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**Interpersonal emotion regulation, borderline personality disorder symptoms, and
working memory during socio-affective distraction**

Running head: Interpersonal emotion regulation and BPD

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Abstract

Background: Difficulties in emotion regulation (ER) are a core feature of borderline personality disorder (BPD). To date, studies in BPD have mainly focused on intrapersonal rather than interpersonal ER strategies. Attention to social-affective distractors was found to interfere with working memory (WM) in BPD, which may contribute to impairments in ER. However, whether these difficulties might affect the use of interpersonal ER (ipER) is an open question. The aim of this study was to investigate associations between BPD symptoms, ipER strategies, basic WM, and social-affective interference on WM. **Methods:** 124 women with a wide range of BPD symptoms rated the frequency of using the ipER strategies enhancing positive affect, perspective taking, soothing, and social modeling (Interpersonal Emotion Regulation Questionnaire, IERQ). In a subsample of $N = 70$ women, we measured attentional impairments (omission errors) induced by social-affective distractors (neutral, happy, fearful, and angry faces) and performance during distractor-free trials within a modified Sternberg WM task. **Results:** Women with more severe BPD symptoms reported less frequent use of enhancing positive affect and showed more omission errors, especially for distracting happy faces. Better performance during distractor-free trials was related to more frequent use of enhancing positive affect. Task performance largely accounted for the association between BPD symptoms and the use of enhancing positive affect. **Discussion:** Findings suggest that BPD symptoms are associated with changes in specific domains of ipER, especially a reduced tendency to increase feelings of happiness and joy through others. Attentional deficits may be an important mechanism here.

Keywords: Borderline Personality Disorder; Emotion Regulation; Interpersonal Emotion Regulation; Selective Attention; Working Memory

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Emotions can have different functions depending on the context in which they occur (Cole et al., 2004; Thompson, 1994, 2011). When experienced in social situations, emotions may be expressed to signal current mental states, communicate needs, secure social support, and achieve important relationship goals. These functions may also influence how emotions are regulated (Barthel et al., 2018; Butler et al., 2006; Hofmann et al., 2016; Ray-Yol et al., 2022). In general, emotion regulation (ER) has been defined as any kind of intrinsic or extrinsic process responsible for evaluating, monitoring, expressing, and modifying the intensity of emotions to accomplish certain goals (Thompson, 1994). This definition implies that ER does not only involve intrapsychic processes (intrapersonal ER), but also interpersonal attempts to modify emotions through others or together with others (Barthel et al., 2018; Hofmann et al., 2016). Yet, most studies so far have focused on intrinsic strategies a person uses to regulate affective states internally, through mechanisms such as cognitive reappraisal, distraction, or suppression of emotions (Cohen & Ochsner, 2018; Gross & John, 2003; Ochsner & Gross, 2008).

Interpersonal emotion regulation

More recently, studies have focused on interindividual differences in the tendency to regulate emotions by interacting with others (Altan-Atalay & Ray-Yol, 2023; Barthel et al., 2018; Hofmann et al., 2016). While the term interpersonal emotion regulation (ipER) has been used in different contexts, it primarily refers to the process of regulating emotions in the presence of others, that is, with, for, or through them (Barthel et al., 2018). Zaki and Williams (2013) highlight that ipER strategies can be used to (simultaneously) regulate own emotions (for example seeking comfort in a friend when being upset) and/or to regulate someone else's emotions (for example soothing a distressed friend). This can include both an individual's desire to modulate own emotions (for example attenuate negative affect) through social interaction with others (Hofmann et al., 2016) and to change the feelings of others (Niven et al., 2009). In

the current study, we focus on the facet of ipER as the process of modulating own emotions through social interactions.

Hofmann and colleagues (2016) have developed and validated a model of ipER comprising four strategies (enhancing positive affect, perspective taking, social modeling, and soothing) along with a self-report questionnaire that measures the frequency of their use. Enhancing positive affect refers to the tendency to seek others to increase feelings of happiness and joy. Through perspective-taking, people remind themselves not to worry or that others have it worse. Social modeling involves learning from others how they might cope with a particular situation. Soothing refers to seeking others' comfort and sympathy.

Not much is known yet about the use and adaptiveness of ipER strategies, especially in groups with severe problems in ER (Hofmann et al., 2016). Social support and close affiliation are usually associated with positive affect, being well-known buffers against distress and depression (Cacioppo et al., 2010; Holz et al., 2020; Krijnen et al., 2021). Therefore, ipER strategies that help enhance feelings of happiness, joy, and comfort may be adaptive in times of distress (Hofmann et al., 2016). At the same time, findings by Hofmann and colleagues (2016) suggest that people who experience more distress and negative emotions use more perspective-taking and social modeling; they may pay more attention to others to regulate own emotions. However, the authors call for more research in groups characterized by severe emotion dysregulation and interpersonal problems.

Borderline personality disorder and interpersonal emotion regulation

Borderline personality disorder (BPD) is characterized by severe emotion dysregulation (Bohus et al., 2021). Etiological models of BPD, such as the biosocial theory (Linehan, 1993), propose that emotion dysregulation is at the core of the disorder and results from complex interactions of neurobiological genetic vulnerabilities and stressful interpersonal experiences.

