OPTIMIZING EMOTION REGULATION IN BORDERLINE PERSONALITY DISORDER:
WHY AND WHEN STRATEGIES DO AND DO NOT WORK

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Skyler Fitzpatrick

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BA, Dalhousie University, 2012

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Do and Do Not Work

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Skyler Fitzpatrick

Psychology

Ryerson University

Abstract

This dissertation aimed to delineate ways to optimize emotion regulation in borderline personality disorder (BPD) by 1) identifying factors that influence general emotion regulation effectiveness and 2) examining whether these factors predict *differential* effectiveness of two classes of emotion regulation strategies: engagement (i.e., engaging with emotional content) versus disengagement (i.e., shifting attention away from emotional content) strategies. Factors that occur before (i.e., antecedent-focused) and after (i.e., response-focused) emotion provocation were examined. Specifically, four predictors of general and differential emotion regulation effectiveness were identified: antecedent-focused sleep quality (impaired sleep efficiency and rated sleep quality), antecedent-focused biology (basal vagal tone), antecedent-focused emotion (baseline emotional intensity), and response-focused emotion (emotional reactivity). Secondary analyses also investigated whether the relationships of these factors to general and differential emotion regulation effectiveness varied across BPD and healthy control (HC) groups. A sample of individuals with BPD ($n = 40$) and matched HCs ($n = 40$) completed a weeklong assessment of sleep efficiency and quality and then participated in an experimental procedure. First, basal vagal tone and baseline emotional intensity data were collected. Following, participants were trained to use two BPD-relevant emotion regulation strategies, mindful awareness (engagement strategy) and distraction (disengagement strategy), in response to negative emotion inductions. Emotional reactivity in response to the inductions, and the extent to which emotion was decreased using the strategies following the inductions (i.e., emotion regulation effectiveness), was examined. Emotion was measured comprehensively across self-

report, sympathetic, parasympathetic, and behavioural/expressive domains. Results indicated that sleep efficiency and rated sleep quality predicted *differential* emotion regulation effectiveness as they improved distraction but not mindful awareness effectiveness across groups. As well, higher basal vagal tone and emotional reactivity predicted improved emotion regulation effectiveness across strategies and groups. Findings suggest that targeting sleep quality may specifically facilitate the attention mechanisms required for effective use of distraction in BPD. They also suggest that identifying ways to increase vagal tone may potentiate the emotion regulation capacity of individuals with BPD. Finally, results indicate that high emotional reactions may not necessarily be problematic and, in fact, may mark a particularly fluid emotional system that is responsive to emotion regulation attempts.

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Optimizing Emotion Regulation in Borderline Personality Disorder: Why and When Strategies Do and Do Not Work

Borderline Personality Disorder (BPD) is a prevalent public health problem that exists in 5.9% of the United States population (Grant et al., 2008; Pagura et al., 2010) and 22.6% of psychiatric outpatients (Korzekwa, Dell, Links, Thabane, & Webb, 2008). BPD also co-occurs with mood, anxiety, and eating disorders more so than the other personality disorders (Zanarini et al., 1998). BPD is characterized by pervasive instability of identity, actions, behaviours, cognitions, and relationships, and self-destructive behaviours (American Psychiatric Association, 2013). Almost all people with BPD (84%) have engaged in suicidal behaviours at some point in their lifetime (Soloff, Lynch, & Kelley, 2002) and 10% of Canadians with BPD die by suicide (Paris & Zweig-Frank, 2001). BPD also accounts for a high proportion of suicides. For example, in Sweden, people with BPD diagnoses reflect over one-third of completed suicides in Sweden (Runeson & Beskow, 1991). Moreover, in female inmates, having a diagnosis of BPD and a family history of suicide predict suicide attempts whereas depression, childhood abuse, other personality disorders, and reasons for living do not (Chapman, Specht, & Cellucci, 2005). Thus, BPD is a common and highly lethal public health problem.

BPD is also associated with a heavy societal toll; people with BPD are three times more likely to receive disability payments from the American government than those with other personality disorders (Zanarini, Jacoby, Frankenburg, Reich, & Fitzmaurice, 2009). In the Netherlands, the bootstrapped annual healthcare, disability, and productivity related costs of BPD are over three billion Canadian dollars, or \$25,659(CAN) per patient (van Asselt, Dirksen, Arntz, & Severens, 2007). In the United States, the average annual healthcare utilization costs for

individuals with BPD receiving treatment as usual are approximately \$18,275(US) per patient (Linehan & Heard, 1999).

