ACCEPTED MANUSCRIPT

A mixed methods examination of emotional expression and its impact on emotion regulation effectiveness in borderline personality disorder

Sonya Varma[1], Jenna Traynor[2,3], Skye Fitzpatrick[1]

[1]Department of Psychology, York University

[2]Department of Psychology, University of Toronto Scarborough

[3]Centre for Addiction and Mental Health

Word count: 5485

Author Note:

The authors have no known conflicts of interest to disclose. All participants provided informed consent, and this work was conducted under approval from relevant institutional research ethics boards. Correspondence regarding this article should be addressed to Skye Fitzpatrick, Department of Psychology, York University, 4700 Keele Street, Toronto, Ontario, M3J 1P3, Canada. E-mail: skyefitz@yorku.ca

Funding: This work was supported by the Canadian Institutes of Health Research (CIHR) Frederick Banting and Charles Best Canada Graduate Scholarship Doctoral Award and the CIHR postdoctoral fellowship award [grant numbers 201210GSD-304038-229817 and 201711MFE-395820-229817], The Harry Rosen Stress Institute Award, Toronto, ON; and the Ontario Mental Health Foundation Studentship Award, Toronto, ON.

Key Words: emotional expression, borderline personality disorder, valence, emotionality, vocabulary

Abstract

Background and Objectives: Emotional expression (i.e., identifying and labeling emotion using specific words), is theorized to reduce negative emotion and facilitate emotion regulation. However, it remains unclear how individuals with borderline personality disorder express emotion, and whether this influences their emotion regulation. This study examined whether: 1) emotional expression in borderline personality disorder differed from healthy controls based on word valence, emotionality, and vocabulary; and 2) whether such characteristics predict emotion regulation effectiveness across self-reported and physiological emotion domains differentially across these groups.

Methods: Individuals with borderline personality disorder (n=29) and age and sex-matched healthy controls (n=30) listened to an evocative story, expressed emotion, and regulated emotion by applying Mindfulness or Cognitive Reappraisal. Emotion regulation was measured by changes in self-report, parasympathetic, and sympathetic emotion, while implementing the emotion regulation strategies. The words used to express emotion were coded based on valence, emotionality, and depth of vocabulary.

Results: Generalized estimating equations revealed no differences between groups in valence, emotionality, and vocabulary. Additionally, using a larger emotional vocabulary predicted more effective sympathetic emotion regulation, and using more negatively valenced words predicted more effective parasympathetic emotion regulation across groups.

Limitations: Among other things, this study is limited by its predominantly female sample, and that it does not determine whether valence, emotionality, or vocabulary independently predict emotional *expression* effectiveness.

Conclusions: Emotional expression may not be deficient in borderline personality disorder across the indices studied. Using more negative words and broadening vocabulary while expressing emotion may offer emotion regulation benefits.

Keywords: emotional expression, borderline personality disorder, valence, emotionality, vocabulary

Highlights:

- Emotional expression may not be deficient in borderline personality disorder
- Using a broader vocabulary to express emotion improves emotion regulation
- Using more negative words to express emotion improves emotion regulation

CRediT Author Statement:

Sonya Varma: Conceptualization, Methodology, Formal Analysis, Writing – Original draft preparation, Project Administration, Investigation
Jenna Traynor: Writing – Original draft preparation; Writing - Reviewing and Editing,
Skye Fitzpatrick: Supervision, Conceptualization, Methodology, Funding Acquisition, Resources, Project Administration, Investigation, Writing - Reviewing and Editing

1 Introduction

Emotion dysregulation, which includes disrupted experiences of emotion and emotion regulation deficits (i.e., difficulties modulating emotion automatically or of one's own volition (Gross & Thompson, 2007), is theorized to be the core feature of Borderline Personality Disorder ([BPD]; Linehan, 1993, 2015; Glenn & Klonsky, 2009). Improvements in emotion regulation are associated with improved BPD treatment outcomes (e.g., McMain et al., 2010; Neacsiu et al., 2010). However, emotion regulation involves several processes which may, or may not, be deficient in BPD.

One facet of emotion regulation in BPD is emotional expression, which involves the verbal and nonverbal language or behaviours deployed to convey one's emotional experiences (Gross, 1998). The Biosocial Model of BPD (Linehan, 1993) theorizes that, throughout development, individuals with BPD are intermittently reinforced by caregivers for escalating the emotionality or negative-valence of emotional expressions (e.g., I'm "enraged" versus "annoyed"). Such early environments theoretically fail to teach individuals with BPD to understand, accurately identify, and express their emotions (e.g., see Fruzzetti et al., 2005; 2015; Linehan, 1993). Such inaccurate expression is theorized to result in others misunderstanding and invalidating individuals with BPD, further exacerbating their emotion dysregulation over time (Fruzzetti et al., 2005). However, limited research has examined which facets of emotion identification and expression may be deficient in BPD, and whether people with BPD actually do express emotion differently than healthy controls (HCs). Therefore, it is unclear *how* clinicians should specifically encourage people with BPD to improve their emotional expression.

1.1 Emotional Expression in BPD

Extensive work suggests that the ways individuals with BPD interpret and express the emotions of and to others is deficient. Several theorists postulate, for instance, that BPD is associated with low empathy towards others and deficits in perspective taking (e.g., Clarkin et al., 2007), and difficulties reflecting on the mental states of others or oneself (e.g., Sharp et al., 2011; Fonagy & Bateman, 2008; Bender & Skodol, 2007). BPD also involves increased negative appraisal biases towards interpersonal information compared to healthy and clinical groups (e.g., Dyck et al., 2009; Thome et al., 2016; Barnow et al., 2009), and a negative bias in emotion recognition specifically, attributing negative emotions to neutral facial expressions (e.g., Fenske et al., 2015). Thus, research generally suggests that there are deficits in recognizing the mental states (including emotional experiences) of others in BPD. However, less research has examined individuals with BPD's own capacity to recognize and express their emotional states *to* others.

Although there are some exceptions (e.g., Derks et al., 2017), BPD is strongly associated with self-reported difficulties identifying and describing emotional experiences (i.e., alexithymia; Sinfeos, 1973; Lecours & Bouchard, 2011; Modestin et al., 2004; Zlotnic et al., 2001) compared to healthy and clinical groups (e.g., avoidant personality disorder; Berenson et al., 2018; van Dijke et al., 2013). Overall emotional expression deficits, which encompass identifying and expressing one's own emotional state *to* others, may therefore be specifically characteristic of BPD. However, emotional expression is multifaceted. Indeed, Gross and Jazaieri (2014) review several types of emotion-related processes (encapsulating emotional experiencing and expression) that can be problematic in the context of psychopathology. Although not an exhaustive list, they highlight that emotional intensity can be problematic when experiencing positive or negative emotions, and when experienced excessively (e.g., heightened emotion intensity) or deficiently (Gross & Jazaieri, 2014). They also indicate that emotional

hypoawareness (i.e., alexithymia, or having a narrower emotional vocabulary) can impede emotion regulation effectiveness. Emotional expression can accordingly vary based on its *emotionality* (e.g., irritated versus enraged), *valence* (e.g., positive versus negative), and *vocabulary* (e.g., how many or few distinct emotion words are used). While these do not represent *all* components or problems associated with emotional expression, these are particularly relevant given extensive evidence indicating that BPD is characterized by problems with emotion intensity in excess (heightened baseline emotional intensity and reactivity; e.g., Kuo & Linehan, 2009; Dixon-Gordon et al., 2013; Baskin-Somers et al., 2012), increased levels of negative emotion compared to positive emotions (e.g., Chu et al., 2016), and alexithymia (e.g., Lecours & Bouchard, 2011).

