

Self–other distinction and borderline personality disorder features:

Evidence for egocentric and altercentric bias in a self–other facial morphing task

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#### Author Note

We are grateful to all our participants, and to Amber Perdieu and Nil Anarat for their help in  
the data collection.

P.L. has been involved in the development, training and dissemination of mentalization based  
treatments.

C.D.M. is supported by a PhD fellowship from the Research Foundation – Flanders (FWO)  
[Project 11B9718N]. A.F.’s time was supported by a “European Research Council  
Consolidator Award” [ERC- 2018-COG-818070 for the project METABODY].

Partial findings have been presented in a symposium at the 2018 Conference of the European  
Society for the Study of Personality Disorders (ESSPD) in Sitges (Spain), and in a poster at  
the 2018 workshop “From self-knowledge to knowing others” in Brussels (Belgium).

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### **Abstract**

Self–other distinction (SOD) refers to the ability to distinguish one’s own body, actions, and mental representations from those of others. Problems with SOD are considered to be a key feature of borderline personality disorder (BPD). However, empirical studies on SOD in BPD are scarce. Here, we present a study providing preliminary support for the usefulness and validity of a self–other facial morphing task to capture the capacity for SOD in a sample of nonclinical participants high ( $n = 30$ ) and low ( $n = 32$ ) in BPD features. Participants had to watch a video sequence in which their own face was gradually morphed into the face of an unfamiliar other (self-to-other) or vice versa (other-to-self), requiring them to indicate at which point they judged the morph to look more like the target face than the starting face. Consistent with predictions, results showed that participants in the high BPD group judged the morph to look like themselves for longer in the self-to-other direction (suggestive of egocentric bias), but only with a relatively more attractive target face. In the other-to-self direction, the high BPD group had more difficulty recognizing their own face (i.e., an altercentric bias), but this time only with the relatively less attractive face. Further research is needed to replicate these findings in clinical samples, but overall they suggest that the current task might be suited to investigate SOD problems in BPD.

**Keywords:** self–other distinction; borderline personality disorder; self–other facial morphing task; self–other face discrimination; mentalizing

The capacity to differentiate one’s own body, actions, and mental states from those of others is crucial in order to connect with others while maintaining a stable sense of self (Bird & Viding, 2014; Lamm, Bukowski, & Silani, 2016; Tsakiris, 2017). In the absence of this capacity for self–other distinction (SOD), self–other confusion may arise. The experience of others may be confused as originating from the self (i.e., altercentric bias) or one may assume to understand the mind of the other based on one’s own experience (i.e., egocentric bias) (Hoffmann et al., 2016; Silani, Lamm, Ruff, & Singer, 2013).

Problems with SOD have been assumed to play a central role in several types of psychopathology, in particular borderline personality disorder (BPD). BPD is a prevalent and pervasive psychiatric condition characterized by instability in affect, identity, and relationships (American Psychiatric Association, 2013). Several theoretical approaches assume that problems with SOD are central in BPD (Bender & Skodol, 2007; Fuchs, 2007; Jorgensen, 2010; Luyten & Blatt, 2013; Neustadter, 2019). From an object-relational perspective, for instance, these problems are assumed to reflect severe impairments in the development of representations of self and others, leading to a proclivity for identity diffusion (Kernberg, 2006). From a mentalizing perspective, problems with SOD are assumed to stem from difficulties in mentalizing, that is, the ability to reflect upon the internal mental states of self and others (Fonagy & Luyten, 2009; Luyten, Campbell, & Fonagy, 2019), which is for an important part rooted in bodily processes, that is, in the experience of one’s own bodily states and of how others impact these experiences (i.e. embodied mentalizing) (Besharati et al., 2016; Fotopoulou & Tsakiris, 2017; Neustadter, 2019).

Regardless of the theoretical approach, SOD impairments in BPD are assumed to be expressed in two directions. On the one hand, individuals with BPD are assumed to experience emotional contagion, in that they tend to conflate others’ feelings with their own (Dinsdale & Crespi, 2013; Niedtfeld, 2017) (“altercentric bias”). On the other hand, BPD

patients are also assumed to have difficulty in taking the perspective of others (Colle et al., 2018; Haas & Miller, 2015), suggesting difficulties in inhibiting the “self” when representing the “other” (i.e., egocentric bias).

To date, empirical studies on SOD in BPD are scarce. Studies using self-report questionnaires have typically found that BPD patients have more difficulty than controls in maintaining self–other boundaries (Beeney, Hallquist, Ellison, & Levy, 2016; Beeney et al., 2015). Furthermore, their self-concept has been found to be more fragmented and less consistent over time than that of controls (Beeney et al., 2016; Evans et al., 2015; Vater et al., 2015). However, these studies do not directly address problems with SOD, but rather experiences of fragmentation and a lack of consistency in the representation of the self. Two studies using the Rubber Hand Illusion (RHI) (Bekrater-Bodmann et al., 2016; Neustadter, Fineberg, Leavitt, Carr, & Corlett, 2019) have addressed SOD in BPD more directly. These studies found that BPD patients are more prone to the RHI, which can be interpreted as reflecting a greater tendency to incorporate the non-self into the self. However, the RHI task focuses only on the potential of BPD patients to confuse self and other based on one part of the body (the hand), which may lack ecological validity. More importantly, the RHI is not primarily a SOD task (as the “other” is typically merely a rubber hand) but a test of multisensory integration and body ownership.

The present study builds on previous studies in this area by investigating SOD in relation to BPD using an experimental task that may have greater ecological validity. Specifically, this is the first study to use a self–other facial morphing task, which requires participants to discriminate their own face from an unfamiliar face (Keenan, Freund, Hamilton, Ganis, & Pascual-Leone, 2000), in relation to BPD features. In this task, participants watch a video sequence in which a picture of their own face gradually transforms into the face of an unfamiliar other (self-to-other direction) or vice versa (other-to-self

direction), and indicate at which point they judge the morph to look more like the target face than the starting face. As self–other confusion in BPD is assumed to arise particularly in close social interactions, in which BPD patients are very focused on facial cues, this self–other facial discrimination task may be particularly relevant to capture SOD problems in BPD.

The self–other facial morphing task has often been used in studies in nonclinical adults to investigate SOD and its neural underpinnings, but it has not yet been used in research on BPD. In nonclinical samples, participants typically stop recognizing the self slightly before the 50% self and 50% other point (i.e., the objective “switch” point between self and other) in the self-to-other direction, while in the other-to-self direction participants tend to recognize the self slightly after the 50% self/other point (Heinisch, Dinse, Tegenthoff, Juckel, & Brune, 2011; Heinisch, Kruger, & Brune, 2012; Tajadura-Jimenez, Grehl, & Tsakiris, 2012; Tsakiris, 2008).

Although this task has not yet been used in BPD patients, a few studies have used it in other psychiatric conditions, such as schizophrenia (Heinisch, Wiens, Grundl, Juckel, & Brune, 2013) and anorexia nervosa (Hirotsu et al., 2016), reporting an altercentric bias (i.e., judging self–other morphs to look more like “other” than “self”). Conversely, in a sample of undergraduate students, vulnerable narcissism was related to egocentric bias (i.e., judging self–other morphs to look more like “self” than “other”) in self–other face discrimination (Karan, Diamond, Grinband, & Fertuck, 2019). These studies demonstrate the potential of a self–other facial morphing task to investigate problems with SOD in relation to psychopathology and disorders that are characterized by severe impairments in SOD, such as BPD.

### **The present study**

Based on the literature reviewed above, this study has two aims. First, we expected individuals high in BPD features to show weaker SOD than individuals low in BPD features on a self–other facial morphing task. Specifically, we hypothesized that the high-BPD group would show both egocentric and altercentric bias depending on task demands, that is, depending on whether participants had to switch their perspective from “self” to “other” or from “other” to “self”, in line with recent conceptualizations of SOD as being achieved through the ability to switch between self and other representations (Quesque & Brass, 2019; Sowden & Shah, 2014). In the self-to-other morphing sequence, we expected that the high-BPD group would have more difficulty recognizing the “other”, consistent with an egocentric bias (i.e., keep seeing the “self” despite visual changes), and more difficulty recognizing the “self” in the other-to-self morphing direction, reflecting an altercentric bias (i.e., keep seeing the “other” despite visual changes). Furthermore, we included two unfamiliar faces in the task that differed in their relative attractiveness, to account for the alternative hypothesis that the general valence of the stimuli, rather than the task demands (i.e., the morphing direction), would differentiate egocentric from altercentric bias in the high-BPD group. Indeed, previous studies have found an egocentric bias (i.e., judging the morphs to look more like “self” in both directions of morphing) in self–other facial morphing tasks with a more attractive relative to a less attractive face (Epley & Whitchurch, 2008; Panagiotopoulou, Crucianelli, Lemma, & Fotopoulou, 2020). We expected that the type of bias would be determined by the direction of morphing (i.e., egocentric bias in self-to-other morphs and altercentric bias in other-to-self morphs), reflecting SOD impairment, rather than the attractiveness of the face of the other (i.e., egocentric bias with attractive face in both morphing directions, and altercentric bias with less attractive face in both directions), which would reflect a more general tendency to self-identify with more positive stimuli.