Treatments for BPD

It is clear that BPD is a significant mental health issue from both an individual and societal perspective. Fortunately, several evidence-based treatments for BPD exist, such as Dialectical Behaviour Therapy (DBT; Linehan, 1993a), Mentalization Based Therapy (MBT; Bateman & Fonagy, 2004), Schema-Focused Therapy (Young, Klosko, & Weishaar, 2003), and Transference-Focused Therapy (Clarkin, Yeomans, & Kernberg, 1999; Yeomans, Clarkin, & Kernberg, 2002). Of these, DBT has received the most empirical attention and support. For example, a recent meta-analysis showed a moderate effect size for the reduction of suicidal and self-injurious behaviours in clients undergoing DBT (Kliem, Kroger, & Kosfelder, 2010). DBT also yields improved retention in treatment, reduced hospitalizations, emergency department visits, disability due to days spent in bed, depressive symptoms, psychotropic medication use, and greater improvements in quality of life and social adjustment compared to alternative treatments such as treatment as usual or community treatment by experts (e.g., Carter, Willcox, Lewin, Conrad, & Bendit, 2010; Feigenbaum et al., 2012; Linehan et al., 2006; Pistorello, Fruzzetti, MacLane, Gallop, & Iverson, 2012).

However, despite the clear benefits of treatments like DBT for individuals with BPD, standard evidence based treatments are very long (e.g., one-year for standard DBT and 18 months for MBT) and highly intensive (e.g., DBT consists of weekly individual sessions, two hour skills groups, therapist team consultation, and a 24-hour on-call therapist; MBT is a partial hospitalization program; Bateman & Fonagy 2004; Linehan, 1993a). Furthermore, although many clients certainly benefit from these treatments, some do not respond. For example,

approximately 35% of people with BPD engage in self-harm behaviours within the last six months of a course of standard year-long DBT (Verheul et al., 2003) post-treatment. Thus, there is still a great need for treatments to be more efficient and effective. However, little empirical data points to ways in which this could be done.

One logical starting place for improving treatments would be to ensure that treatments directly target the mechanisms that underpin or maintain the disorder. Indeed, targeting these mechanisms would yield more effective treatment by directly altering the factors that underpin the pathology, thereby destabilizing the disorder, rather than attempting change through indirect avenues (Kazdin, 2007). Thus, a clear understanding of BPD and its maintenance factors is key to identifying specific targets for treatment and subsequently improving therapeutic outcomes. In line with this objective, this dissertation is an experimental investigation of emotion dysregulation as a key mechanism underpinning BPD. Specifically, the aims of this study are to delineate 1) factors that likely impede or facilitate general emotion regulation in BPD and 2) factors that determine which *specific* emotion regulation strategies an individual with BPD should use at a given point in time in order to achieve the most effective outcomes.

Summary of Dissertation

In Chapter I of this dissertation, theory and research on the maintenance factors underpinning BPD are reviewed. Specifically, emotion dysregulation, and in particular its subsidiary component- emotion regulation deficits- as a central component underpinning BPD, is discussed. Chapter II of this work distinguishes between two classes of emotion regulation, engagement and disengagement strategies, and examines the effectiveness of these two classes of emotion regulation in BPD. In Chapter III, a model for optimizing emotion regulation in BPD will be presented by highlighting baseline antecedent-focused factors (i.e., baseline behaviour/

sleep quality, baseline biology, and baseline emotional intensity) and response-focused factors (i.e., emotional reactivity) that influence the 1) *general* effectiveness of emotion regulation, and 2) indicate the *differential effectiveness* of specific types of emotion regulation strategies (i.e., which strategy type is a particular individual most likely to benefit from?). In Chapter IV, the current study is described, which examines these factors as predictors of general and differential emotion regulation strategy effectiveness across BPD and healthy groups. Chapter V delineates the methodology of the present study, and Chapter VI describes the study results. In Chapter VII, the findings regarding the impact of key antecedent- and response-focused factors on emotion regulation are discussed. This work is then brought to a conclusion in Chapter VIII wherein clinical implications, limitations, future directions, and concluding comments are presented. Ultimately, this project bears significant clinical relevance as it provides specific implications regarding (a) what factors treatment providers need to directly target in order to improve emotion regulation in BPD, and (b) which types of emotion regulation strategies work best for those with BPD and when.