Furthermore, as individuals with BPD's early environments theoretically reinforce escalations in emotional expression (e.g., Fruzzetti & Payne, 2015; Linehan, 1993), both the *valence* and *emotionality* of the expression may be elevated in this group. Such elevations may be present even after accounting for the heightened negative emotional *intensity* that characterizes BPD (e.g., Kuo & Linehan, 2009; Kuo et al., 2016). Further, while research examining emotional *vocabulary* is also limited, given that individuals with BPD theoretically fail to learn to identify and regulate emotions early in life (Linehan, 1993; Fonagy et al., 1995; Bateman & Fonagy, 2010), they may not have developed sufficient emotion vocabulary. This may exacerbate other emotion dysregulation components, as one study demonstrates that those with BPD who evince a broader, as opposed to narrower, *general* vocabulary exhibit less affective instability (Dick & Suvak 2018). Taken together, theory suggests that emotional expression in BPD is deficient, although little research has examined *how* by simultaneously examining several emotional expression characteristics in BPD. Such research is essential to

illuminate specific areas of problematic emotional processing in BPD, and therefore provide additional information about the nature of BPD itself, as well as which components (i.e., valence, emotionality, or vocabulary) of emotional expression require targeting in BPD-interventions.

1.2 Emotional Expression and Emotion Regulation

Furthermore, it remains unclear how emotional expression influences emotion regulation in BPD. Emotion regulation can be intentional (i.e., deploying a strategy to decrease emotion), or incidental (i.e., a strategy that modulates emotion without explicit regulatory intention; Lieberman et al., 2007; 2011). Emotional expression can be a form of incidental emotion regulation (Lieberman et al., 2007; 2011) wherein identifying and labelling an emotion may independently decrease emotional intensity (e.g., Lieberman et al., 2011). Indeed, expression with specific emotion words, compared to non-specific or non-emotion words, is associated with increased neural activation patterns reflective of *improved* emotion regulation (Brooks et al., 2017). Moreover, expressing emotion by labelling it *potentiates* the effectiveness of subsequent intentional emotional regulation strategies such as cognitive reappraisal (i.e., thinking about an emotional experience differently; Gross & John, 2003) and distraction (Lieberman et al., 2011).

Preliminary research suggests that the ways individuals with BPD express emotion may influence emotion regulation effectiveness (i.e., the degree to which an intentional emotion regulation strategy alters emotional intensity). Meaney and colleagues (2016) found that difficulties identifying feelings and rumination mediated and moderated the relationship between BPD symptoms and dysregulated behaviours (e.g., binging, self-injury), while difficulties describing one's feelings and expressive suppression mediated the same relationship. However, the relationship between distinct emotional expression characteristics (e.g., valence, vocabulary) and emotion regulation effectiveness in BPD is unclear.

Relatedly, Fitzpatrick et al (2019) examined whether emotional expression via labelling emotion differentially influenced two emotion regulation strategies in BPD compared to HCs in a laboratory study. The emotion regulation strategies studied are emphasized in BPD treatments (e.g., Linehan, 1993) and were mindfulness (i.e., observing present emotion without judgment; Kabat-Zinn, 2003; Segal, William, & Teasdale, 2013) and cognitive reappraisal. Fitzpatrick et al.'s (2019) findings suggested that, while emotional expression increased *parasympathetic* incidental emotion regulation effectiveness using these strategies in BPD, it impacted *self-reported* intentional emotion regulation effectiveness in HCs only. These discrepant findings underscore the importance of studying emotion processes comprehensively across self-report, parasympathetic, and sympathetic domains, which are only imprecisely related rather than direct reflections of each other (e.g., Bernston et al., 1994; Rosenthal et al., 2008). Although Fitzpatrick and colleagues' (2019) work suggested that emotion expression may facilitate parasympathetic emotion regulation in BPD, it did not examine *how* participants expressed emotion (i.e., valence, emotionality, and vocabulary) and whether these influence emotion regulation. This empirical gap prevents understanding how clinicians should target expression in BPD (e.g., improving emotional vocabulary by emphasizing the acquisition of new emotion terms or the capacity to recognize emotionality by emphasizing gradations in emotional intensity) to optimize emotion regulation. Understanding how specific forms of emotional expression influence emotion regulation in BPD would provide clinicians with key information regarding whether valence, emotionality, and/or vocabulary require targeting to improve emotion regulation, consequently optimizing BPD treatment outcomes.

1.3 Present Study

Despite the theorized centrality of deficient emotional expression in BPD, several empirical gaps obfuscate whether and how people with BPD express emotion deficiently, and whether these characteristics predict emotion regulation effectiveness. Therefore, this study first examined whether people with BPD express emotions differently than HCs based on valance, emotionality, and emotional vocabulary, after controlling for self-reported negative emotional intensity. This is particularly necessary to determine whether emotional expression deficits in BPD simply reflect the heightened negative emotional intensity observed in this population (e.g., Kuo & Linehan, 2009; Dixon-Gordon et al., 2013; Baskin-Somers et al., 2012) or instead reflect problems with expression specifically. Based on existing theory and research (e.g., Linehan, 1993; Fruzzetti et al., 2005; 2015; Modestin et al., 2004; Lecours & Bouchard, 2011), we hypothesized that those with BPD would express emotions more negatively, with increased emotionality, and a narrower emotional vocabulary. Second, we investigated whether distinct emotional expression characteristics impact emotion regulation effectiveness of BPD-relevant strategies across self-report, parasympathetic, and sympathetic emotion domains, and whether this differed across BPD and HCs. Given studies suggesting that precise emotional expression potentiates emotion regulation effectiveness (Lieberman et al., 2011; Fitzpatrick et al., 2019), we postulated that, across groups, using a broader emotional vocabulary would bolster emotion regulation effectiveness. Given a dearth of literature, we considered the impact of word valence and emotionality on emotion regulation effectiveness exploratory.

2 Materials and Methods

2.1 Participants

This project is drawn from a parent study examining whether emotional expression (termed “labelling” in the parent manuscript) impacts self-reported and physiological emotion

processes in BPD and HCs. The recruitment procedures, sample characteristics, and study design are described comprehensively elsewhere (Fitzpatrick et al., 2019), and relevant components are reviewed briefly here.

Participants in the present analyses were 29 individuals with BPD and 30 age- and sex-matched HCs between 18 and 60 years old. Prospective BPD and HCs participants were excluded at a screening stage if they: 1) reported experiences consistent with severe psychotic-spectrum disorders, bipolar I disorder, or current alcohol or substance dependence; 2) took psychiatric medications other than selective serotonin reuptake inhibitors, given that these exert less pronounced effects on cardiac measurement (Licht et al., 2010); or 3) took other medications or had medical conditions (e.g., beta-blockers, heart problems, epilepsy) that could interfere with psychophysiological measurement. HCs were also excluded if their reports met diagnostic criteria for any current psychological disorders, if they met at least four BPD criteria, or if they met the suicide/self-injurious behaviour BPD criterion.

2.2 Procedures

Participants were recruited predominantly through flyers posted at relevant health care institutions (e.g., psychotherapy private practices in Toronto, community centres) and online advertisements on Kijiji and Craigslist. Interested participants first underwent brief phone or online screening assessments. Those suspected to be eligible based on such assessments were then invited to undergo diagnostic assessments by undergraduate- and MA-level assessors under a licensed clinical psychologist's supervision. All such participants underwent the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders-IV-TR (SCID-IV-TR; First et al., 1996) to assess for the presence of what were formerly known as "Axis I"

disorders. They were also administered the International Personality Disorders Examination-BPD Module (IPDE-BPD; Loranger et al., 1994) to assess for presence of BPD.

All eligible participants based on these assessments attended an in-person laboratory experiment. The experiment was a within-subjects design with four trials. For each trial, all participants underwent BASELINE, EMOTION INDUCTION, and EMOTION REGULATION blocks.[1] Prior to beginning the experiment, physiological recording equipment was attached to participants and they were trained in the experimental paradigm. Within each trial, following five-minute baselines, participants underwent 2-minute EMOTION INDUCTION blocks. These EMOTION INDUCTION blocks involved participants listening to a distinct evocative story for each trial to elicit negative emotion. Participants were instructed to envision that they were the protagonist during each induction, imagining that the circumstances comprising the stories happened to them directly. Of the four trials, two EMOTION INDUCTION blocks involved a LABEL (i.e., emotional expression) condition, and two involved a CONTROL condition. During the EMOTION INDUCTION, participants were either asked "what are you feeling right now"? (i.e., LABEL condition); or 2) asked to describe the objects they imagined in the scene of the scripts they listened to (i.e., CONTROL condition). The parent study involved a direct examination of the LABEL and CONTROL conditions (Fitzpatrick et al., 2019). However, only data collected during the LABEL conditions were used in this study, given its exclusive focus on emotional expression.