Second, it can be expected that problems with SOD are related to a history of early adversity. Indeed, several theories have related problems with SOD to a lack of marked and contingent mirroring of the child’s experience in early interactions (de Bézenac, Swindells, & Corcoran, 2018; Fotopoulou & Tsakiris, 2017; Kaertner, Keller, Kleis, & Lamm, 2004). When the caregiver is able to respond with *contingent* affect displays in response to the infant’s subjective experience, in such a way that *marks* that the parent is displaying the infant’s rather than their own experience, the infant experiences the self as related to, but also as distinct from the attachment figure (Shai & Fonagy, 2014). In this way, the caregiver provides high-but-imperfectly contingent responses to the infant’s actions, which provide a crucial context for the infant to learn to differentiate the self from the social environment (Beebe et al., 2016). Infants have been shown to be able to detect varying degrees of action-response contingency and learn to differentiate between the perfectly contingent perceptual outcomes of their own actions (“self”) and the high-but-imperfectly contingent social contingencies provided by caregiver mirroring (“other”) (Rochat, 2001). For individuals with BPD, such high-but-imperfect degrees of social contingency may not have been reliably available, which may, potentially in interaction with innate biological vulnerabilities (Gunderson & Lyons-Ruth, 2008), hamper the development of SOD (Koós & Gergely, 2001). Indeed, individuals with BPD typically show high levels of attachment insecurity (Agrawal, Gunderson, Holmes, & Lyons-Ruth, 2004) and childhood trauma (Ball & Links, 2009), pointing towards disrupted caregiver-infant attunement.

Given that attachment insecurity and childhood trauma may play a role in the etiology of SOD impairments, we hypothesize that attachment insecurity and trauma will relate to weaker performance in the self-other facial morphing tasks in both directions, in terms of needing the morph to contain more features of the target face before recognizing the target. Finally, we expect a self-report measure of internally-based mentalizing impairments as

assessed with the reflective functioning questionnaire (RFQ) to relate to weaker performance on the self-other facial morphing task. Although the SOD task primarily taps into externally-based mentalizing (and the ability to distinguish external features of self and others in particular), externally-based mentalizing is generally considered to be a lower-level precursor of, and/or to be modulated by, the capacity for internally-based mentalizing (Fotopoulou & Tsakiris, 2017; Quesque & Brass, 2019). Consistent with this assumption, studies have typically reported small to medium-size correlations between measures assessing externally-based and internally-based mentalizing (Luyten, Fonagy, Lowyck, & Vermote, 2012).

## Methods

### Participants and procedures

The Maclean Screening Instrument for Borderline Personality Disorder (MSI-BPD) (Zanarini et al., 2003) was administered in a large sample ( $n = 397$ ; 90% female) of first-year psychology students at a large university in XXX in exchange for course credits. Female students scoring above the clinical cut-off for BPD (scores  $>6$  out of 10) (high-BPD group) and those with low scores (0 or 1 out of 10) (low-BPD group) were sent an invitation via e-mail to participate in the follow-up study. Only female students were included because BPD is predominantly diagnosed in women (Sansone & Sansone, 2011; Skodol & Bender, 2003). A total of  $n = 62$  individuals participated in the study, 32 in the low-BPD group and 30 in the high-BPD group. The sample size was determined by an a priori power analysis ( $n = 58$  needed to detect a between-factor effect (medium to large size,  $f = 0.3$ ) in repeated-measures ANOVA with a power of 0.8, calculated using Gpower 3.1 (Faul, Erdfelder, Lang, & Buchner, 2007)). The morphing study involved two 1-hour sessions that were scheduled at least one day and at most one week apart in a research room at the university. In the first session, a picture of the participant's face was taken with a 10 megapixel camera (Panasonic

HC-V180) using a standard set-up so that distance and lighting were standardized. Next, they were asked to complete a set of questionnaires (see below) on a laptop using Qualtrics (Provo, UT). Between the first and second sessions, the participant's picture was used to create the self–other facial morphing task, in which the picture of the participant's face is morphed with two unfamiliar faces (see below). In the second session, participants took part in the self–other morphing task. The study was approved by the Social and Societal Ethics Committee of the University of XXX. Written informed consent was obtained before the start of the experiment and all participants received course credits for their participation.

## Measures

**Maclean Screening Inventory for BPD (MSI-BPD).** The MSI-BPD (Zanarini et al., 2003) comprises 10 yes-or-no items based on DSM-IV BPD criteria. The total score represents the number of items answered affirmatively. A score of 7 or higher was found to be the best cut-off in providing both good sensitivity (0.81) and specificity (0.85) in separating individuals with and without BPD, and the diagnostic efficiency was even better for individuals 25 years of age or younger (Zanarini et al., 2003). An initial validation study found high levels of agreement between the MSI-BPD and clinical interview measures of BPD (Zanarini et al., 2003). However, later studies in more heterogeneous samples reported only poor to moderate agreement between the BPD-BPD and interview-based BPD diagnosis (Chanen et al., 2008; Noblin, Venta, & Sharp, 2013; Patel, Sharp, & Fonagy, 2011). Several studies have replicated the one-factor structure of the MSI-BPD (Andre, Verschuere, & Lobbestael, 2015; Gardner & Qualter, 2009; Verschuere & Tibboel, 2011). The internal consistency of the MSI-BPD was excellent in the current sample ( $\alpha = 0.92$ ).

**Experiences in Close Relationships–Revised (ECR-R).** The ECR-R is a 36-item self-report questionnaire measuring attachment insecurity (ECR-R) (Fraley, Waller, &

Brennan, 2000). The ECR-R has two subscales that measure attachment-related anxiety and avoidance in intimate relationships in general, with 18 items each, answered on a 7-point Likert scale. The two-factor structure of the ECR-R was replicated (Kooiman, Klaassens, Lugt, & Kamperman, 2013; Sibley, Fischer, & Liu, 2005). The reliability of the ECR-R was excellent in the current study with Cronbach's alpha coefficients of 0.94 for the anxiety and 0.96 for the avoidance scale (Kooiman et al., 2013).

**Reflective Functioning Questionnaire (RFQ).** The RFQ is a self-report measure of general mentalizing (i.e., reflective functioning) capacities. It comprises eight items answered on a Likert scale that ranges from 1 (*I do not agree at all*) to 6 (*I very much agree*). The Uncertainty scale (RFQ-U) contains six items that are rescored so that high scores reflect extreme uncertainty about mental states, assumed to reflect hypomentalizing. The Certainty scale (RFQ-C) also contains six items that are rescored, so that higher scores reflect more certainty about mental states, with very high scores reflecting excessive mentalizing or hypermentalizing. The RFQ-U scale has been found to relate to other measures assessing impairments in mentalizing and to measures of personality pathology, while the RFQ-C has been shown to relate to eating disorder symptoms (Badoud et al., 2015; Fonagy et al., 2016). The internal consistency of the RFQ was found to be good ( $\alpha = 0.77$ ), and the test–retest reliability over 3 weeks was very good ( $r = 0.84$ ) (Fonagy et al., 2016). Cronbach's alpha in the current study was good for the RFQ-C ( $\alpha = 0.77$ ) and moderate for the RFQ-U ( $\alpha = 0.67$ ).

**Childhood Trauma Questionnaire–Short Form (CTQ-SF).** The CTQ-SF (Bernstein et al., 2003) is a 28-item self-report measure that retrospectively assesses the experience of childhood maltreatment with five subscales of five items each: physical abuse (PA), emotional abuse (EA), sexual abuse (SA), physical neglect (PN), and emotional neglect (EN). Only the 25 clinical items were used in the current study, and all items were answered on a 5-

point Likert scale. In this study, we used the CTQ Total scale, which had excellent internal consistency (Cronbach's  $\alpha = 0.885$ ).

**Self–other facial morphing task.** Individually tailored morphing tasks were created in which the participant's own face was morphed with the face of two different unfamiliar faces (Face 1 and Face 2), in accordance with previous studies (Panagiotopoulou et al., 2020; Panagiotopoulou, Filippetti, Tsakiris, & Fotopoulou, 2017; Tsakiris, 2008). Front-view digital photographs of the participants' faces were taken with a neutral facial expression and with their hair tied back and glasses/piercings removed. The pictures were in color and were mirror-transposed and cropped in a square shape above the eyebrows and under the chin. All remaining nonfacial attributes were removed using GNU Image Manipulation Program (GIMP). Pictures of two unknown, female, age-matched faces were adapted in the same way. These two pictures have been validated in previous research as differing significantly in attractiveness, with Face 1 rated as more attractive and Face 2 as less attractive by a group of  $n = 65$  raters, while they were rated equal on dominance, distinctiveness, and trustworthiness (Panagiotopoulou et al., 2020).