Chapter I: Borderline Personality Disorder and Emotion Dysregulation

Though BPD is generally described as a complex disorder, most theorists agree that emotion dysregulation is one of its central components. Linehan (1993a) suggests that emotion dysregulation is, in fact, the core of the disorder and accounts for all BPD-relevant behaviours and diagnostic criteria. Within Linehan's (1993a) model, BPD features are either direct outcomes of emotion dysregulation (e.g., anger outbursts), or are maladaptive attempts to manage emotion dysregulation (e.g., self-harm). Other prominent BPD theorists emphasize the importance of emotion dysregulation to the disorder, albeit alongside other constructs. For example, Selby and Joiner (2009) proposed an extension and elaboration on Linehan's (1993a) model called the "Emotion Cascades Model", in which emotion dysregulation is maintained and connected to behavioural dysregulation via cognitive processes such as rumination. Though rumination is at the forefront of Selby and Joiner's (2009) model, emotion dysregulation remains a "key player." Fonagy and Bateman (2008) have similarly proposed a mentalizing model of BPD, in which difficulty conceptualizing one's own and other's internal states is central to the disorder. While the primary emphasis is on mentalization, this model proposes that emotion dysregulation leads to breakdowns in the mentalization process. For example, Fonagy and Bateman (2007) describe that accurate emotion signals are required throughout the lifespan in order to be able to understand oneself and others (mentalizing), which is disrupted by emotion dysregulation. Thus, even models that position alternative constructs at the center of BPD pathology acknowledge the significant role of emotion dysregulation. Consistent with these theoretical models, findings from the empirical literature also emphasize emotion dysregulation as a central feature of the disorder. Sanislow and colleagues (2002) provided empirical support for a three-factor model of BPD criteria consisting of emotion dysregulation, behavioural dysregulation, and disturbed relatedness

via a confirmatory factor analysis. Evidence also suggests that the emotional components of BPD (such as emotional instability and anger) are the most robust over two and six years compared to other components such as identity disturbance and interpersonal instability (McGlashan et al., 2005; Zanarini, Frankenburg, Hennen, & Silk, 2003), and the strongest predictor of suicide attempts in BPD over sixteen years (Wedig, Silverman, Frankenburg, Reich, Fitzmaurice, & Zanarini, 2012).

Defining Emotion Dysregulation

Of the proposed theoretical models, Linehan's (1993a) is the only one that offers a definition of emotion dysregulation. Her model suggests that emotion dysregulation in BPD arises from a transaction between a biological vulnerability to emotion dysregulation, and an invalidating environment. According to her model, emotion dysregulation in BPD occurs across two emotion components: disrupted emotion *response* and deficits in emotion *regulation*.

Disrupted emotion *response* consists of abnormalities in the onset or presentation of the emotion such as heightened sensitivity (i.e., lower threshold for emotional responding such that individuals are more likely to experience emotional responses after stimulus presentation), emotional reactivity (i.e., larger change in emotional intensity from baseline once an emotional response is initiated), and slow return to baseline (i.e., delayed reductions in emotional responding after an emotional response). Deficits in emotion *regulation* refer to difficulties in the emotion regulation process, which involves modulating emotional intensity either volitionally or automatically (Gross & Thompson, 2007). Though emotion regulation can be employed to either increase or decrease emotional intensity, BPD theorists typically focus on deficits in decreasing negative emotional intensity. Consequently, many evidence-based treatments for BPD involve training individuals in emotion regulation strategies designed to regulate negative emotional

intensity. For example, emotion regulation skills training is a central component of DBT (Linehan, 1993a). Other treatments, such as Mentalization-Based Therapy (Bateman & Fonagy, 2004), have also emphasized the utility of training individuals with BPD to use emotion regulation strategies as a mechanism to improve mentalizing (Lewis, 2006).

Chapter II: Borderline Personality Disorder and Deficits in Emotion Regulation

Consistent with theory, emerging evidence suggests that targeting emotion regulation deficits is critical to the successful treatment of BPD. For example, Neacsiu, Rizvi, and Linehan (2010) showed that, among individuals with BPD receiving DBT, reductions in suicide attempts, depression, and increases in anger control were fully mediated by the use of DBT skills (including emotion regulation skills). The use of these skills was also found to partially mediate the decrease of nonsuicidal self-harm behaviours throughout treatment. Research with individuals receiving DBT for BPD and substance use problems also suggests that improvements in emotion regulation can account for reductions in substance use frequency whilst other key variables, such as reductions in negative mood, do not (Axelrod, Perepletchikova, Holtzman, & Sinha, 2011). In a sample of individuals with high BPD features undergoing DBT skills training (Stepp, Epler, Jahng, & Trull, 2008), emotion regulation skills were found to predict reductions in BPD features. In sum, consistent with models proposing that emotion regulation problems are central to BPD, data suggest that improving emotion regulation is central to obtaining positive clinical outcomes in BPD treatments.