For the LABEL condition, participants were instructed to type their current emotional states into a computer, even in the absence of negative emotion (e.g., happy, neutral, boredom). Simultaneously, a list of example emotions (i.e., anxious, angry, afraid, sad, ashamed, guilty,

[1] Additional EMOTION INDUCTION (i.e., describing the auditory scripts used to induce negative emotion) and EMOTION REGULATION block (i.e., Mindfulness and Cognitive Reappraisal training procedures) details are available in the Supplement.

disgusted, surprised, interested, happy, neutral) appeared on the screen. Participants were allowed to: 1) use any word, whether or not it appeared on the list; 2) write the same word multiple times; 3) provide as many responses as they wanted to in order to accurately reflect their emotional experience; and were told to 4) write at least one response. The screen refreshed every 20-seconds, removing previously-added words from view.

Following the EMOTION INDUCTION, there was a 2.5-minute EMOTION REGULATION block wherein participants were instructed to sit quietly and practice either Mindfulness or Cognitive Reappraisal to help reduce negative emotion. During Mindfulness, participants were instructed to notice and observe their present emotional experiences without judgment. During Cognitive Reappraisal, participants were instructed to try to change their emotions by thinking about the emotion induction in an alternative way. Participants were trained in these strategies prior to beginning the experiment. Participants completed visual analog scales (VAS) after each block, and then repeated the entire trial, implementing the strategy that they hadn't yet completed. All participants underwent LABEL and CONTROL conditions, and Mindfulness and Cognitive Reappraisal trials, and strategy order was counterbalanced. Participant data from conditions was removed if participants were obviously not complying with task instructions, data was uninterpretable (physiological data only), or participants did not provide at least one word during the LABEL condition.

2.3 Materials

2.3.1 Emotional Expression Characteristics

2.3.1.1 Data Cleaning and Coding Procedures. Words used during the LABEL condition were systematically cleaned and coded for emotional expression valence, emotionality, and depth of vocabulary. If a word contained a minor spelling error but the intended word was

apparent or the word seemed to be accidentally fragmented (e.g., participant wrote "dis" before the screen refreshed and "gust" after it), it was modified to reflect the accurate spelling and retained. Non-sensical strings of letters that do not exist in the dictionary and incomplete words unable to be reasonably inferred were excluded from further coding and analysis.

2.3.1.2 Alexithymia. In order to characterize the sample's baseline capacity regarding emotion identification and expression, we administered the *Toronto Alexithymia Scale (TAS; Bagby et al., 1994)* prior to physiological equipment set up and training in the experimental paradigm. The TAS is a 20-item self-report questionnaire. Participants are asked to indicate the extent to which they agree or disagree with statements related to difficulties identifying and labeling emotion on a scale from 1 ("strongly disagree") to 5 ("strongly agree").

2.3.1.3 Valence and Emotionality. Valence and emotionality ratings were obtained from the English EMOtional TErms (EMOTE) Database (Gruhn, 2016). This database provides researchers with nouns and adjectives drawn from previous work (e.g., Strauss & Allen, 2008; Bradley & Lang, 1999) to allow for empirical investigation of words based on various socio-emotional constructs. Valence was identified as "how positive or negative the feeling elicited by each word was," on a scale from 1 (very negative) to 7 (very positive). Emotionality was defined as "how emotional the meaning of each word was," ranging from 1 (not at all/neutral) to 7 (very emotional).

Each word used by participants (i.e., participant-word) was searched in the EMOTE database to determine whether there was an available "match," and, if so, assign it a valence and emotionality score. A match was identified if a word in EMOTE was either: 1) identical to the participant-word (e.g., anger = anger); or 2) had an identical word root, where the meaning of the word did not change given the prefix or suffix (e.g., sad = sadness). Participant-words without a

match within the EMOTE database were captured as missing data[2]. Of the 813 times all participants wrote a word to express their emotion, 14.5% did not have a match in the EMOTE database and these instances were not included in the study analyses. When words had a noun and adjective match, the adjective-version scores were retained. Scores for noun words were only used if those words were unavailable in the database as adjectives. The mean valence and emotionality of words within each condition (i.e., Mindfulness and Cognitive Reappraisal) was computed for each participant.

2.3.1.4 Vocabulary. Depth of vocabulary was calculated by tallying how many "unique" words (i.e., a real emotion word, different from the other words used by the participant while expressing emotion) were expressed by each participant within condition. For example, if a participant wrote "angry, mad, frustrated, angry" prior to implementing Mindfulness, they were assigned a code of 3 for vocabulary within that condition.

2.3.2 Emotion Regulation Effectiveness

Emotion regulation was indexed by changes in self-reported, parasympathetic (respiratory sinus arrhythmia; RSA), and sympathetic (skin conductance responses; SCR) emotion indices during the EMOTION REGULATION block.

2.3.2.1 Self-Reported Emotion. Consistent with the parent study (Fitzpatrick et al., 2019), VAS of discrete emotions ranging from 0 (not at all) to 100 (very) assessed self-reported emotion before and after the EMOTION REGULATION block. VAS are regarded as a reliable examination of psychological states (McCormack et al., 1988). An average, composite score of the following negative emotions was computed: fear, loneliness, anger, anxiety, shame, disgust, emptiness, guilt, hopelessness, sadness, and tension. Cronbach's alpha for this negative emotion

[2] There was one exception to these rules. Authors discussed and decided "uncomfortable" and "discomfort" were a match given their similarity in meaning.

composite was calculated independently before the BASELINE, EMOTION INDUCTION, and EMOTION REGULATION blocks for Mindfulness and Cognitive Reappraisal conditions and ranged from 0.91 to 0.94.

2.3.2.2 Parasympathetic Emotion. RSA was recorded as a measure of parasympathetic emotion (Beauchaine, 2001; Porges et al., 1994). A respiratory band secured around the chest, and a two-electrode electrocardiography configuration with a bioimpedance module for grounding was used. R-R intervals across 30-second epochs were calculated using Mindware Technologies HRV 2.33 software. All data was visually inspected and double-scored by trained research assistants to identify R-spikes and artifacts correctly. The electrocardiogram was decomposed into three frequency ranges by spectral analysis, applying an algorithm to determine spectral densities within the highest frequency band (>.15 Hz) across 30-second epochs, reflecting parasympathetic influence consistent with Berntson et al. (1997).

2.3.2.3 Sympathetic Emotion. Skin conductance responses (SCR) were measured to assess sympathetic emotion (Dawson et al., 2007), using the BIOPAC 6-channel acquisition system (Model MP150, Goleta, CA). Electrodes were placed on the medial phalanges of the non-dominant index and middle finger of participants (Fowles et al., 1981). Using low (35 Hz) and high (.05 Hz) pass filters, SCRs were digitized at 1000 samples per second, with a gain of 1000. The Mindware Technologies EDA 2.40 program was used to process all data. A rolling filter was applied to detect and remove artifacts. Within each 30-second epoch, SCR was indexed as the total number of responses above 0.05 μS.

RSA and SCR data were analyzed within 30-second epochs to yield four epochs during each EMOTION INDUCTION block, and five during each EMOTION REGULATION block.

2.4 Data Analytic Strategy

All analyses were conducted using Generalized Estimating Equations (GEE; Burton et al., 1998;) with SPSS version 26. GEE is a semi-parametric derivation of generalized linear modeling. It allows outcome variables to be examined over time and maintains information from participants with missing data to maximize statistical power. For each GEE analysis, autoregressive, exchangeable, and unstructured covariance structures were considered, retaining the structure with the lowest Quasilikelihood under the Independence Model Criterion (QIC) value. SCR is a count variable that was positively skewed (Atkins & Gallop, 2007). Therefore, a negative binomial distribution was specified for analyses examining SCR data. All continuous predictors were grand mean-centered. Multiple test corrections were not employed in present analyses given concerns regarding their potential distortion of results (e.g., Bonferroni corrections; e.g., O'Keefe, 2003; Armstrong, 2014).