An increased sensitivity to experience emotions more intensely that persist over a longer period before returning to baseline is assumed to constitute an important mechanism underlying

1 BPD psychopathology. A pervasive pattern of emotion dysregulation is assumed to contribute
2 to maladaptive coping behaviors, such as non-suicidal self-injury and suicidal behaviors
3 (Crowell et al., 2009). The biosocial model proposes that an invalidating social environment
4 critically contributes to emotion dysregulation in BPD (Linehan, 1993). Within this invalidating
5 environment, vulnerable individuals may learn that the most efficient way to signal individual
6 needs is to intensify emotional expressions. At the same time they may learn to suppress
7 emotions to avoid social conflicts and may stop seeking social support from others (Fitzpatrick
8 et al., 2023).

9 Until recently, studies on ER in BPD mainly focused on intrapersonal ER strategies and
10 revealed that individuals with the disorder use adaptive strategies, such as cognitive reappraisal,
11 less often. At the same time, they make more use of maladaptive strategies, such as suppression
12 and rumination, to cope with primarily negative emotions (Daros & Williams, 2019; Sorgi-
13 Wilson & McCloskey, 2022). More recent research points to an inflexible use of potentially
14 adaptive strategies in social situations (Fitzpatrick et al., 2023). Based on growing evidence,
15 Fitzpatrick, Liebman, and Monson (2021) propose that ER in BPD needs to be understood in
16 an interpersonal context, since distressing, harmful and invalidating relationship experiences
17 can lead to a hypersensitivity to social threat. Social cues signaling potential threat and
18 difficulties communicating emotions are assumed to promote dysfunctional behavior, including
19 self-harm (Fitzpatrick et al., 2021). While emotion dysregulation is a core characteristic of
20 BPD, it is triggered and exacerbated by problematic interpersonal transactions with others.
21 From their systematic review of the literature, Fitzpatrick and colleagues (2023) conclude that
22 relational stressors typically elicit and maintain ER problems in BPD. Social stressors were
23 found to lead to stronger urges for maladaptive coping behaviors and less functional behaviors
24 in individuals with high BPD features. People with BPD also use interpersonal contacts less
25 efficiently to regulate emotions (Dixon-Gordon et al., 2021). While research on the use of ipER
26 strategies in BPD is still sparse, the existing studies point to an altered use of ipER strategies in

individuals with a BPD diagnosis or high levels of BPD features. A study by López-Pérez and colleagues (2017) found that patients with BPD do not differ from healthy individuals in the use of adaptive intrapersonal ER strategies (attention deployment, cognitive change) or maladaptive strategies (expressive suppression), but engage less in interpersonal affect enhancement without a difference in affect worsening (López-Pérez et al., 2017). These findings suggest that individuals with BPD find it particularly hard to enhance their affect together with others. They may also find it harder to adjust their emotions to certain goals in social relationships, for example during collaboration and confrontation. Both individuals with a BPD diagnosis and those with high BPD features showed a preference for emotion goals in social contexts (that is, anger during collaboration and happiness during confrontation) (López-Pérez & McCagh, 2020). Howard and Cheavens (2023) investigated the use of ipER in social networks. While the level of BPD features was not related to the frequency of ipER, higher BPD features were associated with perceiving a lower efficiency of ER and a lower willingness of interaction partners to participate in ER. Moreover, only individuals with high BPD features chose ER partners who were less close and less central members in their networks (Howard & Cheavens, 2023).

In summary, research has begun to focus on the intersection of interpersonal and emotional processes in BPD, but studies on the use of specific ipER strategies to regulate own emotions are still sparse. In particular, it remains unclear if ipER is associated with deficits in attention regulation during social-affective interference. Investigating these associations may help to better understand the adaptiveness of certain ipER strategies in general and in BPD specifically. As outlined below, maintaining task-related attention in the presence of distracting social-affective information plays a crucial role in goal-directed behavior and ER.

First, it is important to mention that ER strategies are neither adaptive nor maladaptive per se. Their adaptiveness depends on the situational context, the consequences, and the impact on accomplishing goals (Thompson, 1994). In social contexts, goal-directed behavior usually

requires the regulation of attention in the presence of social-affective stimuli, such as facial expressions. This domain of executive functioning has been shown to be impaired in BPD (Krause-Utz et al., 2012; Krause-Utz, Elzinga, Oei, Spinhoven, et al., 2014), which emphasizes the need to investigate ipER in the context of susceptibility to social-affective interference.

Cognitive functioning during social-affective distraction

The ability to adjust attention to specific goals in the presence of interfering social and emotional information heavily relies on attentional control and working memory (WM, Koch et al., 2018). Executive functions, such as attention and WM, are an important prerequisite for effortful ER and self-regulation. This is supported by empirical evidence that WM involves a fronto-parietal brain network that is critically implicated in effortful cognitive reappraisal (Cohen & Ochsner, 2018; Krause-Utz et al., 2020; Ochsner & Gross, 2008; Schweizer et al., 2013).

While only a few studies revealed impairments of cognitive functioning in BPD in general (see Marceau et al., 2023), many studies have provided evidence for altered attentional processing of social-affective information during cognitive tasks, including modified WM tasks and attentional control tasks (Kaiser et al., 2016, 2020; Krause-Utz et al., 2012, 2014, 2020; Lazarus et al., 2014; Veague & Hooley, 2014; see also Carpenter & Trull, 2013; Fitzpatrick et al., 2023; Sorgi-Wilson & McCloskey, 2022). While research focused on hypersensitivity and hypervigilance towards negative content, such as the evaluation of anger in facial stimuli (Lazarus et al., 2014; Mitchell et al., 2014), an increasing number of studies suggest that changes might be even stronger for positive social stimuli. This includes alterations in the appraisal of facial emotions regarding their trustworthiness (Biermann et al., 2022; Kleindienst et al., 2019; Thome et al., 2016), social touch (Schulze et al., 2022), feeling included during virtual ball-tossing games (De Panfilis et al., 2015; Domsalla et al., 2014), and adverse effects of social feedback on trust behavior (Liebke et al., 2018) or memorizing cooperation partners (Niedtfeld et al., 2020).