The picture of the participant's own face and the two unfamiliar faces (Face 1 and Face 2) were morphed using a computerized morphing procedure (Abrasoft Fantamorph, [www.fantamorph.com](http://www.fantamorph.com)) in 1% steps, resulting in 100 frames with gradual blending of the facial features of “self” (that is, the participant's own face) and “other” (that is, one of the two unfamiliar faces). These 100 frames were presented in a video moving at three frames per second (i.e., each video lasted 33.3 seconds). Four tasks per participant were created, two for each unfamiliar face (Face 1 and Face 2) and in two directions, either starting from the self-face and gradually morphing into Face 1 or Face 2 (the “self-to-other” morphing direction) or starting from Face 1 or 2 and gradually morphing into the participants' own face (the “other-to-self” direction). For the tasks in the self-to-other direction of morphing, participants were

asked to press a key and stop the video when they judged the face to look more like “other” than like “self”. For the other-to-self direction of morphing, the participants responded when they judged the face to look more like “self” than like “other” (see Figure 1).

The task was presented using Presentation® software (Version 18.0, Neurobehavioral Systems, Inc., Berkeley, CA, [www.neurobs.com](http://www.neurobs.com)). All instructions were presented on a black computer screen with white letters. Participants completed a practice trial before the experimental task with the two unfamiliar faces and were shown the picture of their own and the unfamiliar faces before the start of the self–other facial morphing tasks. Each morphing video was presented once and the order in which the videos were presented was randomized.

[FIGURE 1 ABOUT HERE]

### **Data analysis**

The group differences in the self–other facial morphing tasks were analyzed within a signal detection framework (DeCarlo, 1998). For every frame in the task, the response was recorded as 0 (= frame judged as looking like the starting face) or 1 (= frame judged as looking like the face the morph is turning into). The data were entered into a mixed-effects logistic regression analysis with 20,000 iterations using the *lme4* package (Bates, Mächler, Bolker, & Walker, 2014) in R (version 3.6). This analysis fits logistic regression curves predicting the odds that the face the morph is turning into is recognized for each of the 100 frames depending on various predictors. Morphing Percentage (0–100%, with 0% being the starting face of the morph and 100% being the target face), Group (low BPD vs. high BPD), Direction (self-to-other vs. other-to-self), and Face (Face 1 vs. Face 2) were entered as fixed predictors, with the latter three being dummy-coded. The goodness of fit was determined with marginal (considering the variance of the fixed effects only) and conditional (taking both fixed and random effects into account)  $R^2$  indices (Nakagawa, Johnson, & Schielzeth, 2017).

First, the random structure of the model was tested using likelihood-ratio tests, with a random intercept for participant ( $\chi^2(1) = 747.38, p < 0.001$ ) and a random slope for percentage per participant ( $\chi^2(2) = 14659, p < 0.001$ ) significantly improving the fit of the model. Then, a mixed-effects logistic regression model including all fixed predictors and interactions was fitted. This full model provided a good fit to the data, but resulted in high levels of multicollinearity (Variance Inflation Factor (VIF)= 60.49 for the four-way interaction), inflated standard errors, and unstable estimates. Because our hypotheses concern the differences in intercepts between groups in the different morphing tasks rather than the differences in slopes, we decided to exclude all interactions with the continuous predictor percentage in our final model (see Table 2). This model explained almost as much variance in the data as the full model (marginal  $R^2 = 0.629$  vs.  $R^2 = 0.666$ ) with low levels of multicollinearity (max. VIF = 3.99). Importantly, the effects of interest (i.e., the main effect of Group and all interactions with Group) remained significant and in the same direction in both models. For ease of interpretation, all odds ratios (OR) smaller than 1 (i.e., indicating a decreased odds of recognizing the target face) were recalculated as 1/OR to express how many times less likely it was for the target face to be recognized. The calculation of odds ratios for the group difference considering all two-way and three-way interactions was done following Jaccard (2001).

Participants completed the task four times, with the two faces and in the two directions (i.e., self-Face 1, Face 1-self, self-Face 2, Face 2-self). In the final  $n = 39$  participants (i.e.,  $n = 21$  high-BPD group,  $n = 18$  low-BPD group), only Face 1 or Face 2 was randomly presented instead of both because we wanted to minimize participant burden. The maximum likelihood estimation method for mixed models we used can effectively deal with missing data in repeated measures (Molenberghs & Kenward, 2007), because maximum likelihood will use the information from other repeated measures for that individual to project what would

happen in the missing measures, while at the same time fully accounting for the uncertainty of this projection in the standard errors (Allison, 2012).

Group differences in the questionnaire data were investigated with independent-sample *t*-tests. Associations between self–other morphing task performance (coded as the percentage of the target face needed to recognize the target) and questionnaire measures were analyzed using Pearson correlations with Bonferroni correction applied ( $\alpha = 0.05/5 = 0.01$  for testing correlations with five questionnaire measures). These analyses were performed with IBM SPSS statistics for Windows, version 26 (IBM Corp., Armonk, N.Y., USA).

## Results

### Sample description

The means and standard deviations, as well as the group differences, of all measures are summarized in Table 1. The two groups did not differ in age. Psychotropic medication use in this sample was very low, with only two participants (3.2% of total sample) of the high-BPD group reporting the use of either a sleep or an antidepressant medication. The high-BPD group scored significantly higher than the low-BPD group on attachment avoidance and anxiety, childhood trauma, and uncertainty about mental states, and significantly lower on certainty about mental states.

[TABLE 1 ABOUT HERE]

### Self–other facial morphing tasks

A main effect of morphing percentage was found, showing that with every 1% increase in features of the target face, the odds of recognizing the target face as self or other increased by 33% (OR = 1.33) (see Table 2). Furthermore, the main effects of Group, Direction, and Face were significant, however, these main effects should be interpreted in light of significant two- and three-way interactions. The high-BPD group was less likely to

recognize the target face in the morphs, however, this depended on the type of face and the direction of the morphing sequence.

[TABLE 2 ABOUT HERE]

Specifically, in the self-to-other morphing task for the more attractive Face 1, the high-BPD group was 7.7 times less likely to recognize the “other” compared with the low-BPD group; the high-BPD group needed the morph to contain about 7% more information from Face 1 before recognizing Face 1 with a probability of 0.5 (53% vs. 46%; see Figure 2a). In the self-to-other morph for Face 2 (i.e., the less attractive face), however, the high-BPD group was only 1.77 times less likely to recognize this face compared with the low-BPD group. Conversely, in the other-to-self morphing task for Face 2, the high-BPD group was 6.6 times less likely to recognize the “self” in Face 2, needing the morph to contain about 6% more self-features before recognizing it with a probability of 0.5 (59% vs. 53%; see Figure 2b). When their own face emerged from Face 1, however, the high-BPD group was only 1.2 times less likely to recognize the “self”.

Taking these findings together, both an egocentric and an altercentric bias was found in the high-BPD group compared with the low-BPD group, and these effects depended both on the direction in which the morph was presented and on the attractiveness of the other face.

[FIGURE 2 ABOUT HERE]

### **Associations with attachment, mentalizing, and childhood trauma**

In both groups and across the two different faces, attachment insecurity, in terms of both attachment anxiety ( $r = 0.28, p = 0.035$ ) and attachment avoidance ( $r = 0.40, p = 0.002$ ), related to seeing the “self” for longer in the self-to-other facial morphing tasks, consistent with an egocentric bias (Table 3). There were no correlations between mentalizing as measured with the RFQ and morphing task performance in the low-BPD group. However, in

the high-BPD group only, certainty about mental states (RFQ-C) related to more egocentric bias for the more attractive face ( $r = 0.48, p = 0.039$ ), while uncertainty about mental states (RFQ-U) related altercentric bias for the less attractive face ( $r = 0.43, p = 0.068$ ). The correlations with childhood trauma were in the hypothesized direction but did not reach significance. After applying Bonferroni correction for multiple testing, only the association between attachment avoidance and self-to-other morphing remained significant.

[TABLE 3 ABOUT HERE]

## Discussion

This study investigated self–other distinction (SOD) in a nonclinical sample of female students high and low in BPD features using a self–other facial morphing task. Overall, participants high in BPD features showed both an altercentric and an egocentric bias compared with those low in BPD features, depending both on the direction of the morphing sequence (i.e., from self-to-other or from other-to-self) and on the attractiveness of the face of the other. To our knowledge, this is the first experimental study demonstrating SOD impairments in young adults with BPD features. Consistent with clinical descriptions, BPD patients typically reported difficulties defining the psychological boundaries between self and others (Beeney et al., 2016; Beeney et al., 2015), and they were found to have more malleable self–other bodily boundaries (Bekrater-Bodmann et al., 2016; Neustadter et al., 2019). However, problems with SOD in BPD had not been shown before in a behavioral task directly requiring participants to distinguish between “self” and “other”.