2.4.1 Do Individuals With BPD Express Emotion Differently Than HCs?

Separate GEE analyses were conducted for each outcome (i.e., valence, vocabulary, and emotionality) to examine whether emotion expression characteristics differ in individuals with BPD compared to HCs. Group (i.e., BPD or HC) was included in each analysis as the predictor. Self-reported negative emotion via the VAS immediately following the EMOTION INDUCTION block was entered as a covariate to control for the confounding role of heightened subjective negative emotion with emotional expression.

2.4.2 Does Emotional Expression Predict Emotion Regulation Effectiveness?

To examine whether emotional expression characteristics predict subsequent emotion regulation effectiveness, separate analyses were conducted for each emotion regulation index (i.e., self-report, RSA and SCR). For self-reported emotion analyses, self-reported negative emotion via the VAS following each EMOTION INDUCTION and EMOTION REGULATION

block was entered as the outcome. Group, section (i.e., EMOTION INDUCTION to EMOTION REGULATION), vocabulary, valence, and emotionality, were entered as predictors. Three-way interactions between group, section, and each emotional expression characteristic were then added to examine whether the degree of change in emotion indices between sections varied based on changes in expression characteristics by group. All lower-level two-way interactions required to build these three-way interactions were also entered in the model. For psychophysiological analyses, we also controlled for self-reported negative emotion VAS during the induction. RSA or SCR across the EMOTION INDUCTION and EMOTION REGULATION blocks were entered as the outcomes. Group, section (EMOTION INDUCTION to EMOTION REGULATION block), vocabulary, valence, and emotionality were entered as predictors. The negative emotion composite variable was also entered as a covariate. The same interaction terms in the self-report analyses were then added.

3 Results

The mean age for BPD and HC groups was 24.24 (SD = 4.69) and 23.37 (SD = 5.00) respectively. With respect to sex, 86.2% and 86.7% of the BPD and HC groups, respectively, were female. The most highly reported ethnic group was Other Asian/Asian-Canadian (33.3%) for HCs, and White/Caucasian/European Origin (37.9%) for BPD participants. The most frequently endorsed current psychiatric diagnoses for the BPD group were Generalized Anxiety Disorder (51.7%), Social Anxiety Disorder (44.8%), Posttraumatic Stress Disorder (24.1%), Major Depressive Disorder (24.1%), and Obsessive Compulsive Disorder (24.1%). Additionally, on the experiment day, 13.6% of participants reported having a prescription for psychiatric medications. Finally, in the present sample, individuals with BPD demonstrated significantly

higher alexithymia scores (mean=56.31, standard deviation=12.58) compared to HCs (mean=38.37, standard deviation=11.48), t (57)=−5.73, $p < .001$.

3.1 Emotional Expression in BPD

Table 1 presents emotional expression characteristics descriptive statistics, and Table 2 presents GEE results examining the main effect of group on such characteristics. There were no statistically significant main effects of group predicting vocabulary, valence, and emotionality.

3.2 Emotional Expression and Emotion Regulation Effectiveness

3.2.1 Self-Reported Emotion Analyses

Table 3 presents GEE results examining the effects of emotional expression on self-reported emotion regulation effectiveness. Group, valence, emotionality, vocabulary, and interactions involving these variables did not significantly predict self-reported emotion regulation effectiveness.

3.2.2 Parasympathetic Emotion Analyses

Table 4 presents GEE results examining the effects of emotional expression on parasympathetic emotion regulation effectiveness. Across BPD and HC groups, a statistically significant section×valence interaction emerged on change in RSA during emotion regulation. Using words with greater negative valence predicted more increases in RSA, suggestive of *more* effective emotion regulation for RSA (B = .271, SE = .135), $\chi^2(1) = 4.768$, $p = .029$, 95% CI[.007,.535]. Group, vocabulary and emotionality, and interactions involving these variables did not predict parasympathetic emotion regulation effectiveness.

3.2.3 Sympathetic Emotion Analyses

See Table 5 for GEE results examining the effects of emotional expression on sympathetic emotion regulation effectiveness. Across BPD and HC groups, a statistically

significant section×vocabulary interaction emerged on change in total number of SCRs during the emotion regulation phase. Using *more* unique words predicted a greater reduction in SCRs, suggestive of *more* effective emotion regulation for SCR (B = -.038, SE = .0278), $\chi^2(1) = 4.874$, $p = .027$, 95% CI[-.093,.016]. Group, valence, and emotionality, and interactions involving these variables, did not predict sympathetic emotion regulation effectiveness.

4 Discussion

This study examined which components of emotional expression, if any, are deficient in BPD, and how these components impact emotion regulation effectiveness. Counter to our hypothesis, individuals with BPD did not express emotion differently than HCs based on valence, emotionality, or vocabulary, regardless of their experienced emotional intensity. Partially in line with our hypothesis, across groups, using greater emotional vocabulary during emotion expression improved sympathetic emotion regulation, while using more negative words improved parasympathetic emotion regulation. Emotionality was not associated with emotion regulation effectiveness.

That emotional expression was *not* deficient in BPD was unexpected, especially given that the BPD group had higher alexithymia scores than HCs. Perhaps the emotions induced were not sufficiently intense to elicit deficient emotional expression. Alternatively, ineffective emotional expression in BPD may be more apparent in interpersonal contexts where emotions are expressed *to* another person, rather than in a laboratory setting. Future researchers are advised to investigate the emotional and interpersonal contexts in which emotional expression is deficient in BPD, if at all. Finally, ineffective emotional expression in BPD may not involve valence, emotionality, and vocabulary, but instead may reflect processes not assessed in this study, such as expressing an initially experienced primary emotion (e.g., shame) versus a

secondary one that followed it (e.g., anger), or other forms of maladaptive expression. As Fruzzetti and colleagues' (2005) suggest, inaccurate emotional expression in BPD may also involve other types of potentially ineffective communication, such as behavioural dyscontrol (e.g., self-harm, aggression) or interpersonal dysregulation (e.g., making threats or demands), which can elicit invalidation from others and further exacerbate emotional intensity (Linehan, 1993).

4.1 The Impact of Emotional Expression on Emotion Regulation Effectiveness

These findings revealed a significant association between emotional expression using a broader emotional vocabulary and sympathetic emotion regulation. This aligns with previous research showing that emotional expression has a dampening effect on sympathetic intensity in healthy and clinical samples (Tabibnia et al., 2008). Importantly, in BPD, better emotion differentiation (whereby deficits constitute a facet of alexithymia) is associated with reductions in rumination and self-harm urges (Zaki et al., 2013). Thus, perhaps deploying a larger vocabulary can differentiate between similar, but discrete negative emotions (i.e., expressing emotion with *sad* and *frustrated*, rather than *bad*). This may potentiate individuals' capacity to subsequently regulate these emotions. Indeed, in HCs, higher emotion differentiation ability is associated with using a wider range of emotion regulation strategies (Barrett et al., 2001). Emotion differentiation is also associated with lower aggressive provocation levels when feeling angry (Pond et al., 2012). Clinically, these results imply that implementing therapeutic tools to support emotion differentiation and deepening clients' emotional vocabulary (e.g., directing a client's attention to an emotion word list and encouraging them to express present emotion), may increase emotion regulation effectiveness. These findings provide further support for including skills training in emotion expression in BPD treatments (McMain et al., 2013; Rudge et al.,

2017). Indeed, previous work suggests that *how* one attends to their emotional state may promote maladaptive rumination or emotional reflection (Kross et al., 2005; Kross et al., 2012). Therefore, maximizing emotional vocabulary may support adaptive emotional reflection that then subsequently potentiates its regulation.

