheless, whether preprogrammed or not, social interaction is always a dynamic sequence of multiple actions, each of which influences future anticipations of the partner's behavior and future adaptations of the own behavior during the course of the exchange. Therefore, it is difficult to disentangle effects of the different interpersonal experiences, e.g., the effects of the trustee's repayment behavior and the provocations by the second co-player in the trust game. Moreover, knowledge is missing about how long such effects last, bearing the opportunity of a trustee's cooperation in early rounds of the trust game to superimpose later interaction behavior. Hence, in future studies exactly these questions should be addressed by varying single characteristics of an interaction in separate partial studies. Having done this, the insight into the processes at hand can be used to design further studies that again combine different aspects of interaction behavior. By doing so, it would be interesting to enrich the environment of the trust game, such that it becomes equally ecologically valid as the MVGIP, since data on credibility of the cover story (see study III) show that less participants believed that there were real other co-players in the trust game than in the social encounter of the MVGIP.

5.3 Conclusions and Practical Implications

Studies I-III of the present thesis point to huge social difficulties in BPD on emotional, cognitive, and behavioral levels, rendering consolidation of positive interpersonal relations difficult: BPD patients live in smaller and less diverse social networks than healthy individuals, are restricted in social functioning across various domains of social life, and exhibit thereto related severe feelings of loneliness. They expect less social acceptance by interaction partners than healthy individuals and do not adapt these reduced expectations towards actual positive feedback by others, which could be due to mistrust, as could be reduced cooperative behavior towards cooperating interaction partners that is present only after having received such unexpected positive feedback which might trigger such mistrust.

Exaggerated negative emotional responses to social acceptance (as we found in anger in study III) and alterations in subsequent cooperation (as we found in the trust game in study III) could potentially be explained by repeated experiences of a discrepancy between heightened needs of closeness to social partners (Bateman & Fonagy, 2013; Fonagy, 1998; Hill et al., 2008) and reduced expectations towards others' expressed social affiliation (study III of this thesis). BPD patients do not expect positive interactions, and when they occur do not expect them to last or to occur again in future social interactions (study III), nor do they seem to gain positive emotional experiences or feelings of social connection from such encounters (De Panfilis et al., 2015). This altered processing of positive social interactions might lead to subsequent alterations in behavior via mistrust (like in the trust game of study III), which in turn could lead to actual rejection by means of self-fulfilling prophecies (Downey et al., 1998). From this pattern, vicious circles might evolve, since after actual rejection, BPD patients find their negative expectations confirmed. Slow return to baseline as one important aspect of BPD-specific emotional dysregulation (Linehan, 1993; Reitz, Krause-Utz, Pogatzki-Zahn, & Ebner-Priemer, 2012) could be one mechanism to contribute to the explanation of the observed spreading of interpersonal experiences (i.e., from the MVGIP to completely different interaction partners in the trust game). Future research should further examine these complex processes, that all point to tremendous difficulties in processing of positive social cues.

The present findings lay path for improvement of psychotherapeutic interventions, like e.g., interventions to reduce loneliness (for a review see Masi et al., 2011). According to social feedback processing, more detailed knowledge on updating mechanisms could provide useful suggestions for therapeutically working with BPD patients' negative expectations by trying to "provide a safe interpersonal context in which the personality-disordered patient's perceptions and expectations from self an others can be re-evaluated" (Clarkin, 2006, p. 1). As the present results suggest, it is particularly important to draw on processing of positive social interaction. Therefore, the to-be-provided interpersonal context might not only have to be safe, but also especially trustworthy. Comprehen-

sively, a training of positive social interaction behavior and accepting praise would be desirable to prevent interference by generalizing experiences of social encounters to subsequent independent interaction situations and thus avoid development of vicious circles as described above. Interventions that enable the formation of feelings of social connectedness or belonging with others as well as the development of trust are needed. As a promising encouragement I want to mention that Bevington, Fuggle, and Fonagy (2015) postulate "not only that evolution has prepared our brains for psychological therapy, to learn about ourselves and the social world from figures we are attached to and trust, but also that therapist behaviors might foster such trust" (Bevington et al., 2015, p. 160).

All in all, this thesis argues that problems in developing and maintaining positive social relationships – as reflected in smaller and less diverse social networks, impaired social functioning, and remarkably increased loneliness; potentially through altered processing of positive social cues of acceptance and cooperation – together with an extremely increased wish for closeness to others might be a fatal combination at the core of BPD. Deeper understanding of underlying processes is necessary to draw explicit conclusions and designing effective psychotherapy. Nonetheless, this thesis provides several important starting points for advanced development of psychotherapeutic interventions, while simultaneously disclosing future directions for extended research that will hopefully gain further insight into mechanisms explaining BPD patients' tremendous difficulties in social relations that are yet so crucial for living a fulfilling life as the inherently social beings we all are.