Moreover, results suggested that individuals with BPD features might have problems in SOD in two directions, that is, (a) in the self-to-other direction of morphing when having to shift their perspective from “self” to “other”, resulting in egocentric bias (i.e., keep seeing “self” despite visual changes), and (b) in the other-to-self direction when having to shift from

“other” to “self”, reflecting altercentric bias (i.e., keep seeing “other” despite visual changes). Although the precise mechanism underlying SOD is still being debated, this type of SOD impairment depending on task demands (i.e., morphing direction) is in line with recent conceptualizations of SOD as being achieved through self–other control, that is, the ability to control or switch between representations of self and other by inhibiting the representation that is not relevant in a given situation (Quesque & Brass, 2019; Sowden & Catmur, 2015; Sowden & Shah, 2014). Previous studies using self–other facial morphing tasks in individuals with schizophrenia (Heinisch et al., 2013), anorexia nervosa (Hirots et al., 2016), and narcissistic features (Karan et al., 2019) did not differentiate between directions but presented the morphs with different percentages of self versus other in a random order. In line with other studies (Heinisch et al., 2011; Tsakiris, 2008), we presented the morphs incrementally from 0% self/other to 100% self/other in two directions separately. This allowed us to disentangle the two types of confusion between self and other (i.e., egocentric vs. altercentric bias) that clinicians working with BPD are all too familiar with.

These effects, however, were dependent on the attractiveness of the other face, which we did not expect. Specifically, the high-BPD group kept seeing the “self” for longer in the self-to-other morphs (i.e., egocentric bias) compared with the low BPD-group, but only in relation to a more attractive other. Conversely, the high-BPD group kept seeing the “other” for longer in the other-to-self morphing sequence, consistent with altercentric bias, but only with a relatively less attractive “other” face. Previous research has found egocentric bias in self–other facial morphing tasks (i.e., judging the morphs to look more like the self in both directions of morphing) with attractive versus nonattractive faces (Epley & Whitchurch, 2008; Panagiotopoulou et al., 2020). Moreover, recent research has shown that others’ attractiveness may lead to positive distortions of the self, with nonclinical individuals identifying with more attractive rather than less attractive others (Panagiotopoulou et al., 2020). Results of the

current study suggest that this type of “self-enhancement” (i.e., wanting to self-identify with positive attributes) may be even stronger in individuals with BPD features. However, the fact that the differential effect of attractiveness in the high-BPD group did not appear equally in both morphing directions suggests that this self-enhancement bias may interact with a more general perceptual SOD impairment in BPD. Furthermore, even though the two faces did not differ significantly in perceived trustworthiness, distinctiveness, and dominance, we cannot ascertain, based on our findings, whether they reflect an effect of solely attractiveness or a more general effect of the valence of stimuli. Additionally, the effect of attractiveness may play a larger role in the specific age and gender group used in the present study, namely, female young adults. Future research should replicate and further explore when and with whom individuals with BPD may show egocentric versus altercentric bias when making SODs.

Finally, both anxious and avoidant attachment were positively related to an egocentric bias in the self-to-other direction of morphing. This is in line with developmental research suggesting that insecure attachment experiences may hamper the development of SOD (Kaertner et al., 2004; Kristen-Antonow, Sodian, Perst, & Licata, 2015). Furthermore, an association between attachment and SOD has been found in previous investigations with self–other facial morphing tasks in adults (Colonnello, Chen, Panksepp, & Heinrichs, 2013; Martini, Bufalari, Stazi, & Aglioti, 2015). Contrary to our expectations, no significant correlation was found between SOD task performance and childhood traumatic experiences; however, this may be due to the fact that the levels of trauma were relatively low in this sample (e.g., compared with the clinical and nonclinical sample means in Thombs, Bernstein, Lobbestael, and Arntz (2009)). Furthermore, impairments in internally-based mentalizing as measured with the RFQ did not correlate with task performance in the total sample. However, in the high-BPD group, certainty about mental states (RFQ-Certainty scale) related to more

egocentric bias for the more attractive face, and uncertainty about mental states (RFQ-Uncertainty scale) related to higher levels of altercentric bias for the unattractive face. These findings mirror the group differences found in the main analysis, suggesting that individuals high in BPD features exhibit both egocentric and altercentric bias, but that the type of bias that is expressed may be related to their specific mentalizing profile (i.e. whether there show deficits in terms of certainty or uncertainty about mental states of self and others). Further research in this area is needed.

Of note, the self–other facial morphing task used in this study taps into perceptual SOD, that is, the capacity to identify one’s own body (here, one’s own face) and to distinguish it from others (Quesque & Brass, 2019). Impairments in this capacity may lead to inappropriate personal distress in response to the observation of others’ embodied experience (i.e., altercentric bias) as well as interference of one’s own “embodied” mental state with the understanding of others’ physical experiences (i.e., egocentric bias) (Lamm et al., 2016). The weaker perceptual SOD we found in individuals high in BPD features may thus relate to deficits in embodied mentalizing, that is, the capacity to represent one’s own and others’ bodily states (Fotopoulou & Tsakiris, 2017). Impaired mental-state SOD, that is, the ability to distinguish the mental states of self and others, has been frequently noted in BPD (Beeney et al., 2016; Colle et al., 2018; Luyten, Campbell, Allison, & Fonagy, 2020), and our results suggest that SOD impairment in BPD may extend to perceptual SOD as well, in line with previous findings using the RHI (Bekrater-Bodmann et al., 2016; Neustadter et al., 2019). Although perceptual SOD and mental-state SOD should not be equated, evidence shows that they may be related (Krol, Theriault, Olson, Raz, & Bartz, 2019; Paladino, Mazzurega, Pavani, & Schubert, 2010) and that SOD may operate in a domain-general rather than specific manner (Quesque & Brass, 2019). Nonetheless, the findings from the present study cannot simply be generalized to other domains of SOD.

The egocentric bias found in the self–other facial morphing task for the attractive face in the self-to-other direction shows that individuals high in BPD features need more visual information on an attractive other face before they are able to perceptually discriminate it from their self-image. This type of egocentric bias in self–other face discrimination has recently been associated with vulnerable narcissism (Karan et al., 2019), which is often present in BPD (Euler et al., 2018). A similar egocentric bias has been found in mental-state SOD as well, in terms of impaired perspective-taking in BPD, that is, difficulty representing others’ mental states in situations where this requires the inhibition of one’s own perspective (Colle et al., 2018; Haas & Miller, 2015; Harari, Shamay-Tsoory, Ravid, & Levkovitz, 2010). The egocentric bias found in the present study can also be interpreted as difficulty in establishing the boundary of the self in relation to an attractive other. Indeed, clinically, BPD patients are noted to have difficulty in treating others as being separate from the self (Bender & Skodol, 2007; Fuchs, 2007).

The altercentric bias found in the high-BPD group corresponds with findings from other psychiatric populations, such as patients with schizophrenia and anorexia nervosa (Heinisch et al., 2013; Hirot et al., 2016), and may reflect the profound identity disturbance associated with BPD (Jorgensen, 2009; Sollberger et al., 2012). Indeed, the high-BPD group needed more visual information on the “self” before recognizing their own face in the other-to-self morphing direction with a less attractive face, suggesting that individuals high in BPD features may find it more difficult to recognize their own face and/or that they are less likely to self-identify with a relatively less attractive face. This difficulty representing the self when confronted with others is also seen in the emotional domain in terms of high levels of emotional contagion in BPD (Dinsdale & Crespi, 2013; Niedtfeld, 2017). Furthermore, an important aspect of identity diffusion in BPD is a tendency to “lose the self” in relationships with others.

Future research could use the self–other facial morphing task to investigate the neural underpinnings of SOD impairment in BPD. Previous studies using the self–other facial morphing task have shown that the inhibition of the right temporoparietal junction (rTPJ), an area that plays an important role in SOD (Quesque & Brass, 2019), resulted in participants judging the morphs to look more like the self (i.e., egocentric bias) (Heinisch et al., 2011; Heinisch et al., 2012), whereas stimulation of the rTPJ resulted in judging the morphs to look more like the other (i.e., altercentric bias) (Payne & Tsakiris, 2017). Findings on rTPJ activation in BPD are mixed: some studies have found hypoactivation of the rTPJ (Haas & Miller, 2015), others have reported hyperactivation (Beeney et al., 2016; Bozzatello et al., 2019), and in one study both hypo- and hyperactivation of the rTPJ was found, depending on the valence of the stimuli (van Schie, Chiu, Rombouts, Heiser, & Elzinga, 2019). The latter finding may tie in with the effect of attractiveness (which may reflect a more general valence effect) on SOD in the present study in individuals high in BPD features. Future research could investigate the role of the rTPJ in SOD impairment in BPD using the self–other facial morphing task.

There are important limitations of the present study to note. First, we investigated a nonclinical sample of female students high and low in BPD features, and screened participants using a self-report questionnaire. Although participants in both groups differed significantly from each other on other measures such as attachment security, mentalizing capacity, and levels of childhood trauma, further research in clinical samples with individuals with more severe BPD features and matched controls is necessary to further validate these findings. Yet, investigating subclinical samples has the advantage of avoiding the effects of complex comorbidities found in clinical BPD samples. Furthermore, subthreshold BPD symptoms have been found to impact psychological functioning in young people, legitimizing a more dimensional approach to BPD (Chanen, Sharp, & Hoffman, 2017; Sharp,

Vanwoerden, & Wall, 2018). The fact that only female students were studied precludes the generalization of these findings to the male population of individuals with BPD features.