Most importantly, selective attention to social-affective information, such as stimuli depicting interpersonal scenes or fearful and angry facial expressions, was found to interfere with task performance during a modified WM paradigm in BPD (Krause-Utz et al., 2012; Krause-Utz, Elzinga, Oei, Spinhoven, et al., 2014). These performance deficits were not only associated with increased amygdala reactivity (Krause-Utz, Elzinga, Oei, Paret, et al., 2014; Krause-Utz et al., 2012) or reduced heart rate variability (Krause-Utz et al., 2022) but also with impairments in ER, in terms of less successful down-regulation of emotions during a cognitive reappraisal task (Krause-Utz et al., 2020). Whether the same holds true for positive social distractors, such as happy faces, remains unclear. Investigating the relevance of task performance during social-affective interference within a modified WM paradigm might help uncover an important mechanism underlying altered ipER in BPD. This can ultimately help to identify relevant targets for prevention and interventions.

Present study

With the current study, we aimed to fill this gap in the literature by investigating associations between 1) BPD symptoms and ipER strategies, 2) performance on a modified WM task (with and without social-affective interference) and ipER strategies, and 3) BPD symptoms and task performance (with and without social-affective interference).

Based on altered appraisals of others as being close and trustworthy in BPD (Lis et al., 2021; Masland et al., 2019), we hypothesized that 1) higher levels of BPD symptoms will predict a less frequent use of ipER strategies involving social support and affiliation. Given that difficulties in attention regulation during social-affective distraction were associated with ER deficits (Cohen & Ochsner, 2018; Krause-Utz et al., 2020; Ochsner & Gross, 2008; Schweizer et al., 2013), we further expected that 2) a stronger interference of social-affective distractors on task performance in the modified WM paradigm predicts an altered use of ipER strategies. Drawing on evidence for a stronger interference effect of social-affective distraction in BPD (Krause-Utz, Elzinga, Oei, Spinhoven, et al., 2014; Krause-Utz et al., 2012), we further

expected that 3) higher levels of BPD symptoms predict more task impairments induced by social-affective distraction, including happy faces. We focused on omission errors as an indicator of attentional control in WM. Finally, for those ipER strategies, which were associated with the severity of BPD symptoms, we investigated whether the observed link can be explained by task impairments - in particular, omission errors during social-affective distraction.

Methods

Participants and procedure

The study received approval from the local Psychology Ethics Committee and was conducted between June 2020 and August 2021. To recruit people with a wide range of BPD symptoms, interested participants were screened with the International Personality Disorder Examination (IPDE) screening questionnaire (Loranger, 1994). We aimed at including at least 25% of participants scoring above a proposed cut-off, confirming at least five of the twelve items on the screener (see Chanen et al., 2008; Magallón-Neri et al., 2013). Participants were mostly recruited via mental health online platforms and social media (Facebook, Twitter, Instagram etc., 74%). Additional recruitment took place via the research participation website of the University. When advertising the study, we indicated that we were interested in people who experienced problems in ER, especially trouble concentrating when stressed. Inclusion criteria were being at least 18 years old, having sufficient English proficiency (defined as the ability to “understand the main points of clear standard input on familiar matters regularly encountered in work, school, and leisure”, as checked before and after the survey), and self-reported female biological sex (to avoid a confounding effect of biological sex and to increase the comparison with earlier studies using similar tasks). The exclusion criterion was being in a mental crisis [“Please do not participate in this survey if you are in a current crisis or very upset about certain events.”]. Eligible participants were informed about background, aims, potential risks, and their right to end the study at any time without negative consequences. The questionnaires were presented in an online survey via the software Qualtrics (©Qualtrics,

Provo, UT, 2015). After providing informed consent, participants got access to this online survey via an internet link or QR code. Scales were presented in randomized order. Completion of the survey took approximately 10-20 minutes. Afterward, participants were asked to perform an experimental modified WM task. Given the ongoing COVID-19 pandemic the experimental task was programmed in Python and presented online via Pavlovio. Participants were asked to perform it on a separate website. Completion of the experimental task took approximately 20 minutes. Upon completion of each part, participants were reimbursed receiving 6.50 Euro per hour. Alternatively, psychology students from the University could gain credits for participation. All participants were debriefed and encouraged to contact the principal investigator in case of discomfort due to the intimate nature of the items.

Sample characteristics

Overall, $N = 127$ women were included in the study and completed its first part. Out of these $N = 127$ women, $N = 70$ participants were willing to participate in the experimental task. This subsample ($N = 70$) showed similar characteristics as the total sample (see Supplementary Table 1). Participants were aged between 18 and 42 ($M = 25.07 \pm SD = 4.70$ for the full sample versus 24.87 ± 3.91 for the sample completing the experimental task). Most participants were European ($N = 97$, 76% versus $N = 49$, 70%), had completed at least Secondary School ($N = 36$, 28% versus $N = 17$, 24%), and were single ($N = 61$, 48% versus $N = 40$, 57%). Forty-two (33%) participants from the full sample and twenty-seven (39%) participants who completed the experimental task have been in treatment. Participants reported the full range of BPD symptoms on the IPDE screening questionnaire (0-12, $M = 3.53 \pm 2.54$). Thirty-five (28%) and twenty-two (31%) participants, respectively, confirmed ≥ 5 BPD criteria-related items.