Classes of Emotion Regulation: Engagement and Disengagement Strategies

Given the centrality of emotion regulation deficits to BPD as well as the demonstrated link between improvements in emotion regulation and therapeutic outcomes, researchers have begun to more finely delineate the nature of emotion regulation deficits in BPD. Gross' (1998) Process Model has been instrumental in delineating between different forms of emotion regulation by mapping them across several overlapping and recursive stages of the emotion generation process. The first component of the emotion generation process is the Situation Selection stage, when individuals enter an emotionally evocative situation (e.g., going to a sad

movie). Next, at the Attention Deployment stage, participants attend to the emotionally evocative stimulus instead of other alternative stimuli in the environment that may be less likely to evoke an emotional response (e.g., attending to the sad movie instead of staring at the floor or distracting oneself with a mental to-do list). The Appraisal stage follows, wherein participants make an appraisal of the emotionally evocative stimulus that is likely to elicit the emotional response (e.g., “this is a sad movie”). Last, the emotional response is elicited at the Response stage (e.g., sadness). Although these stages are distinguishable, they inform each other in a cyclical nature (e.g., an emotional response gives rise to a new form of situation, reiterating the cycle; Gross & Thompson, 2007). Gross (1998) suggests that individuals regulate emotion at any of these stages; through situation modification (e.g., leaving the movie), attention deployment (e.g., focusing on positive thoughts instead of the film), altering appraisals of the stimulus or the emotion (e.g., reinterpreting the film in a way that is less likely to elicit sadness), or response modulation (e.g., watching a comedy film after the sad one in order to alter the emotional response which has already been elicited). Just as effective emotion regulation can occur across any of these stages of the process model, emotion regulation deficits can similarly occur across any of these stages. For example, individuals may not implement a strategy at all, implement the wrong strategy, or fail to implement a strategy effectively (Gross & Jazaieri, 2014). This dissertation will focus on the latter (i.e., failure to implement a strategy effectively), and examine ways to modulate the effectiveness of emotion regulation strategies in BPD.

Although it is possible to regulate across any stage of the emotion-generative cycle, the basic and clinical literatures have largely examined two main forms of emotion regulation that occur at distinct stages in the emotion generative process: *engagement* and *disengagement* strategies. *Engagement strategies* are ones that operate at the “appraisal” stage of the cycle

because they involve engaging with or processing the emotional content in some way by representing it in working memory. Conversely, *disengagement strategies* operate earlier in the emotion generative cycle at the attention deployment stage. Rather than engaging with emotional content, these strategies involve diverting attention away from emotional responding or stimuli all together. Thus, in contrast to engagement strategies, disengagement strategies involve reallocating attention to prevent the processing of emotional responding or stimuli in the first place (Sheppes & Gross, 2011; Sheppes, Scheibe, Suri, & Gross, 2011; Sheppes et al., 2014).

Engagement (mindful awareness) and disengagement (distraction) strategies in BPD.

Two engagement and disengagement strategies that have received particular attention in BPD are mindful awareness and distraction, respectively. Mindful awareness involves nonjudgmentally acknowledging, accepting, observing, and embracing the present experience without attempting to modulate or change it (Kabat-Zinn, 1990; Segal, Williams, & Teasdale, 2013). Mindful awareness is an example of an engagement strategy as it involves attending to the current emotion, rather than distracting from it. Distraction, conversely, involves diverting attention from emotionally evocative stimuli with the aim of reducing its negative emotional impact (Sheppes et al., 2011). Distraction is a quintessential example of a disengagement strategy as it involves reallocating attention to a neutral or positive stimulus, and away from the negative emotionally evocative one (e.g., Sheppes et al., 2011). There is a range of evidence from basic affective neuroscience supporting the notion that these two strategies are particularly effective for healthy controls (HCs) (Kohl, Rief, Glombiewski, 2012; Webb, Miles, & Sheeran, 2012).

Mindful awareness has also been emphasized in several treatments for BPD. For example, MBT aims to increase mentalizing, which involves (though is not limited to) drawing attention towards psychological states, akin to mindful awareness. Though the definition of mindful

awareness is broader than that of mentalizing, when mentalizing is directed towards current mental states it operates similarly (or equivalently) to mindful awareness (Allen, Fonagy, & Bateman, 2008). DBT more explicitly incorporates mindful awareness of current emotions as a backbone of its emotion regulation training. Interestingly, DBT also emphasizes distraction in its training and, similar to the basic emotion literature, delineates between the two strategy types. Indeed, within the DBT skills curricula, a distinction is made between “emotion regulation strategies” and “distress tolerance strategies”. Emotion regulation strategies are designed to alter emotional responses, typically with the aim of decreasing negative emotional intensity. These strategies are posited to facilitate problem solving, and reduce intense or painful emotional responding over time. *Mindful awareness of the current emotion* is a central emotion regulation strategy taught to clients within this module. In this context, clients are taught to nonjudgmentally notice and accept emotional responses as they are in the moment, rather than evaluate, reject, or suppress them. There are also other strategies in this module that involve different approaches to reducing emotional responding, such as *opposite to emotion action* wherein clients act opposite to the urges associated with their emotion (e.g., approaching when afraid or gently avoiding when angry). However, even in this context, therapists emphasize that mindfulness of the current emotion is a necessary antecedent step to engaging in behaviours designed to more directly alter the emotion (Linehan, 1993b; 2015).