4.2 Parasympathetic Regulation and The Negative Valence of Emotional Expression

The finding that using more negative words to express emotion, but not more varied or emotional words, was associated with improved parasympathetic emotion regulation suggests a potential exposure mechanism by which maximizing the negative valence of emotion may specifically activate an emotion regulatory response for it. Mechanistically, expressing emotions with negative words may result in the inhibitory effect of increased RSA on limbic-related emotional intensity (Porges, 2001). Alternatively, expressing emotion with more negative valence may reflect doing so with greater accuracy given the high baseline emotion that characterizes BPD (e.g., Kuo & Linehan, 2009; Kuo et al., 2016). Therefore, expressing emotions *accurately* rather than with negativity *per se* may facilitate subsequent parasympathetic emotion regulatory processes.

That emotional expression effects did not differentially impact emotion regulation *across* BPD and HC groups aligns with previous work showing that approaching negative emotion via exposure (i.e., rather than avoiding it by using less negatively valanced words, or more restricted words) may facilitate reductions in distress by promoting habituation in both non-BPD psychiatric samples (Craske, et al., 2014) and HCs (e.g., Feinstein et al., 2002). Such research suggests that exposure-related habituation may be a transdiagnostic or diagnostic-independent phenomenon that can be facilitated through the use of varied and negative emotion words. Our present findings thus suggest that, even among a cohort of emotionally reactive participants,

using a broader vocabulary and more negative emotion words can facilitate emotion regulation effectiveness.

More broadly, a recent systematic review of 45 studies on empathy and related constructs in BPD (Salgato et al., 2020) identified empathy deficits in 80 percent of studies reviewed. Individuals with BPD also tend to perceive neutral facial expressions as negative, and exhibit hypersensitivity to negative facial expressions such as anger (e.g., Fenske et al., 2015). Although we did not explore associations between emotion expression and these social cognitive constructs, our finding that use of more negative and broad vocabulary to express emotions is effective for regulation in both BPD and HCs suggests that, although individuals with BPD may not accurately recognize and label the emotionality of others, they are able to express their own in a way that is comparable to HCs. Whereas popular theories of BPD suggest that people with BPD exhibit deficits in understanding both their own and others mental states (Fonagy, 1991), our findings suggest that, particularly with respect to emotional expression, the former may be more accurate than the latter.

4.3 Clinical Implications

Extant literature demonstrates an association between high emotional intensity and ineffective behaviour (e.g., self-harm; Brown et al., 2009; Sadeh et al., 2014). Here, we show that sympathetic and parasympathetic emotion regulation is potentiated by emotional expression using more negative words and a broader emotional vocabulary. As such, clinicians are advised to encourage clients to develop their emotional vocabularies and accurately apply negative emotion words (as opposed to suppressing or minimizing emotion expressions) to facilitate emotion regulation and potentially thwart engagement in destructive behaviors that may function to downregulate emotion such as self-harm.

4.4 Limitations and Future Directions

There are several limitations to note. Participants were instructed to implement an emotion regulation strategy immediately after expressing emotions, obfuscating whether using more negative words or a deeper vocabulary may regulate emotion on its own. Therefore, our results can further inform *how* to implement an *intentional* emotion regulation strategy, but more work is needed to explore the impact of expression characteristics on incidental emotion regulation. Moreover, the majority of our participants were female, and future work should be conducted on a more sex-representative sample, especially given that males with BPD exhibit poorer top-down regulation of negative emotions such as anger (Herpertz et al., 2017), and may therefore differentially express and regulate emotion. Further, studies can expand this work through using a more ecologically relevant paradigm of emotional expression in interpersonal interactions, particularly since interpersonal stressors are more emotionally evocative in BPD than non-interpersonal ones (e.g., Limberg et al., 2011). Indeed, although some of the emotion inductions in this study were interpersonally-themed, participants did not read scripts about personal events or express emotion directly to another person. Emotional intensity following induction may therefore have been lower than what is typically experienced outside of the laboratory. Additionally, we did not examine whether participants were involved in active or past BPD-treatments (e.g., DBT), which improves emotional expression and regulation in BPD (e.g., Neasciu et al., 2014). This may have masked emotional expression deficits and potential differential effects of emotional expression on emotion regulation effectiveness in BPD. Future replication of this work with treatment utilization included as a covariate is warranted. Finally, we did not assess whether participants accurately express emotions, nor did our coding differentiate between using primary emotions and secondary emotions that follow them. These

are important next steps given that expressing secondary emotion may exacerbate negative emotional intensity in BPD (Fruzzetti et al., 2015), and exposure to specific emotions may differentially impact treatment outcomes (Foa et al., 1995).

4.5 Conclusions

Overall, these findings contribute novel and incremental information to the existing BPD literature, showing that qualitative emotional expression characteristics *are* important moderators of emotion regulation effectiveness in BPD. Importantly, we suggest that both individuals with BPD and control participants may benefit from maximizing negative valence and broadening their emotional vocabulary before implementing an emotion regulation strategy.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders* (5th ed.). https://doi.org/10.1176/appi.books.9780890425596

Armstrong, R. A. (2014). When to use the Bonferroni correction. *Ophthalmic and Physiological Optics*, *34*(5), 502–508. https://doi.org/10.1111/opo.12131

Atkins, D. C., & Gallop, R. J. (2007). Rethinking how family researchers model infrequent outcomes: A tutorial on count regression and zero-inflated models. *Journal of Family Psychology, 21*(4), 726-735. doi:10.1037/0893-3200.21.4.726

Bagby, R. M., Parker, J. D., & Taylor, G. J. (1994). The twenty-two item Toronto Alexithymia Scale-I: Item selection and cross-validation of the factor structure. Journal of Psychosomatic Research, 38, 23–32. https://doi.org/10.1016/0022-3999(94)90005-1.

Barrett, L.F., Gross, J., Conner, T., & Benvenuto, M. (2001). Knowing what you're feeling and knowing what to do about it: mapping the relation between emotion differentiation and emotion regulation. *Cognition and Emotion, 15*, 713-724. https://doi.org/10.1080/02699930143000239

Baskin-Sommers, A., Vitale, J. E., MacCoon, D., & Newman, J. P. (2012). Assessing emotion sensitivity in female offenders with borderline personality symptoms: Results from a fear-potentiated startle paradigm. *Journal of Abnormal Psychology, 121*, 477-483. doi:10.1037/a0026753

Bateman, A., & Fonagy, P. (2010). Mentalization based treatment for borderline personality disorder. *World psychiatry : official journal of the World Psychiatric Association (WPA)*, *9*(1), 11–15. https://doi.org/10.1002/j.2051-5545.2010.tb00255.x

Beauchaine, T. P. (2001). Vagal tone, development, and gray's motivational theory: Toward an integrated model of autonomic nervous system functioning in psychopathology. *Development and Psychopathology, 13*(2), 183-214. doi:10.1017/S0954579401002012

Bender, D. S., & Skodol, A. E. (2007). Borderline personality as a self-other representational disturbance. *Journal of personality disorders*, *21*(5), 500–517. https://doi.org/10.1521/pedi.2007.21.5.500

Berenson, K. R., Dochat, C., Martin, C. G., Yang, X., Rafaeli, E., & Downey, G. (2018). Identification of mental states and interpersonal functioning in borderline personality disorder. *Personality Disorders: Theory, Research, and Treatment, 9*(2), 172-181. https://doi.org/10.1037/per0000228

Berntson, G. G., Cacioppo, J. T., Quigley, K. S., & Fabro, V. T. (1994). Autonomic space and psychophysiological response. *Psychophysiology*, *31*(1), 44-61. https://doi.org/10.1111/j.1469-8986.1994.tb01024.x

Bradley, M. M. & Lang, P. J. (1999). *Affective Norms for English Words (ANEW): Stimuli, instruction manual, and affective ratings* (Tech. Report C-1). Gainesville: University of Florida, Center for Research in Psychophysiology.