Material and Measures

Interpersonal Emotion Regulation Questionnaire

The Interpersonal Emotion Regulation Questionnaire (IERQ) was developed by Hofmann and colleagues (2016) to assess ER in interpersonal contexts. The scale consists of

20 items with four subscales containing five items each: enhancement of positive affect (tendency to seek out others to increase feelings of happiness and joy), perspective-taking (use of others to be reminded not to worry and that others have it worse), social modeling (looking to others to see how they might cope with a given situation), and soothing (seeking out others for comfort and sympathy). The IERQ subscales show very good psychometric properties (Hofmann et al., 2016). In the present study, internal consistency (Cronbach's alpha) for the subscales were as follows: $\alpha = 0.85$ for enhancing positive affect, $\alpha = 0.84$ for perspective taking, $\alpha = 0.83$ for social modeling, and $\alpha = 0.90$ for soothing.

International Personality Disorder Examination (IPDE) Self-Report Screener

We measured BPD symptom severity with the continuous count of the 12-item screening questionnaire of the IPDE (Loranger, 1999). In this self-report instrument, participants report the presence of BPD (criteria-related) symptoms as being either true (1) or not true (0), resulting in a total sum score ranging from 0 to 12. Proposed cut-offs of the screener for the diagnosis of BPD vary between 5 (Chanen et al., 2008; Magallón-Neri et al., 2013) and 7 (Lewin et al., 2005). While this would typically correspond to a diagnostic threshold, it cannot be considered a confirmation of meeting criteria for the diagnosis. Earlier studies found high test-retest reliability (Intraclass Coefficient $ICC = 0.83$, Chanen et al., 2008) but varying sensitivity (0.77 to 0.90, Chanen et al., 2008; Lewin et al., 2005) and specificity (0.77 to 0.88, Chanen et al., 2008; Lenzenweger, 1997).

Experimental Task

The emotional working memory task (EWMT) was an extended version of the adapted Sternberg item recognition task by Krause-Utz and colleagues (2012; 2014). The present version consisted of 80 trials. Each trial started with three letters (memoranda, 1000 milliseconds), was followed by a delay interval of 1500 milliseconds, and at the end, another set of three letters was presented (probe, 2000 milliseconds). In half of the trials, one of the three memoranda was also present in the probe. In the other half of the trials, none of the probe

1 letters matched the memoranda. Once the probe letters were presented, participants had to
2 indicate whether they had recognized a memorandum or not by pressing a “yes” or “no” button
3 within the response window of 2000 milliseconds during the presentation of the probes. During
4 the delay interval between the memoranda and the probe, either a fixation cross (control
5 condition: 40 distractor-free working memory trials) or faces (distractors) were demonstrated
6 (40 trials). In line with previous studies using the emotional working memory task (for example
7 Krause-Utz et al., 2014, 2020), we selected distracting female facial stimuli with a neutral,
8 fearful, and angry emotional expression. Due to the increasing number of studies confirming
9 alterations in the processing of positive social cues in BPD (Liebke et al., 2018), we extended
10 the emotional distractor categories by including happy facial expressions. All facial stimuli
11 were white faces retrieved from the Karolinska Directed Emotional Faces Set (KDEF, Calvo &
12 Lundqvist, 2008). Ten trials were presented for each of the different emotions depicted in the
13 female faces. Participants were instructed to ignore the faces and press the button as fast and
14 accurately as possible. Both the order of emotional face distractors (for example happy, angry)
15 and the memoranda with or without repeating (probe) letters, were pseudorandomized (counter-
16 balanced across subjects) to control for order and learning effects. This task aims for
17 participants to engage in cognitive processing by inhibiting emotional processing. The outcome
18 measures were reaction times (RTs) of correct trials, accuracy, and the number of omissions
19 (within the allotted time) of the participants. As a primary outcome variable, we decided to use
20 omission errors, which are a well-established measure of attention, as opposed to commission
21 errors indicative of impulsive errors (Wright et al., 2014).

22 Statistical analysis

23 Data was analyzed with IBM SPSS version 28. The severity of BPD symptoms was
24 represented by the IPDE continuous count. Interpersonal ER was operationalized by the scores
25 of the four IERQ subscales (enhancing positive affect, perspective taking, soothing, and social

modeling). Omission errors were calculated as the proportion of trials in which responses were either not given at all or given after the allotted time of 2000 milliseconds.

Data from three participants were excluded due to missing data for the IERQ. In addition, task data from two participants, who completed the IPDE screening, had to be excluded from analyses because no responses were recorded. The resulting sample sizes are indicated per analysis below.

To ensure validity of responses, several steps were taken before analyzing the data set. Responses were first screened for unrealistic responses (for example age of 110 or always responding with the same answer option). In the survey settings, it was ensured that participants could not respond more than once using the same link. Task data were screened for extreme outliers and patterns in accuracy and reaction times (see below).