Conversely, DBT distress tolerance strategies consist of two subsets of skills, one of them being “crisis survival” skills; skills that are designed to help clients get through crisis situations without making them worse. Rather than modulating emotional intensity per se, as is the case with emotion regulation strategies, distress tolerance strategies either involve tolerating intense emotional responses, or “surviving” crises without engaging in destructive behaviours (e.g.,

suicide attempts). Unlike emotion regulation strategies, these strategies are conceptualized as “short term” solutions that help one to tolerate intense emotions rather than modulate them in the long term. Within the distress tolerance module, *distraction* is taught as a quintessential skill that provides clients with a quick reduction in emotional intensity for crisis situations. Thus, within DBT, mindful awareness and distraction are conceptualized as two key skills belonging to different groups of strategies (emotion regulation and distress tolerance, respectively). Importantly, of the vast array of strategies taught to individuals with BPD when receiving standard DBT, Lindenboim, Comtois, and Linehan (2007) found that individuals with BPD report using mindful awareness and distraction the most in their daily lives throughout treatment. These two are thus key candidate strategies for examinations of emotion regulation and BPD.

Examinations of the implementation of mindful awareness and distraction in BPD. In parallel with the theoretical models conceptualizing these two strategies as different forms of emotion regulation, researchers have examined whether or not individuals with BPD exhibit deficits in their implementation. Interestingly, extant studies examining whether this group exhibits deficits in the ability to apply a range of emotion regulation strategies suggest that they, in fact, may *not*. Chapman, Rosenthal, and Leung (2009) trained individuals high and low in BPD features in a suppression (i.e., actively suppressing negative emotions; Gross & John, 2003) and mindful awareness based strategy. Participants were then monitored in their environments via palm pilot for four days and were instructed to react as they normally would on the first and last day, suppress for one day, and utilize mindful awareness on the other day. Interestingly, whereas the low BPD feature group reported increases in negative emotions on the suppress day, the high BPD feature group reported increases in positive emotions. Furthermore, the two groups did not differ in self-reported negative emotions on the mindful awareness day. These findings

suggest that individuals with BPD or high in BPD features are able to implement mindful awareness-based emotion regulation strategies to the same extent as low BPD feature groups, and may be able to benefit even more so from suppression. However, it is important to note that emotion is a multi-faceted construct, one with distinct experiential (self-report), physiological (peripheral and central nervous system activity), and behavioural/expressive (e.g., electromyography activity) domains that are independent of each other and do not necessarily correlate (Berntson, Cacioppo, Quigley, & Fabro, 1994; Gross & Thompson, 2007). It is possible that individuals with BPD are able to implement emotion regulation strategies to effectively downregulate emotion in some domains, but not others. As this study solely examined the experiential domain, this remains unclear.

Recently, Kuo, Fitzpatrick, Metcalfe, and McMain (2016) conducted a laboratory study to examine whether individuals with BPD are able to regulate their emotions using mindful awareness and distraction upon instruction as indexed by experiential and peripheral physiologic (e.g., heart rate, skin conductance) domains. Consistent with the previous literature, findings indicated that the BPD group was able to utilize both mindful awareness and distraction to decrease negative emotional responding across all indices as effectively as the HC group in response to negative images. However, the BPD group reported less intense positive emotions than HCs when distracting, suggesting that HCs may uniquely benefit from distraction (i.e., experience more positive emotions when distracting). Although the inclusion of physiological assessment importantly provided a more comprehensive assessment of emotion regulation in BPD, like Chapman and colleagues' (2009) work, this study did not include an assessment of behavioural/expressive domains of emotion.

Effectiveness of other emotion regulation strategies in BPD. Despite these limitations, the extant work suggests that individuals with BPD can implement emotion regulation strategies as effectively as HCs. These findings are also not specific to mindful awareness and distraction, although these strategies are particularly BPD-relevant. In fact, several studies have examined individuals with BPDs' ability to implement reappraisal, an engagement-based strategy wherein participants re-examine interpretations of emotional stimuli to reduce their impact (Gross & John, 2003). As with mindful awareness and distraction, results generally indicate that BPD and HC groups do not differ in the extent to which they benefit from this strategy. For example, participants with BPD did not differ from HCs in reductions in self-reported negative emotions or electrophysiological indices of emotional responding while reappraising negative images (Lang et al., 2012; Marissen, Meuleman, & Franken, 2010; Ruocco, Meaglia, Ayaz, & Chute, 2010; Schulze et al., 2011).