Second, based on our findings, we cannot exclude the possibility that the egocentric and altercentric bias we found may be due to more general cognitive biases rather than SOD impairment itself. BPD is associated with neurocognitive impairments in the domains of response inhibition, set-shifting, and decision-making, reflecting cognitive inflexibility (LeGris & van Reekum, 2006; Ruocco, 2005). However, cognitive impairments may have been lower in our subclinical sample than in samples of individuals with more severe BPD. Nonetheless, future studies should include cognitive tests to rule out this alternative explanation. Lastly, we cannot exclude that comorbid psychological conditions, such as, for instance, depression, may have driven the group differences identified in the present study.

Despite these limitations, the present study provides the first experimental demonstration of impairments in SOD in relation to BPD features using a self–other facial morphing task. An impaired ability to distinguish self and other may have a profound impact on an individual’s ability to maintain a coherent sense of self, and to treat others as separate from the self, which may help explain the profound difficulties BPD patients have in terms of self- and interpersonal functioning. If further replicated, the implications of the present study for our understanding of BPD and treatment are important. Providing BPD patients with plenty of opportunity to practice making fine-grained SODs in embodied interactions, for instance in non-verbal therapies (de Bézenac et al., 2018), as well as explicitly mentalizing with the patient about self-other boundaries (Fonagy & Bateman, 2006), may strengthen their capacity for SOD and thus address self- and interpersonal dysfunction in BPD. Although different evidence-based treatments for BPD, such as transference-focused psychotherapy (TFP), dialectical behavior therapy (DBT) and mentalization-based treatment (MBT),

presumably already target BPD patients' capacity for SOD, a more explicit focus on strengthening SOD may enhance the effectiveness of treatment for BPD patients.

### References

- Agrawal, H. R., Gunderson, J., Holmes, B. M., & Lyons-Ruth, K. (2004). Attachment studies with borderline patients: A review. *Harvard Review of Psychiatry, 12*(2), 94-104. doi: 10.1080/10673220490447218
- Allison, P. D. (2012). *Handling missing data by maximum likelihood*.
- Andre, J. A., Verschuere, B., & Lobbestael, J. (2015). Diagnostic Value of the Dutch Version of the Mclean Screening Instrument for Bpd (Msi-Bpd). *Journal of Personality Disorders, 29*(1), 71-78. doi: DOI 10.1521/pedi\_2014\_28\_148
- Badoud, D., Luyten, P., Fonseca-Pedrero, E., Eliez, S., Fonagy, P., & Debbané, M. (2015). The French Version of the Reflective Functioning Questionnaire: Validity Data for Adolescents and Adults and Its Association with Non-Suicidal Self-Injury. *PLoS One, 10*, e0145892. doi: 10.1371/journal.pone.0145892
- Ball, J. S., & Links, P. S. (2009). Borderline personality disorder and childhood trauma: Evidence for a causal relationship. *Current Psychiatry Reports, 11*(1), 63-68. doi: 10.1007/s11920-009-0010-4
- Bates, D., Mächler, M., Bolker, B., & Walker, S. (2014). Fitting linear mixed-effects models using lme4. *arXiv preprint arXiv:1406.5823*.
- Beebe, B., Messinger, D., Bahrck, L. E., Margolis, A., Buck, K. A., & Chen, H. (2016). A systems view of mother-infant face-to-face communication. *Developmental Psychology, 52*(4), 556-571. doi: 10.1037/a0040085

Beeney, Hallquist, M. N., Ellison, W. D., & Levy, K. (2016). Self-other disturbance in borderline personality disorder: Neural, self-report, and performance-based evidence.

*Journal of Personality Disorders*, 7, 28-39. doi: 10.1037/per0000127

Beeney, Stepp, S. D., Hallquist, M. N., Scott, L. N., Wright, A. G. C., Ellison, W. D., . . .

Pilkonis, P. A. (2015). Attachment and Social Cognition in Borderline Personality Disorder: Specificity in Relation to Antisocial and Avoidant Personality Disorders.

*Personality Disorders-Theory Research and Treatment*, 6(3), 207-215. doi: 10.1037/per0000110

Bekrater-Bodmann, R., Chung, B. Y., Foell, J., Gescher, D. M., Bohus, M., & Flor, H. (2016).

Body plasticity in borderline personality disorder: A link to dissociation. [Research Support, Non-U.S. Gov't]. *Compr Psychiatry*, 69, 36-44. doi:

10.1016/j.comppsy.2016.05.002

Bender, D. S., & Skodol, A. E. (2007). Borderline personality as a self-other representational disturbance. *Journal of Personality Disorders*, 21, 500-517. doi:

10.1521/pedi.2007.21.5.500

Bernstein, D. P., Stein, J. A., Newcomb, M. D., Walker, E., Pogge, D., Ahluvalia, T., . . .

Zule, W. (2003). Development and validation of a brief screening version of the Childhood Trauma Questionnaire. *Child Abuse & Neglect*, 27(2), 169-190. doi:

10.1016/S0145-2134(02)00541-0

Besharati, S., Forkel, S. J., Kopelman, M., Solms, M., Jenkinson, P. M., & Fotopoulou, A.

(2016). Mentalizing the body: spatial and social cognition in anosognosia for hemiplegia. *Brain*, 139(Pt 3), 971-985. doi: 10.1093/brain/awv390

Bird, G., & Viding, E. (2014). The self to other model of empathy: Providing a new

framework for understanding empathy impairments in psychopathy, autism, and

- alexithymia. *Neuroscience and Biobehavioral Reviews*, 47, 520-532. doi:  
10.1016/j.neubiorev.2014.09.021
- Bozzatello, P., Morese, R., Valentini, M. C., Rocca, P., Bosco, F., & Bellino, S. (2019).  
Autobiographical memories, identity disturbance and brain functioning in patients  
with borderline personality disorder: An fMRI study. *Heliyon*, 5(3), e01323. doi:  
10.1016/j.heliyon.2019.e01323
- Chanen, A., Sharp, C., & Hoffman, P. (2017). Prevention and early intervention for borderline  
personality disorder: a novel public health priority. *World psychiatry : official journal  
of the World Psychiatric Association (WPA)*, 16(2), 215-216. doi: 10.1002/wps.20429
- Chanen, A. M., Jovev, M., Djaja, D., McDougall, E., Yuen, H. P., Rawlings, D., & Jackson,  
H. J. (2008). Screening for borderline personality disorder in outpatient youth. *Journal  
of Personality Disorders*, 22(4), 353-364. doi: DOI 10.1521/pedi.2008.22.4.353
- Colle, L., Gabbatore, I., Riberi, E., Borroz, E., Bosco, F. M., & Keller, R. (2018).  
Mindreading abilities and borderline personality disorder: A comprehensive  
assessment using the Theory of Mind Assessment Scale. *Psychiatry Res*, 272, 609-  
617. doi: 10.1016/j.psychres.2018.12.102
- Colonnello, V., Chen, F. S., Panksepp, J., & Heinrichs, M. (2013). Oxytocin sharpens self-  
other perceptual boundary. *Psychoneuroendocrinology*, 38(12), 2996-3002. doi:  
10.1016/j.psyneuen.2013.08.010
- de Bézenac, C. E., Swindells, R. A., & Corcoran, R. (2018). The Necessity of Ambiguity in  
Self–Other Processing: A Psychosocial Perspective With Implications for Mental  
Health. [Conceptual Analysis]. *Front Psychol*, 9(2114). doi:  
10.3389/fpsyg.2018.02114
- DeCarlo, L. T. (1998). Signal detection theory and generalized linear models. *Psychological  
Methods*, 3(2), 186-205. doi: Doi 10.1037//1082-989x.3.2.186

- Dinsdale, N., & Crespi, B. J. (2013). The Borderline Empathy Paradox: Evidence and Conceptual Models for Empathic Enhancements in Borderline Personality Disorder. *Journal of Personality Disorders, 27*(2), 172-195.
- Epley, N., & Whitchurch, E. (2008). Mirror, mirror on the wall: enhancement in self-recognition. *Pers Soc Psychol Bull, 34*(9), 1159-1170. doi: 10.1177/0146167208318601
- Euler, S., Stobi, D., Sowislo, J., Ritzler, F., Huber, C. G., Lang, U. E., . . . Walter, M. (2018). Grandiose and Vulnerable Narcissism in Borderline Personality Disorder. *Psychopathology, 51*(2), 110-121. doi: 10.1159/000486601
- Evans, D., Dalgleish, T., Dudas, R. B., Denman, C., Howard, M., & Dunn, B. D. (2015). Examining the Shared and Unique Features of Self-Concept Content and Structure in Borderline Personality Disorder and Depression. *Cognitive Therapy and Research, 39*, 613-626. doi: 10.1007/s10608-015-9695-3
- Faul, F., Erdfelder, E., Lang, A.-G., & Buchner, A. (2007). G\*Power 3: A flexible statistical power analysis program for the social, behavioral, and biomedical sciences. *Behav Res Methods, 39*(2), 175-191. doi: 10.3758/bf03193146
- Mechanisms of change in mentalization-based treatment of BPD, 62 411-430 (2006).
- Fonagy, P., & Luyten, P. (2009). A developmental, mentalization-based approach to the understanding and treatment of borderline personality disorder. [Review]. *Dev Psychopathol, 21*(4), 1355-1381. doi: 10.1017/S0954579409990198
- Fonagy, P., Luyten, P., Moulton-Perkins, A., Lee, Y., Warren, F., Howard, S., . . . Lowyck, B. (2016). Development and validation of a self-report measure of mentalizing: The reflective functioning questionnaire. *PLoS One, 11*. doi: 10.1371/journal.pone.0158678