Preliminary analyses

Preliminary analyses were conducted to test the distribution of variables and to test underlying assumptions. Residual plots and scatterplots revealed no deviations from linearity. To check outliers, data were standardized. Outliers were defined as scores being either ≥ 3.5 SD or ≤ -3.5 SD of mean WM values. Three outliers were identified. Since *Cook's d* values indicated no influential cases, we did not exclude these outliers to avoid data loss and increase generalizability. Collinearity was examined by tolerance values and VIF scores (Hair et al., 2010). For omission errors as predictors, collinearity diagnostics partly indicated scores outside of the normal range.

Bivariate associations between all variables were analyzed with Pearson correlations and are reported in Table 1. Omission errors during each distractor condition as well as during distractor-free trials were moderately to highly correlated (between $r=.309$ and $r=.823$).

Using Pearson correlations, we further tested if age, education level, and nationality correlated with the main outcomes. No significant correlations were found between these demographic variables and WM or BPD symptom severity. Age and education were

significantly correlated to a few ipER strategies ($p < .05$, see Table 1). In all analyses, we added age as a possible confounder (statistical covariate). Given that education was an ordinal variable, using it as a covariate may present a methodological issue, which is why we tested for its effect in separate analyses. Analysis with and without education level did not differ substantially (see Supplementary Tables 3-7).

Manipulation check

We ran a manipulation check to test if the proportion of omission errors differed between distractor and distractor-free trials ($N = 70$). A repeated measures analysis of covariance (rm-ANCOVA) revealed a significant main effect of condition ($F_{(4,66)} = 3.30$, $p = .016$, $\text{partial } \eta^2 = .17$). There were significant differences for omission errors during distractor-free trials versus facial distractors ($t_{(64)} = 3.35$, $p = .001$, Cohen's $d = 0.45$). There were no significant differences between the four distractor conditions (see Table 1 for means with standard deviation).

No significant main effects of condition were detected for RT of correct trials ($F_{(4,66)} = 1.32$, $p = .272$, $\eta^2 = .07$. BPD symptoms: $F_{(4,66)} = 1.83$, $p = .327$, $\eta^2 = .07$). Findings indicated that the different distractor types (facial expressions) did not have differential effects on task performance. To test if results for the distractor conditions were confounded by basic WM performance (omission errors during distractor-free trials), we ran additional analyses, controlling for basic omission errors, as described below.

Hypotheses testing

To test our hypotheses, a series of linear regression analyses was performed. In all analyses, age was added as a statistical covariate. Hypotheses 1-3 were analyzed with a series of multivariate linear regression analyses. For all multivariate linear regression models, effect size *partial* eta squared ($\text{partial } \eta^2$) was calculated. Values of $\text{partial } \eta^2 \leq .01$ indicate a small effect, $\text{partial } \eta^2 = .06$ corresponds to a medium effect, and $\text{partial } \eta^2 \geq .14$ represents a large effect. Post-hoc power analyses indicated that with a sample size of $N=124$ and $N=65$, a

multivariate analysis would result in a power of 0.99 and 0.92 respectively to detect medium to large effect size ($f^2 = .25$).

In the first analysis (hypothesis 1), a multivariate linear regression analysis with the mean IPDE sum score as the predictor and the means of the four IERQ subscales as the dependent variables was performed. In the second analysis (hypothesis 2), we included omission errors during the task conditions as predictors and the four IERQ subscales as dependent variables. While we were interested in differential effects of neutral, positive (happy), and negative (fear, anger) distractors versus distractor-free conditions, omission errors during these task conditions were moderately to highly correlated (see Table 1). Therefore, we performed a series of separate multivariate analyses, each containing the four IERQ subscales as dependent variables and one of the task conditions as the predictor. For analyses including omission errors during a distractor condition, we controlled for a potentially confounding effect of basic WM (omission errors during no distractors as statistical covariate). We proceeded in a data-driven manner and only reported univariate effects on IERQ subscales for task conditions with a significant overall effect in the multivariate analyses. We further applied a Bonferroni correction for multiple testing, dividing $p = .05$ by 5 ($p_{adjusted} = .010$).

In the third model (hypothesis 3), omission errors calculated for each of the four distractor task conditions (neutral faces, happy faces, angry faces, and fearful faces) were entered as dependent variables, with the IPDE sum score as the predictor. Additionally, we controlled for a potentially confounding effect of basic WM (omission errors during no distractors) and again applied a Bonferroni correction for multiple testing ($p_{adjusted} = .010$).

To test our fourth hypothesis that at least part of the effect of BPD symptoms on using ipER strategies would be accounted for by WM functioning, a hierarchical regression analysis was performed. We specifically did this for the ipER strategies associated with the severity of BPD symptoms in the sample of participants who conducted the experimental task ($N = 68$). The dependent variable (Y variable) was ipER (IERQ subscales, for which a significant effect

had been observed in the previous analyses). In a first step, the IPDE sum score was included as predictor (X variable). In a second step, omission errors were added as predictors. Again, we proceeded in a data-driven manner and only included omission errors for the experimental task conditions that were correlated with ipER and BPD symptoms. In a third step, we again controlled for a potentially confounding effect of basic WM (omission errors during no distractors as a covariate). In order to have a consistent sample size of $N = 68$ with a similar statistical power, missing items of IERQ scores in three participants, who completed both the IPDE and the task, were replaced by the series means (please note that this did not change the results as compared to the $N = 65$ sample).