However, findings from neuroimaging studies comparing BPD and HC groups in their use of reappraisal are more mixed; one neuroimaging study suggested that BPD and HC groups exhibited similar levels of prefrontal oxygenated haemoglobin when using reappraisal (Ruocco et al., 2010). However, others suggested that BPD groups show less reduction, or greater general activation, of the amygdala (Koenigsberg et al., 2009) and the insula (Schulze et al., 2011), respectively, areas that are associated with negative emotion (e.g., Phillips, Drevets, Rauch, & Lane, 2003). Research has also demonstrated that, compared to HCs, those with BPD have less activation of the anterior cingulate cortex, a region implicated in attention deployment and executive functions required for cognitive reappraisal (Koenigsberg et al., 2009; Lang et al., 2012). A recent study also demonstrated that, following reappraisal, individuals with BPD exhibited less functional connectivity between emotion regions (i.e., the amygdala) and regions

that may inhibit them such as the prefrontal cortex, the superior temporal gyrus, and the posterior cingulate cortex than HCs. Also, the BPD group in this study demonstrated increased functional connectivity between the amygdala and the superior parietal lobe relative to HCs (Baczkowski et al., 2016). Importantly, all of these neuroimaging studies also measured self-reported negative emotions, and showed that BPD and HC groups did not differ in self-report following reappraisal (Baczkowski et al., 2016; Koenigsberg et al., 2009; Lang et al., 2012; Ruocco et al., 2010; Schulze et al., 2011). These findings therefore indicate that emotion regulation may recruit distinct neural regions or networks in those with BPD compared to HCs, but their outcomes are experienced similarly.

There are thus somewhat mixed findings with respect to whether BPD and HC groups can benefit equally from reappraisal. Indeed, one reason for these mixed findings may be the lack of a fully comprehensive psychophysiological assessment of emotion regulation. Notably, though extant studies have utilized experiential and physiological assessments, none to date have examined the behavioural/expressive domain of emotion. Further, no study to date has examined emotion regulation in BPD across experiential, physiological, and behavioural/expressive indices, and the mixed findings may thus be due to the fact that emotion regulation strategies may be effective in some emotional domains but not others. Despite this limitation and the mixed findings, a majority of the self-report and physiological evidence to date suggests that individuals with BPD can in fact implement emotion regulation strategies as effectively as others. Taken together, extant data thus suggest that (a) emotion regulation strategies are important to the treatment of BPD and (b) for the most part, individuals with BPD do not appear to have deficits in their ability to implement specific types of emotion regulation strategies.

Chapter III: Optimizing Emotion Regulation in Borderline Personality Disorder

The Emotion Regulation Impasse: Is “As Good as Healthy Controls” Good Enough?

In sum, although treatments for BPD target difficulties with emotion regulation, emerging evidence suggests that individuals with BPD may actually be able to regulate emotions as effectively as others, *even without treatment*. These findings have significant implications for treatment development as it suggests that simply increasing emotion regulation abilities in BPD may not be the most effective means of obtaining therapeutic outcomes. These findings also raise the question; if emotion regulation is not “the problem” in BPD, then what is? One possible answer is evident in the wide body of literature showing that BPD is characterized by heightened emotional intensity at baseline. Research supports this notion via general self-reported negativity as well as specific self-reported emotions such as sadness, anger, anxiety, annoyance, shame, and disgust compared to HCs, individuals with major depressive disorder, and individuals with social anxiety disorder (Elices et al., 2012; Gratz, Rosenthal, Tull, Lejuez, & Gunderson, 2010; Kuo & Linehan, 2009; Kuo et al., 2016; Scott, Levy, & Granger, 2013). Indeed, in an ambulatory monitoring study, Ebner-Priemer and colleagues (2007) showed that individuals with BPD report heightened intensity of anxiety, anger, sadness, shame, and disgust in their daily lives compared to HCs. Individuals with BPD also exhibit heightened negative emotional intensity relative to HCs as indexed by sympathetic measures such as skin conductance responses (SCR; Kuo & Linehan, 2009), salivary cortisol (Feliu-Soler et al., 2013; Scott et al., 2013), and salivary alpha amylase (Feliu-Soler et al., 2013).