Brooks, J. A., Shablack, H., Gendron, M., Satpute, A. B., Parrish, M. H., & Lindquist, K. A. (2017). The role of language in the experience and perception of emotion: A neuroimaging meta-analysis. *Social Cognitive and Affective Neuroscience*, *12*(2), 169–183. https://doi.org/10.1093/scan/nsw121

Brown, M. Z., Linehan, M. M., Comtois, K. A., Murray, A., & Chapman, A. L. (2009). Shame as a prospective predictor of self-inflicted injury in borderline personality disorder: A multimodal analysis. *Behaviour Research and Therapy*, *47*(10), 815–822.

https://doi.org/10.1016/j.brat.2009.06.008

Burton, P., Gurrin, L., & Sly, P. (1998). Extending the simple linear regression model to account for correlated responses: An introduction to generalized estimating equations and multi-level mixed modelling. *Statistics in Medicine, 17*(11), 1261-1291. doi:10.1002/(SICI)1097-0258(19980615)17:11<1261::AID-SIM846>3.0.CO;2-Z

Chu, C., Victor, S. E., & Klonsky, E. D. (2016). Characterizing positive and negative emotional experiences in young adults with borderline personality disorder symptoms. *Journal of clinical psychology*, *72*(9), 956–965. https://doi.org/10.1002/jclp.22299

Clarkin, J. F., Lenzenweger, M. F., Yeomans, F., Levy, K. N., & Kernberg, O. F. (2007). An object relations model of borderline pathology. *Journal of personality disorders*, *21*(5), 474–499. https://doi.org/10.1521/pedi.2007.21.5.474

Craske, M.G., Treanor, M., Conway, C., Zbozinek, T., & Vervliet, B. (2014). Maximizing exposure therapy: an inhibitory learning approach. *Behavior Research and Therapy, 58,* 10-23. https://doi.org/10.1016/j.brat.2014.04.006

Dawson, M. E., Schell, A. M., & Filion, D. L. (2007). The electrodermal system. In J. T. Cacioppo, L. G. Tassinary, & G. G. Berntson (Eds.). *Handbook of psychophysiology* (pp. 159–181). New York, NY, US: Cambridge University Press.

Derks, Y. P. M. J., Westerhof, G. J., & Bohlmeijer, E. T. (2017). A meta-analysis on the association between emotional awareness and borderline personality pathology. *Journal of Personality Disorders*, *31*(3), 362–384. http://doi.org /101521pedi201630257

Dick, A. M., & Suvak, M. K. (2018). Borderline personality disorder affective instability: What you know impacts how you feel. *Personality Disorders: Theory, Research, and*

Treatment, *9*(4), 369–378. http://doi.org/10.1037/per0000280

Dixon-Gordon, K., Gratz, K. L., & Tull, M. T. (2013). Multimodal assessment of emotional reactivity in borderline personality pathology: The moderating role of posttraumatic stress disorder symptoms. *Comprehensive Psychiatry, 54*, 639-648. doi:10.1016/j.comppsych.2012.12.019

Feinstein, J.S., Goldin, P.R., Stein, M.B., Brown, G.C., & Paulus, M.P (2002). Habituation of attentional networks during emotion processing. *NeuroReport, 13*(10), 1255–1258. https://doi.org/10.1097/00001756-200207190-00007

Fenske, S., Lis, S., Liebke, L., Niedtfeld, I., Kirsch, P., & Daniela, M. (2015). Emotion recognition in borderline personality disorder: effects on emotional information on negative bias. *Borderline Personality Disorder and Emotion Dysregulation, 2,* 10. doi.org/10.1186/s40479-015-0031-z

First, M. B., Spitzer, R. L., Gibbon, M., & Williams, J. B. W. (1996). Structured clinical interview for DSM-IV-TR Axis I disorders, clinician version (SCID-CV). Washington, D.C.: American Psychiatric Press.

Fitzpatrick, S., Ip, J., Krantz, L., Zeifman, R., Kuo, J. K. (2019). Use your words: The role of labeling in regulating emotion in borderline personality disorder. *Behaviour Research and Therapy*, *120*, 103447. https://doi.org/10.1016/j.brat.2019.103447

Foa, E. B., Riggs, D. S., Massie, E. D., & Yarczower, M. (1995). The impact of fear activation and anger on the efficacy of exposure treatment for posttraumatic stress disorder. *Behavior Therapy*, *26*(3), 487–499. https://doi.org/10.1016/S0005-7894(05)80096-6

Fonagy, P. (1991). Thinking about thinking: some clinical and theoretical considerations in the

treatment of a borderline patient. *The International Journal of Psychoanalysis, 72*(4), 639 – 656.

Fonagy, P., & Bateman, A. (2008). The development of borderline personality disorder--a mentalizing model. *Journal of personality disorders*, *22*(1), 4–21. https://doi.org/10.1521/pedi.2008.22.1.4

Fonagy, P., Steele, M., Steele, H., Leigh, T., Kennedy, R., Mattoon, G., & Target, M. (1995). *Attachment, the reflective self, and borderline states: The predictive specificity of the Adult Attachment Interview and pathological emotional development.* In S. Goldberg, R. Muir, & J. Kerr (Eds.), *Attachment theory: Social, developmental, and clinical perspectives* (p. 233–278). Analytic Press, Inc.

Fowles, D. C., Christie, M. J., Edelberg, R., Grings, W. W., Lykken, D. T., & Venables, P. H. (1981). Publication recommendations for electrodermal measurements. *Psychophysiology, 18*(3), 232-239. doi:10.1111/j.1469-8986.1981.tb03024.x

Fruzzetti, A. E., & Payne, L. (2015). Couple therapy and borderline personality disorder. In A.S. Gurman, J. L. Lebow, & D.K. Snyder (Eds.), *Clinical handbook of couple therapy (5th ed.)* (pp. 606-634). New York, NY: Guilford Press.

Fruzzetti, A. E., Shenk, C., & Hoffman, P. D. (2005). Family interaction and the development of borderline personality disorder: A transactional model. *Development and Psychopathology*, *17*(4), 1007-1030. https://doi.org/10.1017/S0954579405050479

Glenn, C. R., & Klonsky, D. E. (2009). Emotion dysregulation as a core feature of borderline personality disorder. *Journal of Personality Disorders, 23*(1), 20-8. https://doi.org/10.1521/pedi.2009.23.1.20

Gross, J. J. & Jazaieri, H. (2014). Emotion, emotion regulation, and psychopathology: An

affective science perspective. *Clinical Psychological Science, 2*(4), 387-401. https://doi.org/10.1177/2167702614536164

Gross, J. J., & John, O. P. (2003). Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology, 85*(2), 348–362. https://doi.org/10.1037/0022-3514.85.2.348

Gross, J. J. (1998). Antecedent- and response-focused emotion regulation: Divergent consequences for experience, expression, and physiology. *Journal of Personality and Social Psychology, 74*(1), 224-237. https://doi.org/10.1037/0022-3514.74.1.224

Gross, J. J., & Thompson, R. A. (2007). Emotion regulation: Conceptual foundations. In J. J. Gross (Ed.), *Handbook of Emotion Regulation* (3-26). New York, NY: Guilford Press.

Gruhn, D. (2016). An English word database of EMOtional TErms (EMOTE). *Psychological Reports, 119*(1), 290-308. https://doi.org /10.1177/0033294116658474

Gunderson, J.G. (2007). Disturbed relationships as a phenotype for borderline personality disorder. *American Journal of Psychiatry, 164,* 1637-1640.