Transparency and Openness

According to European law (GDPR), the sharing of data containing potentially identifying or sensitive information is restricted. Our data involving identifiers of clinical participants are not freely available in the manuscript, supplementary files, or in a public repository. Data access can be requested on reasonable demand by contacting the corresponding author.

Results

Borderline personality disorder symptoms and ipER-subscales (hypothesis 1).

The analysis ($N=124$) revealed a significant predictive effect of BPD symptom severity on the IERQ subscale scores (*Wilks' Lambda* $\Lambda = 0.92$, $F_{4,118} = 2.58$, $p = .041$), with a *partial* $\eta^2 = .08$ corresponding to a medium to large effect. Age as the covariate had a significant effect (*Wilks' Lambda* $\Lambda = 0.76$, $F_{4,118} = 9.50$, $p < .001$, *partial* $\eta^2 = .24$).

Univariate analyses and parameter estimates are summarized in Table 2. All estimated effects were in a negative direction. Specifically, more severe BPD symptoms predicted a less frequent use of enhancing positive affect ($F_{1,121} = 7.13$, $p = .009$, *partial* $\eta^2 = .06$) and social modeling ($F_{1,121} = 4.58$, $p = .034$, *partial* $\eta^2 = .04$). In contrast, BPD symptoms did not significantly predict perspective taking ($F_{1,121} = 3.79$, $p = .054$, *partial* $\eta^2 = .03$) and soothing ($F_{1,121} = 0.57$, p

= .451, $\text{partial } \eta^2 = .01$). For the subsample of participants, who performed the WM task, only the effect of enhancing positive affect was significant ($F_{1,61} = 7.09$, $p = .010$, $\text{partial } \eta^2 = .11$, all other $p > .099$).

Working memory performance and ipER subscales (hypothesis 2).

In the second analysis ($N = 65$), we separately investigated multivariate effects of omission errors during each task condition on the IERQ subscale scores. There was a significant effect of task performance during distractor-free trials (*Wilks' Lambda* $\Lambda = 0.78$, $F_{4,58} = 4.17$, $p = .005$), with $\text{partial } \eta^2 = .22$ corresponding to a large effect size. None of the distractor conditions had a significant effect, when controlling for basic WM (Supplementary Table 3). Univariate analyses and parameter estimates for omission errors during distractor-free trials revealed that omission errors in distractor-free trials predicted a less frequent use of enhancing positive affect, without significant effects for perspective taking, soothing, or social modeling (Table 3).

Borderline personality disorder symptoms and WM performance (hypothesis 3).

The analysis ($N = 68$) revealed that BPD symptom severity predicted the number of omission errors during the four distractor conditions in the WM task (*Wilks' Lambda* $\Lambda = .85$, $F_{4,62} = 2.72$, $p = .038$), with a $\text{partial } \eta^2 = .15$, equivalent to a large effect. This effect remained significant when controlling for omission errors during distractor-free conditions (*Wilks' Lambda* $\Lambda = .85$, $F_{4,62} = 2.64$, $p = .042$, $\text{partial } \eta^2 = .15$). Univariate analyses and parameter estimates are summarized in Table 4. When separating between the experimental task conditions, BPD symptoms positively predicted omission errors in the presence of happy faces, even when controlling for omission errors at distractor-free trials (see Table 4).

Working memory performance, BPD symptoms, and ipER (hypothesis 4).

Since BPD symptom severity particularly strongly predicted the ipER strategy enhancing positive affect, we focused on this IERQ subscale as a dependent variable. Moreover, only omission errors during distraction by happy faces were correlated with both the ipER strategy enhancing positive affect and with BPD symptoms (Table 1). Therefore, we restricted

the hierarchical regression analysis to this condition: omission errors for distracting happy faces were included in the second step. In the third step, we controlled for basic WM, next to age. Results of the analysis ($N = 68$) are summarized in Table 5.

Adding omission errors for distracting happy faces next to BPD symptoms slightly increased the explained variance of the regression model ($R^2_{\text{change}} = 0.069$, $F_{\text{change}} = 5.90$, $p = .018$). More omission errors during distracting happy faces predicted a less frequent use of IERQ enhancing positive affect, while the effect of BPD symptoms was not significant. Adding omission errors during distractor-free conditions in the third step again slightly increased the explained variance ($R^2_{\text{change}} = 0.050$, $F_{\text{change}} = 4.54$, $p = .037$). In this last (combined) model, only omission errors during distractor-free trials were a significant predictor.

Discussion

In this study, we investigated associations between interpersonal emotion regulation strategies (ipER), borderline personality disorder (BPD) symptoms, performance during a modified working memory (WM) task, and the interfering effect of social-affective distractors. Our findings partially support our hypotheses.

As hypothesized, higher levels of BPD symptoms predicted a less frequent use of ipER strategies (hypothesis 1). This association was most clearly seen for enhancing positive affect. Better task performance during distractor-free trials predicted a more frequent use of ipER strategies. However, in contrast to our second hypothesis, this effect was not observed for trials with social-affective interference but only for trials without any distraction. In line with hypothesis 3, participants with more BPD symptoms showed more omission errors, when social-affective distractors – particularly happy facial stimuli – interfered with task performance. This finding extends previous studies by showing an interference effect for social-affective distractors with positive valence. Lastly, the association between BPD symptoms and using enhancing positive affect seemed to be partly explained by basic task performance

without distractors. All in all, our findings point to a differential effect of task conditions with and without social-affective interference on the use of ipER and BPD symptoms.