Moreover, it is important to note that a majority of extant studies have measured the “effectiveness” of emotion regulation by the degree of change (reduction) in emotional intensity when implementing an emotion regulation strategy. The literature reviewed above suggests that

individuals with BPD exhibit the same *degree of change* as HCs when using emotion regulation strategies. Though these findings are perhaps more hopeful than originally theorized, comparable reductions in emotional intensity relative to HCs also means that individuals with BPD are still at an elevated emotional intensity because they “start off” higher (i.e., heightened baseline emotional intensity). For example, Kuo and colleagues’ (2016) recently reported that, consistent with other literature, individuals with BPD exhibit significantly elevated baseline emotional intensity, but comparable emotional reactivity and emotion regulation effectiveness to HCs. Thus, even after “effective regulation,” the BPD group remains elevated in emotional intensity compared with HCs because the implementation of emotion regulation strategies was *only* as effective as for HCs. Kuo and colleagues (2016) reasoned that, although individuals with BPD can regulate, they may need to exhibit even *greater* abilities in emotion regulation than HCs in order to achieve levels of emotional intensity that are comparable to non-clinical groups. No research suggests that individuals with BPD are *superior* to others in using emotion regulation strategies effectively. Individuals with BPD thus find themselves at an unfortunate impasse; although they can regulate as well as anyone else, it still might not be *good enough*.

Optimizing Emotion Regulation in Borderline Personality Disorder: A Two-Step Procedure

In sum, emotion regulation is critical to the conceptualization of BPD and improving emotion regulation is critical to the successful treatment of the disorder. However, extant data suggest that, although individuals with BPD can regulate their emotions, their emotion regulatory abilities likely need to be *further strengthened* in order to more effectively modulate their general heightened emotional intensity. It is therefore important to identify ways to strengthen emotion

regulation in BPD. Accordingly, this dissertation employs two specific approaches aimed at identifying ways to enhance emotion regulation in BPD.

Step 1: Identifying factors that influence emotion regulation. First, factors that obstruct or facilitate emotion regulation need to be identified. Doing so would provide significant implications for treatment development by delineating specific factors that need to be targeted in order to enhance the effectiveness of emotion regulation strategies. Specifically, identifying factors that obstruct emotion regulation would allow treatment providers to target and reduce these factors alongside emotion regulation-based interventions for effective emotion regulation to occur. Similarly, identifying factors that facilitate emotion regulation could allow treatment providers to attempt to enhance these factors in treatment to potentiate emotion regulation effects. Thus, this work would critically “set the stage” for more effective emotion regulation in BPD.

Step 2: Selecting the right strategies at the right time. Second, factors that indicate which *specific* type of emotion regulation strategy (i.e., engagement versus disengagement) is most likely effective for “who” (i.e., a particular individual) and “when” (i.e., at a particular point in time) warrants investigation. Psychotherapy researchers have long understood that there can be great variability with which people benefit from different treatments, and that knowing which characteristics predict this variation can optimize outcomes (e.g., Menzies, 1996; Simon & Perlis, 2010). Accordingly, ways to match clients to specific treatment strategies based on pre-existing characteristics has been studied. For example, the Cognitive Behavioural model of anxiety disorders involves both cognitive (e.g., catastrophic thoughts), physiological (e.g., racing heart), and behavioural components (e.g., avoiding the feared stimulus; Beck, Emery, & Greenberg, 2005; Zinbarg, Craske, & Barlow, 2006). One group of researchers examined which treatment strategies (relaxation training plus exposure versus cognitive therapy plus exposure)

are particularly beneficial for agoraphobic individuals high in cognitive versus non-cognitive reactivity to anxiety. Their results demonstrated that participants displayed improved treatment outcomes when those with high versus low cognitive reactivity were matched to a cognitive plus exposure versus a relaxation plus exposure intervention, respectively, than when participants were unmatched (Mackay & Liddel, 1986).

While extant research has critically begun to investigate *who* should be “matched” to a particular intervention strategy, in the context of BPD intervention research, it is equally critical to identify *when*, or under what conditions, should a particular intervention (i.e., emotion regulation strategy) be used. The latter question is more pertinent to the study of emotion regulation in BPD because clients are offered a plethora of emotion regulation strategies and emerging research indicates that flexibility in emotion regulation strategy use is linked to psychological well-being (Aldao & Nolen-Hoeksema, 2012). However, little is known about which strategies should be used and when. Examining whether one form of emotion regulation, engagement or disengagement, is more likely to benefit an individual at a particular point in time or under a particular context would be critical to surmounting some of the existing limitations in BPD treatments. Thus, in addition to “working hard” by implementing various emotion regulation strategies, clients could “work smart” by specifically selecting strategies most likely to benefit them at a given moment.