- Fotopoulou, A., & Tsakiris, M. (2017). Mentalizing homeostasis: The social origins of interoceptive inference. *Neuropsychoanalysis*, *19*(1), 3-28. doi: 10.1080/15294145.2017.1294031
- Fraley, R. C., Waller, N. G., & Brennan, K. A. (2000). An item response theory analysis of self-report measures of adult attachment. *Journal of Personality and Social Psychology*, *78*, 350-365. doi: <http://dx.doi.org/10.1037/0022-3514.78.2.350>
- Fuchs, T. (2007). Fragmented selves: temporality and identity in borderline personality disorder. *Psychopathology*, *40*(6), 379-387. doi: 10.1159/000106468
- Gardner, K., & Qualter, P. (2009). Reliability and validity of three screening measures of borderline personality disorder in a nonclinical population. *Personality and Individual Differences*, *46*(5-6), 636-641. doi: 10.1016/j.paid.2009.01.005
- Gunderson, J. G., & Lyons-Ruth, K. (2008). BPD's interpersonal hypersensitivity phenotype: a gene-environment-developmental model. *Journal of Personality Disorders*, *22*(1), 22-41. doi: 10.1521/pedi.2008.22.1.22
- Haas, B. W., & Miller, J. D. (2015). Borderline Personality Traits and Brain Activity During Emotional Perspective Taking. *Personality Disorders-Theory Research and Treatment*, *6*(4), 315-320. doi: 10.1037/per0000130
- Harari, H., Shamay-Tsoory, S. G., Ravid, M., & Levkovitz, Y. (2010). Double dissociation between cognitive and affective empathy in borderline personality disorder. *Psychiatry Res*, *175*(3), 277-279. doi: 10.1016/j.psychres.2009.03.002
- Heinisch, C., Dinse, H. R., Tegenthoff, M., Juckel, G., & Brune, M. (2011). An rTMS study into self-face recognition using video-morphing technique. *Soc Cogn Affect Neurosci*, *6*(4), 442-449. doi: 10.1093/scan/nsq062
- Heinisch, C., Kruger, M. C., & Brune, M. (2012). Repetitive Transcranial Magnetic Stimulation Over the Temporoparietal Junction Influences Distinction of Self From

- Famous but Not Unfamiliar Others. *Behavioral Neuroscience*, 126(6), 792-796. doi: 10.1037/a0030581
- Heinisch, C., Wiens, S., Grundl, M., Juckel, G., & Brune, M. (2013). Self-face recognition in schizophrenia is related to insight. *European Archives of Psychiatry and Clinical Neuroscience*, 263(8), 655-662. doi: 10.1007/s00406-013-0400-9
- Hiro, F., Lesage, M., Pedron, L., Meyer, I., Thomas, P., Cottencin, O., & Guardia, D. (2016). Impaired processing of self-face recognition in anorexia nervosa. *Eating and Weight Disorders-Studies on Anorexia Bulimia and Obesity*, 21(1), 31-40. doi: 10.1007/s40519-015-0223-y
- Hoffmann, F., Banzhaf, C., Kanske, P., Gartner, M., Birmohl, F., & Singer, T. (2016). Empathy in depression: Egocentric and altercentric biases and the role of alexithymia. *Journal of Affective Disorders*, 199, 23-29. doi: 10.1016/j.jad.2016.03.007
- Jaccard, J. (2001). *Interaction Effects in Logistic Regression*: SAGE Publications.
- Jorgensen, C. R. (2009). Identity style in patients with borderline personality disorder and normal controls. *Journal of Personality Disorders*, 23(2), 101-112. doi: 10.1521/pedi.2009.23.2.101
- Jorgensen, C. R. (2010). Invited essay: Identity and borderline personality disorder. *Journal of Personality Disorders*, 24, 344-364. doi: 10.1521/pedi.2010.24.3.344
- Kaertner, J., Keller, H., Kleis, A., & Lamm, B. (2004). Influences of maternal parenting behavior of 3 month old infants on the development of the self-other-distinction and early empathic behavior at 18 months. *International Journal of Psychology*, 39(5-6), 75-75.
- Karan, E., Diamond, D., Grinband, J., & Fertuck, E. A. (2019). Perceptual sensitivity to facial self perception associated with pathological narcissism. *Psychoanalytic Psychology*, 36(4), 303-312. doi: <http://dx.doi.org/10.1037/pap0000259>

- Keenan, J. P., Freund, S., Hamilton, R. H., Ganis, G., & Pascual-Leone, A. (2000). Hand response differences in a self-face identification task. *Neuropsychologia*, *38*(7), 1047-1053. doi: Doi 10.1016/S0028-3932(99)00145-1
- Kernberg, O. F. (2006). Identity: recent findings and clinical implications. *Psychoanal Q*, *75*, 969-1004.
- Kooiman, C. G., Klaassens, E. R., Lugt, J. Q. V., & Kamperman, A. M. (2013). Psychometrics and Validity of the Dutch Experiences in Close Relationships Revised (ECRr) in an Outpatient Mental Health Sample. *Journal of Personality Assessment*, *95*(2), 217-224. doi: 10.1080/00223891.2012.740540
- Koós, O., & Gergely, G. (2001). A contingency-based approach to the etiology of 'disorganized' attachment: the 'flickering switch' hypothesis. *Bulletin of the Menninger Clinic*, *65* 3, 397-410.
- Kristen-Antonow, S., Sodian, B., Perst, H., & Licata, M. (2015). A longitudinal study of the emerging self from 9 months to the age of 4 years. *Front Psychol*, *6*(789). doi: <https://doi.org/10.3389/fpsyg.2015.00789>
- Krol, S. A., Theriault, R., Olson, J. A., Raz, A., & Bartz, J. A. (2019). Self-Concept Clarity and the Bodily Self: Malleability Across Modalities. *Pers Soc Psychol Bull*, 146167219879126. doi: 10.1177/0146167219879126
- Lamm, C., Bukowski, H., & Silani, G. (2016). From shared to distinct self-other representations in empathy: evidence from neurotypical function and socio-cognitive disorders. *Philosophical Transactions of the Royal Society B-Biological Sciences*, *371*(1686). doi: 10.1098/Rstb.2015.0083
- LeGris, J., & van Reekum, R. (2006). The neuropsychological correlates of borderline personality disorder and suicidal behaviour. *Can J Psychiatry*, *51*(3), 131-142. doi: 10.1177/070674370605100303

- Luyten, P., & Blatt, S. J. (2013). Interpersonal relatedness and self-definition in normal and disrupted personality development: retrospect and prospect. *Am Psychol*, *68*(3), 172-183. doi: 10.1037/a0032243
- Luyten, P., Campbell, C., Allison, E., & Fonagy, P. (2020). The Mentalizing Approach to Psychopathology: State of the Art and Future Directions. *Annu Rev Clin Psychol*. doi: 10.1146/annurev-clinpsy-071919-015355
- Luyten, P., Campbell, C., & Fonagy, P. (2019). Borderline personality disorder, complex trauma, and problems with self and identity: A social-communicative approach. *J Pers*. doi: 10.1111/jopy.12483
- Luyten, P., Fonagy, P., Lowyck, B., & Vermote, R. (2012). Assessment of mentalization. *Handbook of mentalizing in mental health practice.*, 43-65. doi: 10.1093/med/9780198570905.003.005
- Martini, M., Bufalari, I., Stazi, M. A., & Aglioti, S. M. (2015). Is That Me or My Twin? Lack of Self-Face Recognition Advantage in Identical Twins. *PLoS One*, *10*(4). doi: 10.1371/journal.pone.0120900
- Molenberghs, G., & Kenward, M. (2007). *Missing Data in Clinical Studies*.
- Nakagawa, S., Johnson, P. C. D., & Schielzeth, H. (2017). The coefficient of determination  $R^2$  and intra-class correlation coefficient from generalized linear mixed-effects models revisited and expanded. *J R Soc Interface*, *14*(134). doi: 10.1098/rsif.2017.0213
- Neustadter, E. S., Fineberg, S. K., Leavitt, J., Carr, M. M., & Corlett, P. R. (2019). Induced illusory body ownership in Borderline Personality Disorder. *bioRxiv*, 628131. doi: 10.1101/628131