Interpersonal emotion regulation and borderline symptom severity.

While higher levels of BPD symptoms overall predicted a less frequent use of ipER strategies, the effect was most pronounced for enhancing positive affect through others. This may align with the finding by López-Pérez and colleagues (2017) that individuals with BPD features are less frequently engaged in improving positive affect in others, although the current study investigated the up-regulation of one's own positive mood. There is growing evidence that people with BPD or BPD features have more difficulties experiencing intimacy and closeness in relationships and describe themselves as an outsider within their social network (Bohus et al., 2021). A strong ambivalence between a need to belong and a fear of intimacy is a typical attachment style that has been associated with BPD and its symptoms. In people with a less supportive network, close affiliations may increase the fear of loss and rejection, which may prevent them from relying on others. This may interfere with the search for social support in general. Surprisingly, our follow-up analyses did not reveal significant associations between BPD symptoms and the use of soothing (that is, seeking out others for comfort and sympathy) or any other ipER strategy. These discrepancies may be explained by methodological aspects. Enhancing positive affect can be differentiated from the other ipER strategies in that it measures the frequency of using ipER depending on current affective states. Although we did not assess the context in which ipER strategies are used, situational factors might modulate the frequency of their use in individuals with more BPD symptoms. Growing research suggests that the main problems in BPD are not only the lack of certain strategies but an inflexible use of them, especially in interpersonal situations (Daros & Williams, 2019; Fitzpatrick et al., 2023; Sorgi-Wilson & McCloskey, 2022). Moreover, enhancing positive affect is the only IERQ scale that refers to positive emotions, while the other strategies refer to regulating negative emotions (Pruessner et al., 2020). In previous research, both state and trait positive affect increased the

use of this particular strategy, while state and trait negative affect decreased the frequency of its use (Hofmann et al., 2016; Pruessner et al., 2020). Therefore, another plausible explanation for our findings is that an increased negative affectivity – or reduced positive affectivity – drives the choice of ipER strategies in those with more BPD symptoms. Since people with more severe BPD symptoms might experience less joy and happiness in general, they may feel less inclined to use a strategy that focuses on their positive mood.

Interpersonal emotion regulation and social-affective interference.

Better task performance was related to a more frequent use of enhancing positive affect. Contrary to our hypothesis, this was only found for task performance without social-affective interference. Interestingly, basic task performance partly accounted for the association between BPD symptoms and IERQ enhancing positive affect. While these findings need to be replicated in further studies, they may highlight the role of cognitive functions such as attentional control and WM in processing social information in BPD.

Interpersonal emotion regulation, BPD symptom severity and the interference of social-affective stimuli with goal-directed behavior.

In line with previous studies, more severe BPD symptoms predicted stronger cognitive impairments in the modified WM task, when facial distractors were present, and this was not explained by task performance in distractor-free trials (Krause-Utz et al., 2014; 2022). Previous studies found an attentional bias to threatening stimuli (for example angry faces), which may generalize to more ambiguous facial expressions (Kaiser et al., 2016; Krause-Utz et al., 2022; Veague & Hooley, 2014). Extending this literature, our findings suggest that the effect of social-affective interference is not restricted to distractors with negative valence, since participants with more severe BPD symptoms specifically showed more omission errors for happy faces. Happy faces may be even more salient for individuals with more BPD symptoms, causing more disturbances in WM performance. Happy faces might also be associated with more ambiguity since BPD patients previously reported lower confidence in the judgment of happy faces

(Biermann et al., 2022; Thome et al., 2016). Our findings underscore the relevance of changes in affective-cognitive processing in people with BPD symptoms, both in negative and positive valence systems.

In contrast to earlier studies, we did not find a distracting effect of fearful, angry, or neutral faces, although neutral faces are usually perceived as highly salient and more ambiguous in BPD (Krause-Utz et al., 2012; 2014). A possible reason for these discrepancies is that our sample may not be fully comparable to these previous studies and findings may be specific for attentional errors in the processing of faces (see Kaiser et al., 2016). Although most participants in the current study reported at least mild BPD symptoms and around 30% met a proposed cut-off suggesting a possible diagnosis, we did not contrast a group of patients with confirmed BPD diagnosis to healthy controls. While we did not investigate ipER in the context of the dimensional model of personality disorders (Bach et al., 2021; Widiger & McCabe, 2020), we included a continuous measure of BPD diagnostic criteria-related symptoms, which may provide additional insights and stimulate future studies.

Limitations, future directions and clinical implications.

Findings need to be interpreted in the light of several limitations. Due to the COVID-19 pandemic, data collection had to take place online. This led to a less controlled setting for the experimental task. It has also decreased the number of individuals participating in the experimental task as the second part of our study, with the consequence of a lower statistical power in the smaller (sub)sample. This is particularly relevant for the analyses of task performance and its relation to BPD symptoms and ipER strategies, which should be replicated with larger samples. In the current study, we included participants who reported that their current biological sex is female. Since we did not additionally assess gender identity, findings cannot be generalized to men or be interpreted in a broader context of gender diversity. Future studies should investigate men and use more comprehensive demographic measures for both sex and gender in order to characterize the sample more precisely. Since we had to make sure

1 that participants were not at acute risk for crisis behavior in the absence of an experimenter,
2 this exclusion criterion might have caused a selection bias. Moreover, the task only included
3 white faces, which might have influenced the findings, as our sample included a diversity of
4 nationalities. In addition, we did not assess co-occurring mental conditions, such as depression
5 or post-traumatic stress disorder (PTSD) symptoms, limiting the specificity and generalizability
6 of findings for individuals with symptoms of BPD.