SUMMARY

Borderline personality disorder is characterized by severe alterations in interpersonal relations that are described as a pattern of unstable and intense interpersonal relationships and frantic efforts to avoid real or imagined abandonment. According to important theoretical frameworks, problems in interpersonal relationships can be both cause and consequence of borderline personality disorder. The overall aim of the present thesis is to gain deeper insight into important aspects of interpersonal relations that might be especially altered in borderline personality disorder: Loneliness, rejection, and belonging. These three concepts are interrelated, since social rejection threatens the fundamental need to belong, and hence can contribute to opposite feelings, like loneliness.

Loneliness, i.e., the subjective feeling of being socially isolated, has been shown to cause fundamental burden to social interaction, health, and well-being. Although generally it has been linked to aspects of social networks and social functioning that are known to be altered in patients suffering from borderline personality disorder, empirical data focusing specifically on the role that loneliness plays in these patients' lives was lacking so far. Hence, in study I, we started to close this gap, confirming that borderline personality disorder patients report remarkably increased levels of loneliness. Moreover, they report smaller and less diverse social networks, as well as lower social functioning across all assessed domains of social skills and behaviors, when compared to healthy individuals. In addition to factors that are related to increased loneliness in general (i.e., small network size and low functioning in the domains of social engagement and prosocial behavior), we identified aspects with particular relevance for loneliness in borderline personality disorder (i.e., diversity of social networks and reduced interpersonal communication). Since after controlling for effects of social network features and social functioning, loneliness scores were still increased, further factors contributing to the painful experience of loneliness in borderline personality disorder need to be investigated in future research. Thus, study I is only a first step in understanding loneliness in borderline personality disorder, nonetheless providing important starting points to determine an approach that might improve these persistent negative social feelings in this clinical sample.

After investigating loneliness as an affective subcomponent of social relatedness in study I, in study II and III we were interested in the effects of social rejection and acceptance on social cognition and interpersonal behavior. Since the paradigm used to induce social rejection and acceptance has been shown to be crucial, we developed a new paradigm specifically tailored to our research needs: The Mannheim Virtual Group Interaction Paradigm.

Along with testing the ecological validity of the Mannheim Virtual Group Interaction Paradigm, in study II, we were particularly interested in whether the degree of affiliation with social partners would affect the degree and the adjustment of expectations of social acceptance and the adjustment

of arousal over the course of repeated experiences of acceptance or rejection. Our findings revealed that expectations change very quickly after experiences of acceptance or rejection. Furthermore, expectations were influenced by affiliation particularly in case of positive social feedback of acceptance, whereas the adjustment of expectations after rejection was not affected by the degree of affiliation. Contrarily, subjects with higher affiliation responded to social rejection with a stronger increase in psychophysiological arousal, particularly during rejection feedback. This supports the idea that becoming part of a group and avoiding rejection constitute distinct domains of affiliation. Moreover, our findings emphasize the need to use social rejection paradigms that include a phase during which participants have the opportunity to create bonds with future executors of rejection or acceptance. Hence, the use of a virtual approach which allows people to become acquainted seems to be a promising approach, combining mundane realism with high experimental control.

In study III, we extended our investigations of study II to a comparison between healthy individuals and patients with borderline personality disorder. Our findings support the assumption that expectations of social acceptance are reduced in borderline personality disorder. Most importantly, they clearly reveal alterations particularly in case of positive social interaction: Patients failed to adjust their expectations to positive feedback, and instead responded with anger and behaved less cooperative towards cooperating interaction partners in a different social context after feedback of social acceptance. These findings suggest deficits in the appraisal and integration of signals of social acceptance in borderline personality disorder. Alterations during the processing of positive social cues disadvantageously affect social encounters in subsequent independent social situations, i.e., interpersonal problems may arise if an interaction partner behaves fair, and the patients were previously confronted with social acceptance of others that violated their expectations. Hence, study III exposes that patients with borderline personality disorder do not only fear and avoid rejection, but also exhibit non-negligible difficulties with becoming part of a dyad or group and developing a sense of belonging.

Taken together, the present thesis emphasizes tremendous alterations in interpersonal relations in borderline personality disorder throughout emotional experiencing (heightened loneliness), cognitive processing (reduced expectations of social acceptance and a failure to update these expectations according to positive social information), and social interaction (reduced cooperative behavior towards a cooperating interaction partner after an independent social encounter that provided feedback of social acceptance). Increased feelings of loneliness as well as the mismatch of expectations and experiences of social acceptance together with resulting consequences for interpersonal relations should be targeted in future research and hereafter in the development of psychotherapeutic interventions.

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