Herpertz, S.C., Nagy, K., Ueltzhoffer, K., Schmitt, R., Mancke, F., Schmahl, C., & Bertsch, K. (2017). Brain mechanisms underlying reactive aggression in borderline personality disorder – sex matters. *Biological Psychiatry, 15*(4), 257-266. https://doi.org/10.1016/j.biopsych.2017.02.1175

Kabat-Zinn, J. (2003). Mindfulness-based interventions in context: Past, present, and future. *Clinical Psychology Science and Practice, 10*(2), 144-156. https://doi.org/10.1093/clipsy.bpg016

Kross, E., Ayduk, O., & Mischel, W. (2005). When asking "why" does not hurt: Distinguishing rumination from reflective processing of negative emotions. *Psychological Science,*

16(9), 709–715. https://doi.org/10.1111/j.1467-9280.2005.01600.x

Kross, E., Gard, D., Deldin, P., Clifton, J., & Ayduk, O. (2012). Asking "why" from a distance: Its cognitive and emotional consequences for people with depression. *Journal of Abnormal Psychology, 121*(3), 559–569. https://doi.org/10.1037/a0028808

Kuo, J.R., & Linehan, M.M. (2009). Disentangling emotion processes in borderline personality disorder: Physiological and self-reported assessment of biological vulnerability, baseline intensity, and reactivity to emotionally evocative stimuli. *Journal of Abnormal Psychology, 118*(3), 531–544. https://doi.org/10.1037/a0016392

Kuo, J.R., Fitzpatrick, S., Metcalfe, R.K., & McMain, S. (2016). A multi-method laboratory investigation of emotional reactivity and emotion regulation abilities in borderline personality disorder. *Journal of Behavior Therapy and Experimental Psychiatry, 50,* 52-60. https://doi.org/10.1016/j.jbtep.2015.05.002

Lecours, S., & Bouchard, M. (2011). Verbal elaboration of distinct affect categories and BPD symptoms. *Psychology and Psychotherapy: Theory, Research and Practice, 84*(1), 26-41. https://doi.org/10.1111/j.2044-8341.2010.02006.x

Licht, C. M. M., de Geus, Eco J. C., van Dyck, R., & Penninx, B. W. J. H. (2010). Longitudinal evidence for unfavorable effects of antidepressants on heart rate variability. *Biological Psychiatry, 68,* 861-868. doi:10.1016/j.biopsych.2010.06.032

Lieberman, M. D., Eisenberger, N. I., Crockett, M. J., Tom, S. M., Pfeifer, J. H., & Way, B. M. (2007). Putting feelings into words: Affect labeling disrupts amygdala activity in response to affective stimuli. *Psychological Science, 18*(5), 421–428. https://doi.org/10.1111/j.1467-9280.2007.01916.x

Lieberman, M. D., Inagaki, T. K., Tabibnia, G., & Crockett, M. J. (2011). Subjective responses

to emotional stimuli during labeling, reappraisal, and distraction. *Emotion, 11*(3), 468–480. https://doi.org/10.1037/a0023503

Limberg, A., Barnow, S., Freyberger, H. J., & Hamm, A. O. (2011). Emotional vulnerability in borderline personality disorder is cue specific and modulated by traumatization. *Biological Psychiatry, 69*(6), 574-582. doi:10.1016/j.biopsych.2010.10.024

Linehan, M. M. (1993). *Cognitive-behavioral treatment of borderline personality disorder.* The Guilford Press.

Linehan, M. M. (2015). *DBT® skills training manual* (2nd ed.). New York, NY: Guilford Press.

Loranger, A. W., Sartorius, N., Andreoli, A., Berger, P., Buchheim, P., Channabasavanna, S. M., Coid, B., Dahl, A., Diekstra, R. F. W., Ferguson, B., Jacobsberg, L. B., Mombour, W., Pull, C., Ono, Y., & Regier, D. A. (1994). The international personality disorder examination: The world health organization/alcohol, drug abuse, and mental health administration international pilot study of personality disorders. *Archives of General Psychiatry, 51*(3), 215–224. https://doi.org/10.1001/archpsyc.1994.03950030051005

McCormack, H. M., Horne, D. J., & Sheather, S. (1988). Clinical applications of visual analogue scales: A critical review. *Psychological Medicine, 18*(4), 1007–1019. https://doi.org/10.1017/S0033291700009934

McMain, S., Links, P., Guimond, T., Wnuk, S., Bergmans, Y., & Warwar, S. (2013). An exploratory study of the relationship between changes in emotion and cognitive processes and treatment outcome in borderline personality disorder. *Psychotherapy Research, 23*(6), 658–73. https://doi.org/10.1080/10503307.2013.838653

McMain, S., Pos, A., & Iwakabe, S. (2010). Facilitating emotion regulation: General principles for psychotherapy. *Psychotherapy Bulletin, 45*, 16–21.

Meaney, R., Hasking, P., & Reupert, A. (2016). Borderline personality disorder symptoms in college students: The complex interplay between alexithymia, emotional dysregulation and rumination. *PLoS ONE, 11*(8), Article e0157294.

Modestin, J., Furrer, R., & Malti, T. (2004). Study on alexithymia in adult non-patients. *Journal of Psychosomatic Research, 56*(6), 707-709. https://doi.org/10.1016/S0022-3999(03)00125-9

Neacsiu, A. D., Lungu, A., Harned, M. S., Rizvi, S. L., & Linehan, M. M. (2014). Impact of dialectical behavior therapy versus community treatment by experts on emotional experience, expression, and acceptance in borderline personality disorder. *Behaviour research and therapy*, *53*, 47–54. https://doi.org /10.1016/j.brat.2013.12.004

Neacsiu, A. D., Rizvi, S. L., & Linehan, M. M. (2010). Dialectical behavior therapy skills use as a mediator and outcome of treatment for borderline personality disorder. *Behaviour Research and Therapy, 48*(9), 832-839, https://doi.org/10.1016/j.brat.2010.05.017

O'Keefe, D. J. (2003). Colloquy: Should familywise alpha be adjusted? Against familywise alpha adjustment. *Human Communication Research, 29*(3), 431-447. https://doi.org/10.1093/hcr/29.3.431

Pond, R.S., Kashdan, T.B., DeWall, C.N., Savostyanova, A.L., Nathaniel, M., Fincham, F.D. (2012). Emotion differentiation moderates aggressive tendencies in angry people: a daily diary analysis. *Emotion, 12*(2), 326-337. https://doi.org/10.1037/a0025762

Porges, S. W., Doussard-Roosevelt, J. A., & Maita, A. K. (1994). Vagal tone and the physiological regulation of emotion. *Monographs of the Society for Research in Child Development, 59*(2/3), 167–186, 250–283. https://doi.org/10.2307/1166144

Porges, S. W. (2001). The polyvagal theory: Phylogenetic substrates of a social nervous system.

International Journal of Psychophysiology, 42(2), 123-146. https://doi.org/10.1016/S0167-8760(01)00162-3

Rosenthal, M. Z., Gratz, K. L., Kosson, D. S., Cheavens, J. S., Lejuez, C. W., & Lynch, T. R. (2008). Borderline personality disorder and emotional responding: A review of the research literature. *Clinical Psychology Review, 28*(1), 75-91. https://doi.org/10.1016/j.cpr.2007.04.001

Rudge, S., Feigenbaum, J.D., & Fonagy, P. (2017). Mechanisms of change in dialectical behaviour therapy and cognitive behaviour therapy for borderline personality disorder: a critical review of the literature. *Journal of Mental Health, 29*(1), 92-102. https://doi.org/10.1080/09638237.2017.1322185

Sadeh, N., Londahl-Shaller, E. A., Piatigorsky, A., Fordwood, S., Stuart, B. K., McNiel, D. E., Klonsky, E. D., Ozer, E. M., & Yaeger, A. M. (2014). Functions of non-suicidal self-injury in adolescents and young adults with Borderline Personality Disorder symptoms. *Psychiatry Research, 216*(2), 217–222. https://doi.org/10.1016/j.psychres.2014.02.018

Salgado, R.M., Pedrosa, R., & Bastos-Leite, A.J. (2020). Dysfunction of empathy and related processes in borderline personality disorder: A systematic review. *Harvard Review of Psychiatry, 28*(4), 238-254.

Sanislow, C.A., Grilo, C.M., Morey, L.C., Bender, D.S., Skodol, A.E., Gunderson, JG., & McGlashan, T.H. (2002). Confirmatory factor analysis of DSM-IV criteria for borderline personality disorder: findings from the collaborative longitudinal personality disorders study. *American Journal of Psychiatry, 159*(2), 284-290. https://doi.org/10.1176/appi.ajp.159.2.284

Segal, Z. V., Williams, J. M. G., & Teasdale, J. D. (2013). *Mindfulness-based cognitive therapy for depression* (2nd ed.). New York, NY, US: Guilford Press.