- Neustadter, E. S., Fotopoulou, A., Steinfeld, M., & Fineberg, S. K. (2019). Mentalization and embodied selfhood in Borderline Personality Disorder. doi: <https://doi.org/10.31234/osf.io/9z3nq>
- Niedtfeld, I. (2017). Experimental investigation of cognitive and affective empathy in borderline personality disorder: Effects of ambiguity in multimodal social information processing. *Psychiatry Res*, 253, 58-63. doi: 10.1016/j.psychres.2017.03.037
- Noblin, J. L., Venta, A., & Sharp, C. (2013). The Validity of the MSI-BPD Among Inpatient Adolescents. *Assessment*, 21(2), 210-217. doi: 10.1177/1073191112473177
- Paladino, M. P., Mazzurega, M., Pavani, F., & Schubert, T. W. (2010). Synchronous multisensory stimulation blurs self-other boundaries. *Psychological Science*, 21(9), 1202-1207. doi: 10.1177/0956797610379234
- Panagiotopoulou, E., Crucianelli, L., Lemma, A., & Fotopoulou, A. (2020). Identifying with the Beautiful: Facial attractiveness effects on unisensory and multisensory self-other distinction. doi: <https://doi.org/10.31234/osf.io/6rcyg>
- Panagiotopoulou, E., Filippetti, M. L., Tsakiris, M., & Fotopoulou, A. (2017). Affective Touch Enhances Self-Face Recognition During Multisensory Integration. *Sci Rep*, 7(1), 12883. doi: 10.1038/s41598-017-13345-9
- Patel, A. B., Sharp, C., & Fonagy, P. (2011). Criterion Validity of the MSI-BPD in a Community Sample of Women. *Journal of Psychopathology and Behavioral Assessment*, 33(3), 403-408. doi: 10.1007/s10862-011-9238-5
- Payne, S., & Tsakiris, M. (2017). Anodal transcranial direct current stimulation of right temporoparietal area inhibits self-recognition. [Randomized Controlled Trial]. *Cogn Affect Behav Neurosci*, 17(1), 1-8. doi: 10.3758/s13415-016-0461-0
- Quesque, F., & Brass, M. (2019). The Role of the Temporoparietal Junction in Self-Other Distinction. [journal article]. *Brain Topography*. doi: 10.1007/s10548-019-00737-5

- Rochat, P. (2001). Social contingency detection and infant development. *Bulletin of the Menninger Clinic*, 65, 347-360. doi: 10.1521/bumc.65.3.347.19847
- Ruocco, A. C. (2005). The neuropsychology of borderline personality disorder: A meta-analysis and review. *Psychiatry Res*, 137(3), 191-202. doi: <https://doi.org/10.1016/j.psychres.2005.07.004>
- Sansone, R. A., & Sansone, L. A. (2011). Gender patterns in borderline personality disorder. *Innovations in clinical neuroscience*, 8(5), 16-20.
- Shai, D., & Fonagy, P. (2014). Beyond words: Parental embodied mentalizing and the parent-infant dance *Mechanisms of social connection: From brain to group*. (pp. 185-203). Washington, DC, US: American Psychological Association.
- Sharp, C., Vanwoerden, S., & Wall, K. (2018). Adolescence as a sensitive period for the development of personality disorder. *Psychiatric Clinics*, 41(4), 669-683.
- Sibley, C. G., Fischer, R., & Liu, J. H. (2005). Reliability and validity of the revised experiences in close relationships (ECR-R) self-report measure of adult romantic attachment. *Personality and Social Psychology Bulletin*, 31(11), 1524-1536. doi: 10.1177/0146167205276865
- Silani, G., Lamm, C., Ruff, C. C., & Singer, T. (2013). Right Supramarginal Gyrus Is Crucial to Overcome Emotional Egocentricity Bias in Social Judgments. *Journal of Neuroscience*, 33(39), 15466-15476. doi: 10.1523/Jneurosci.1488-13.2013
- Skodol, A. E., & Bender, D. S. (2003). Why are women diagnosed borderline more than men? *Psychiatr Q*, 74(4), 349-360. doi: 10.1023/a:1026087410516
- Sollberger, D., Gremaud-Heitz, D., Riemenschneider, A., Kuchenhoff, J., Dammann, G., & Walter, M. (2012). Associations between identity diffusion, Axis II disorder, and psychopathology in inpatients with borderline personality disorder. *Psychopathology*, 45, 15-21. doi: 10.1159/000325104

- Sowden, S., & Catmur, C. (2015). The role of the right temporoparietal junction in the control of imitation. [Research Support, Non-U.S. Gov't]. *Cereb Cortex*, *25*(4), 1107-1113. doi: 10.1093/cercor/bht306
- Sowden, S., & Shah, P. (2014). Self-other control: a candidate mechanism for social cognitive function. [Opinion]. *Frontiers in Human Neuroscience*, *8*(789). doi: 10.3389/fnhum.2014.00789
- Tjadura-Jimenez, A., Grehl, S., & Tsakiris, M. (2012). The other in me: interpersonal multisensory stimulation changes the mental representation of the self. *PLoS One*, *7*(7), e40682. doi: 10.1371/journal.pone.0040682
- Thombs, B. D., Bernstein, D. P., Lobbstaal, J., & Arntz, A. (2009). A validation study of the Dutch Childhood Trauma Questionnaire-Short Form: Factor structure, reliability, and known-groups validity. *Child Abuse & Neglect*, *33*(8), 518-523. doi: 10.1016/j.chiabu.2009.03.001
- Tsakiris, M. (2008). Looking for myself: current multisensory input alters self-face recognition. *PLoS One*, *3*(12), e4040. doi: 10.1371/journal.pone.0004040
- Tsakiris, M. (2017). The multisensory basis of the self: From body to identity to others. *Quarterly Journal of Experimental Psychology*, *70*(4), 597-609. doi: 10.1080/17470218.2016.1181768
- van Schie, C. C., Chiu, C. D., Rombouts, S., Heiser, W. J., & Elzinga, B. M. (2019). Stuck in a negative me: fMRI study on the role of disturbed self-views in social feedback processing in borderline personality disorder. *Psychological Medicine*, 1-11. doi: 10.1017/S0033291719000448
- Vater, A., Schr, M., Oder-Ab E, Weißgerber, S., Roepke, S., & Schütz, A. (2015). Self-concept structure and borderline personality disorder: Evidence for negative

compartmentalization. *Journal of Behavior Therapy and Experimental Psychiatry*, 46, 50-58. doi: 10.1016/j.jbtep.2014.08.003

Verschuere, B., & Tibboel, H. (2011). The Dutch version of the McLean Screening Instrument for borderline personality disorder (MSI-BPD). *Psychologie & Gezondheid*, 39(4), 243-248. doi: DOI 10.1007/s12483-011-0046-0

Zanarini, M. C., Vujanovic, A. A., Parachini, E. A., Boulanger, J. L., Frankenburg, F. R., & Hennen, J. (2003). A screening measure for BPD: The McLean Screening Instrument for Borderline Personality Disorder (MSI-BPD). *Journal of Personality Disorders*, 17(6), 568-573. doi: DOI 10.1521/pedi.17.6.568.25355

*Table 1*

Mean scores per group and significance of group differences on all measures.

Measures	High BPD ( <i>n</i> = 30)			Low BPD ( <i>n</i> = 31)			<i>p</i>
	Mean	<i>SD</i>	Min; Max	Mean	<i>SD</i>	Min; Max	
Age	18.40	0.62	18; 20	18.23	0.56	17; 20	.25
MSI-BPD	7.67	0.96	7; 10	0.39	0.49	0; 1	< .001
Attachment Anxiety	4.32	0.99	2.2; 5.7	2.98	0.74	1.9; 4.4	< .001
Attachment Avoidance	3.81	1.05	1.8; 5.8	2.75	0.99	1.1; 5.2	< .001
Uncertainty about MS	0.96	0.48	0; 2	0.52	0.37	0; 1.3	< .001
Certainty about MS	0.54	0.46	0; 1.83	0.96	0.66	0; 2.7	.006
Childhood Trauma	36.30	7.15	26; 56	29.74	3.91	25; 39	< .001

*Note:* MSI-BPD = Maclean Screening Inventory for Borderline Personality Disorder, MS =

mental states; Min = minimum; Max = maximum.

Table 2

Mixed-effects logistic regression coefficients predicting the likelihood of recognizing the face the morph is turning into. The model includes a random intercept and a random slope for percentage per participant.

<b>Predictors</b>	<b>Model</b>	
	<b>Odds Ratio</b>	<b>95% CI</b>
(Intercept)	0.00 <sup>***</sup>	0.00, 0.00
Percentage	1.33 <sup>***</sup>	1.27, 1.39
Group (0 = low BPD, 1 = high BPD)	0.13 <sup>*</sup>	0.02, 0.89
Direction (0 = self-to-other, 1 = other-to-self)	0.40 <sup>***</sup>	0.30, 0.53
Face (0 = Face 1, 1 = Face 2)	2.18 <sup>***</sup>	1.61, 2.94
Group × Direction	6.22 <sup>***</sup>	4.21, 9.21
Group × Face	4.33 <sup>***</sup>	2.73, 6.88
Direction × Face	0.16 <sup>***</sup>	0.11, 0.24
Group × Direction × Face	0.04 <sup>***</sup>	0.02, 0.08
<b>Random Effects</b>		
ICC	0.92	
N <sub>ID</sub>	61	
Observations	16,200	
Marginal $R^2$ /Conditional $R^2$	0.629/0.970	

Note: <sup>\*</sup> $p < 0.05$ , <sup>\*\*</sup> $p < 0.01$ , <sup>\*\*\*</sup> $p < 0.001$ .