7 Unlike earlier studies that used the adapted Sternberg (emotional WM) task, we did not
8 compare individuals with a BPD diagnosis confirmed by clinical interviews with healthy
9 controls. Instead, we used a continuous count of BPD symptom severity. Considering that many
10 individuals – including former patients – may still lie on the spectrum of having some degree
11 of BPD symptoms, it can be argued that the present results address difficulties in WM, social-
12 affective interference, and interpersonal regulatory strategies for those not included in previous
13 studies. Even when not fully qualifying for a diagnosis, people with severe BPD symptoms may
14 struggle with focusing on goal-directed behavior in the presence of disturbing information and
15 with cognitive problems, which may influence their use of ER strategies. In this sense, our
16 findings may provide additional insights into the relationship between coping with social-
17 affective cues, cognitive performance, and ipER, complementing findings of studies that
18 included well-characterized clinical groups. It is important to consider that we used a screening
19 inventory to assess the number of BPD criteria. Screening inventories often considerably
20 overestimate the presence of diagnostic criteria, resulting in high sensitivity but relatively low
21 specificity, suggesting the need to interpret our findings in regard to BPD with caution.
22 Moreover, the used instrument aims at assessing BPD criteria-related symptoms in contrast to
23 pathological personality traits as suggested in the alternative model of the Diagnostic and
24 Statistical Manual of Mental Disorders 5 (DSM-5; American Psychiatric Association, 2013;
25 Bach et al., 2021).

We focused on four ipER strategies introduced by Hofmann et al. (2016) using a self-report questionnaire. Compared to live-ratings, for example during ambulatory assessment approaches, these responses have reduced ecological validity, which constitutes a limitation of the present study. Translating findings to real life needs to be done with caution. While measuring the frequency of using ipER strategies, we did not take their efficiency or situational context into account. Based on the evaluation of ipER within an individual's social network, Howard and Cheavens (2023) showed that higher BPD features were associated with a lower perceived efficiency of ipER. Moreover, individuals with more BPD features used ipER strategies less often within relationships and more frequently reached out to unsupportive or unavailable contact persons. These findings point to a less adequate and context-adapted use of ipER. Further studies need to investigate ipER in a broader context of other factors, including social reactions and acute stress-related dissociation (Krause-Utz et al., 2012), investigating whether and how the use and perceived efficiency of these strategies are intertwined. These studies would also benefit from a longitudinal design since cross-sectional designs (as used in the current study) have the limitation that they preclude conclusions about temporal relationships relevant to understanding the underlying mechanisms. Alternative conceptualizations of ipER emphasizing the response-dependency of ipER may be of importance here (Zaki & Williams, 2013). In their model, Zaki and Williams (2023) propose that certain ipER processes depend on the reaction of an interaction partner, while others are relatively independent from the social partner's response.

Future studies may also investigate the role of childhood adversities, since ER develops in close interaction with primary caretakers. The prevalence of childhood abuse and neglect in BPD is high (Kleindienst et al., 2020; Porter et al., 2020). Emotional invalidating experiences, such as incongruent responses from the social environment, may constitute an important factor for cognitive performance and ipER in BPD (Krause-Utz et al., 2022; Musser et al., 2018). More specifically, response-dependent ipER strategies could be of particular importance in

those who repeatably experienced invalidation and developed higher levels of distrust, rejection sensitivity, and intimacy fear (Fitzpatrick et al., 2023).

Our findings highlight the relevance of cognitive functioning in the use of ipER strategies. Executive functions, such as attentional control and WM, are crucial to goal-directed behavior. Deficits in these functions can impede processes needed for self-regulation and interpersonal functioning (Koch et al., 2018). Since we did not use a separate basic WM task and focused on attentional errors, we cannot unequivocally interpret omission errors in distractor-free trials as disturbed WM performance. We applied an experimental task which was not primarily designed to capture basic WM functioning. This task rather measures disturbed cognitive performance in the presence of social-affective information. We cannot rule out that other cognitive processes, such as motor slowing or attentional or motivational deficits, have influenced the results. Therefore, our findings should be interpreted in a wider context of cognitive functions, also involving attentional control and task disengagement. Studies using more simple cognitive tasks might find similar effects. To further elucidate this, future research should include other tasks on basic executive functioning, including basic WM tasks. This is of particular interest since WM training improved ER in patients with BPD (Krause-Utz et al., 2020).

Conclusion

In conclusion, our findings point to a diminished use of ipER, especially the enhancement of one's own positive affect, in individuals who report more BPD symptoms. BPD symptoms and cognitive performance deficits were consistently linked to reduced use of enhancing positive emotions through others. If replicated, our findings may have important implications, as they point to altered processing of positive social stimuli, possibly based on an altered valence or reward system in BPD. This may have implications for psychosocial interventions. Individuals with BPD may struggle to improve their affective state in social interactions with the therapist, depending on their cognitive capacities. These difficulties may

- 1 be accentuated in the presence of positive social cues from the interaction partner, similar to
- 2 social cues of threat. However, additional research is needed to investigate context-dependent
- 3 alterations in negative and positive valence systems and how these alterations are related to
- 4 the severity of personality traits and facets.

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