Sharp, C., Pane, H., Ha, C., Venta, A., Patel, A. B., Sturek, J., & Fonagy, P. (2011). Theory of mind and emotion regulation difficulties in adolescents with borderline traits. *Journal of the American Academy of Child and Adolescent Psychiatry*, *50*(6), 563–573.e1. https://doi.org/10.1016/j.jaac.2011.01.017

Sifneos, P. E. (1973). The prevalence of "alexithymic" characteristics in psychosomatic patients. *Psychotherapy and Psychosomatics, 22*(2-6), 255–262. https://doi.org/10.1159/000286529

Strauss, G. P., & Allen, D. N. (2008). Emotional intensity and categorisation ratings for emotional and nonemotional words. *Cognition and Emotion, 22*(1), 114–133. https://doi.org/10.1080/02699930701319154

Tabibnia, G., Lieberman, M. D., & Craske, M. G. (2008). The lasting effect of words on feelings: Words may facilitate exposure effects to threatening images. *Emotion, 8*(3), 307–317. https://doi.org/10.1037/1528-3542.8.3.307

Torrisi, S. J., Lieberman, M. D., Bookheimer, S. Y., & Altshuler, L. L. (2013). Advancing understanding of affect labeling with dynamic causal modeling. *NeuroImage, 82,* 481-488. https://doi.org/10.1016/j.neuroimage.2013.06.025

van Dijke, A., van der Hart, O., van Son, M., Bühring, M., van der Heijden, P., & Ford, J. D. (2013). Cognitive and affective dimensions of difficulties in emotional functioning in somatoform disorders and borderline personality disorder. *Psychopathology, 46*(3), 153-162. https://doi.org/10.1159/000338832

Zaki, L. F., Coifman, K. G., Rafaeli, E., Berenson, K. R., & Downey, G. (2013). Emotion

differentiation as a protective factor against nonsuicidal self-injury in borderline personality disorder. *Behavior therapy*, *44*(3), 529–540. https://doi.org/10.1016/j.beth.2013.04.008

Zlotnick, C., Mattia, J. I., & Zimmerman, M. (2001). The relationship between posttraumatic stress disorder, childhood trauma and alexithymia in an outpatient sample. *Journal of Traumatic Stress, 14*(1), 177–188. https://doi.org/10.1023/A:1007899918410

Table 1

Descriptive statistics for vocabulary, valence, and emotionality

	Vocabulary M(SD)	Valence M(SD)	Emotionality M(SD)
		Borderline Personality Disorder	
Mindfulness	6.62(3.84)	2.58(1.35)	5.22(.86)
Cognitive Reappraisal	6.32(3.57)	2.33(.98)	5.25(.87)
		Healthy Controls	
Mindfulness	6.07(3.54)	2.46(1.22)	5.24(.92)
Cognitive Reappraisal	5.42(3.23)	2.61(1.32)	5.12(1.05)

Note: The mean for vocabulary, valence, and emotionality were computed within each emotion regulation condition (i.e., Mindfulness and Cognitive Reappraisal) within group.

Table 2

Generalized estimating equations results examining whether emotional expression differs between individuals with BPD and HCs

			Vocabulary		
	β	*SE*	χ^2	df	*p*
Intercept	**5.88**	**.54**	**237.30**	**1**	**<.001**
Negative Emotion	.03	.01	4.25	1	**.039**
Group	.46	.80	.33	1	.569
			Valence		
	β	*SE*	χ^2	df	*p*
Intercept	**2.51**	**.08**	**2272.14**	**1**	**<.001**
Negative Emotion	-.003	.002	1.95	1	.162
Group	-.05	.11	.24	1	.623
			Emotionality		
	β	*SE*	χ^2	df	*p*
Intercept	**5.18**	**.06**	**20604.42**	**1**	**<.001**
Negative Emotion	.000	.002	.01	1	.922
Group	.05	.07	.55	1	.458

Note. All statistically significant effects are bolded.

Table 3

Generalized estimating equation results examining the impact of emotional expression on self-reported emotion regulation effectiveness

			Self-report		
	B	*SE*	χ^2	df	*p*
Intercept	**53.93**	**7.59**	**139.03**	**1**	**<.001**
Section	**-20.05**	**2.93**	**83.35**	**1**	**<.001**
Group	.82	9.22	.01	1	.929
Vocabulary	**3.22**	**2.30**	**4.84**	**1**	**.028**
Valence	-2.88	10.60	.01	1	.918
Emotionality	1.92	8.62	.83	1	.363
Section × Vocabulary	**-1.65**	**1.08**	**3.68**	**1**	**.055**
Section × Valence	3.86	5.94	.05	1	.823
Section × Emotionality	-.55	5.05	.56	1	.456
Group × Section	**7.76**	**3.54**	**4.81**	**1**	**.028**
Group × Vocabulary	-.55	2.67	.04	1	.837
Group × Valence	4.34	13.75	.10	1	.752
Group × Emotionality	6.10	10.92	.31	1	.577
Group × Section × Vocabulary	1.05	1.18	.79	1	.375
Group × Section × Valence	-6.24	6.67	.88	1	.350
Group × Section × Emotionality	-3.01	5.49	.30	1	.584

Note. Significant and trending towards significant main effects and interactions are bolded.

Table 4

Generalized estimating equations results examining the impact of emotional expression on parasympathetic emotion regulation effectiveness

	RSA				
	B	*SE*	χ^2	df	*p*
Intercept	**6.60**	**.23**	**1568.02**	**1**	**<.001**
Negative Emotion	-.001	.003	.17	1	.679
Section	.10	.10	1.76	1	.185
Group	-.19	.31	.35	1	.554
Vocabulary	.03	.04	.37	1	.544
Valence	**-.53**	**.30**	**3.99**	**1**	**.046**
Emotionality	-.73	.46	3.46	1	.063
Section × Vocabulary	.002	.02	.30	1	.584
Section × Valence	**.27**	**.13**	**4.77**	**1**	**.029**
Section × Emotionality	.22	.25	1.90	1	.168
Group × Section	-.01	.14	.006	1	.938
Group × Vocabulary	-.10	.07	2.22	1	.137
Group × Valence	.17	.45	.15	1	.701
Group × Emotionality	.32	.61	.28	1	.598
Group × Section × Vocabulary	.02	.04	.22	1	.643
Group × Section × Valence	-.11	.20	.27	1	.607
Group × Section × Emotionality	.02	.33	.004	1	.947

Note. Statistically significant interactions are bolded.

Table 5

Generalized estimating equations results examining the impact of emotional expression on sympathetic emotion regulation effectiveness

	SCR				
	B	*SE*	χ^2	df	*p*
Intercept	**1.60**	**.17**	**128.01**	**1**	**<.001**
Negative Emotion	-.001	.002	.13	1	.717
Section	**-.51**	**.12**	**23.08**	**1**	**<.001**
Group	-.17	.23	.58	1	.446
Vocabulary	**.07**	**.03**	**5.26**	**1**	**.022**
Valence	.17	.18	1.46	1	.227
Emotionality	.53	.30	2.71	1	.100
Section × Vocabulary	**-.04**	**.03**	**4.87**	**1**	**.027**
Section × Valence	-.07	.12	1.33	1	.249
Section × Emotionality	-.23	.18	3.17	1	.075
Group × Section	.13	.16	.68	1	.409
Group × Vocabulary	.02	.07	.08	1	.783
Group × Valence	.04	.32	.02	1	.891
Group × Emotionality	-.38	.40	.91	1	.341
Group × Section × Vocabulary	-.03	.05	.47	1	.491
Group × Section × Valence	-.12	.22	.28	1	.596
Group × Section × Emotionality	.04	.23	.03	1	.870

Note. Statistically significant interactions are bolded.