CI = confidence interval; ICC = Intraclass Correlation; N<sub>ID</sub> = number of unique participants.

*Table 3*

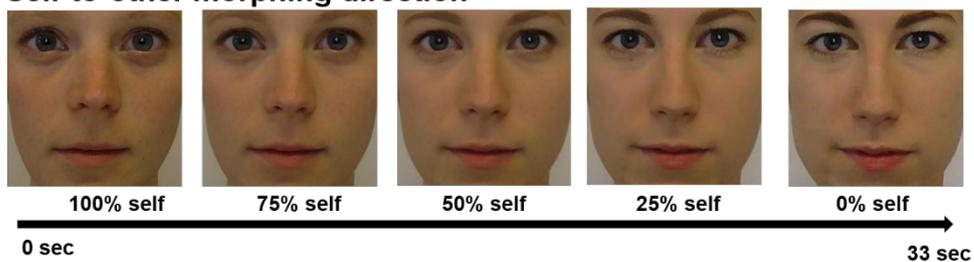
Pearson correlations of self–other facial morphing task performance and self-report questionnaires. Task performance is coded as the percentage of the target face needed in order to recognize the target, in both groups and averaged across the two faces.

Self-report questionnaires	Self-to-other	Other-to-self
Attachment Anxiety	0.28*	–0.04
Attachment Avoidance	0.40**	–0.02
Uncertainty about mental states	–0.06	0.09
Certainty about mental states	0.08	0.08
Childhood trauma	0.17	0.16

*Note.* \*  $p < 0.05$ , \*\*  $p < 0.01$ .

**a.**

**Self-to-other morphing direction**



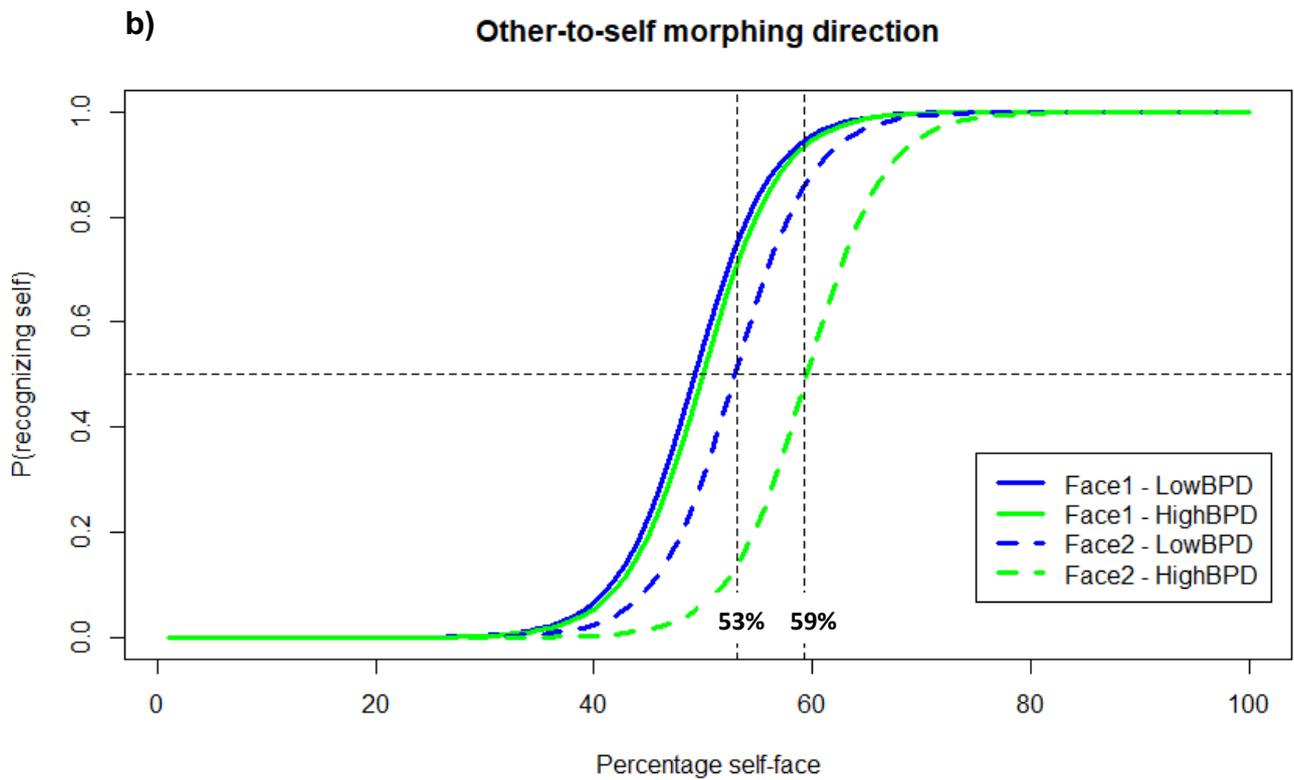
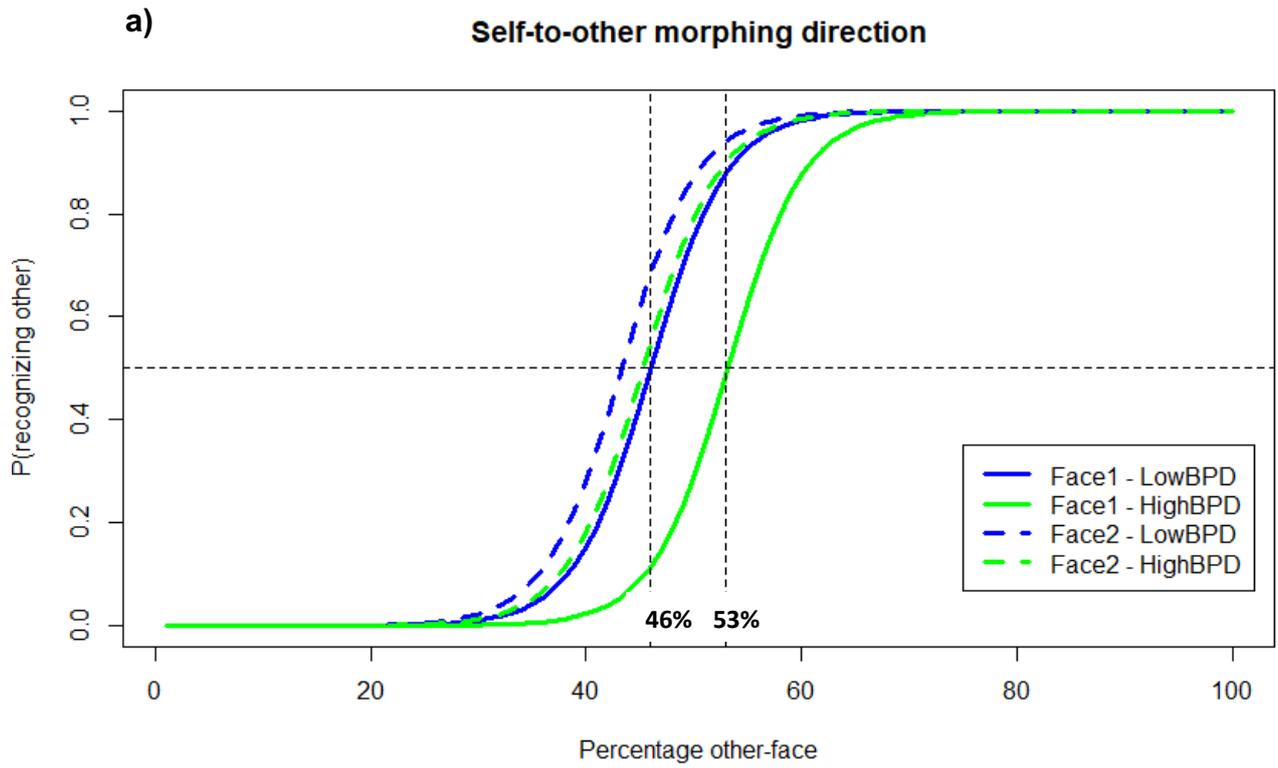
**Other-to-self morphing direction**



**b.**

	<b>Self-to-other</b>	<b>Other-to-Self</b>
<b>Face 1</b>	Self-to-Face1	Face1-to-Self
<b>Face 2</b>	Self-to-Face2	Face2-to-Self

*Figure 1.* (a) Illustrative example of the self–other facial morphing task in two directions. The tasks contain 100 frames each, representing a 1% gradual blend of the participant’s own face and an unfamiliar face. (b) The task was presented four times: with two different unfamiliar faces (Face 1 and Face 2) and in two morphing directions (i.e. self-to-other and other-to-self).



*Figure 2.* Predicted logistic regression curves for the final model, plotting the likelihood of (a) recognizing the other-face in 100 frames containing incremental 1% increases in the other-face in the self-to-other direction of morphing, and of (b) recognizing the self-face in 100 frames containing incremental 1% increases in the self-face in the other-to-self morphing direction. The green (light gray) lines represent the High BPD group, the blue lines (dark gray) the Low BPD group, the full lines Face 1 and the dotted lines Face 2.