Investigating Antecedent and Response-Focused Factors that Influence Emotion Regulation

There are several potential factors that could influence general and differential emotion regulation. Importantly, Gross (1998) has distinguished between *antecedent-focused* and *response-focused* emotion regulation strategies. Antecedent-focused emotion regulation

strategies attempt to modify emotion before, or in anticipation of the presentation of, an emotionally-evocative stimulus/context (i.e., avoiding an emotional situation, preparing oneself for a difficult situation). Conversely, response-focused emotion regulation strategies attempt to modify an emotional response that has been elicited (i.e., engaging in paced breathing after increases in anxiety) after presentation of the emotionally-evocative stimulus/context. Like emotion regulation strategies, the factors that *influence* emotion regulation may also be antecedent- or response-focused. Figure 1 provides an illustration of different factors that can influence emotion regulation.

Figure 1. Visual representation of predictors and outcomes for the present studies

There are several factors that could influence emotion regulation and many ways to classify them. However, distinguishing between, and comprehensively studying, antecedent- and response-focused predictors is particularly meaningful. Indeed, antecedent- and response-focused factors likely require different forms of intervention in order to improve general emotion regulation. Antecedent-focused factors (i.e., contextual factors present prior to the presentation of an emotionally-salient stimulus) are relatively static, habitual, and stable ones that influence emotion regulation (e.g., one's general biological vulnerability). Conversely, response-focused factors (i.e., state-based factors present after the presentation of an emotionally-salient stimulus) are fluid and change from moment-to-moment (e.g., the presence and size of a dynamic emotional reaction). Like many long-standing behavioural patterns, antecedent-focused factors likely require ongoing monitoring and repeated therapeutic intervention to change, rather than an acute, "in-the-moment" intervention. For example, although biological vulnerability to emotion dysregulation as indexed by baseline respiratory sinus arrhythmia (RSA) is theorized to be a relatively stable construct (Beauchaine, 2001), emerging research shows that it can be gradually increased over time through repeated mindfulness or yoga practices (Kok et al., 2013; Tyagi, Cohen, Reece, Telles, & Jones, 2016). Highlighting antecedent-focused factors that are important to emotion regulation thus signals to treatment providers ways in which their ongoing therapeutic interventions should be altered to consistently monitor and target these domains and, accordingly, improve general emotion regulation. Conversely, as a variable that is defined by its dynamic response to an emotional stimulus, response-focused factors are theoretically more labile and acute than antecedent-focused ones. Although a response-focused factor such as emotional reactivity may be reduced over time through ongoing therapeutic intervention, given its lability and acute nature, these factors are likely most directly targeted by a brief intervention in the

moments that they are activated. For example, a wide range of DBT skills are taught to individuals to use specifically in the moments in which an emotional reaction is provoked in order to downregulate the emotion (e.g., intense exercise). Rather than chronic, ongoing intervention per se, it is likely these brief skills that directly target response-focused factors such as emotional reactivity are necessary to improve general emotion regulation effectiveness.

Moreover, these factors would also need to be understood differently when being used to predict *differential* emotion regulation effectiveness thereby indicating which emotion regulation strategy type an individual with BPD should use at a given time. Indeed, treatment providers could use their knowledge of the participant's historical levels of an antecedent-focused factor in order to determine which emotion regulation strategy is most likely to be effective for them. However, for response-focused factors, treatment providers would need to evaluate the magnitude of a response-focused factor *in the moments* that an emotion regulation strategy is required in order to accurately estimate which type of strategy to recommend. Given these distinct forms of intervention, investigating both antecedent- and response-focused factors would significantly clarify the nature of the intervention strategies necessary in order to optimize general and differential emotion regulation.

As indicated in Figure 1, there are many antecedent-focused factors that may influence emotion regulation. First, emotion regulation may be nested within a broader **behavioural context**, such as typical habitual behavioural patterns and tendencies that inform one's potential for effective emotion regulation. There are an infinite number of possible behavioural patterns and tendencies that could influence emotion regulation. This dissertation focuses on one particularly compelling example of an antecedent-focused behavioural factor: sleep quality. In addition to behavioural contexts, emotion regulation is also largely influenced by variability in

one's own **biological context** that may constrain the extent to which emotion can be modulated.

As with behavioural contexts, while there are many possible ways to examine antecedent-focused biology as it pertains to emotion regulation (e.g., neurotransmitter dysfunction or hippocampal/amygdala abnormalities; Friedel, 2004; Nunes et al., 2009), this work examines one biological variable that has been purported to be particularly central to emotion regulation capacity, *basal vagal tone*. Moreover, emotion regulation may also be impacted by variability in individual's **emotion** prior to emotion provocation (i.e., their *baseline emotional intensity*).

Antecedent-focused emotion context is thus a third variable worthy of investigation as a potential predictor of general and differential emotion regulation strategy effectiveness. Similarly, emotional factors that occur after the emotion-provocation (**response-focused emotion**) are also highly plausible predictors of emotion regulation effectiveness. The magnitude with which emotion is elicited following emotion provocation (*emotional reactivity*) will thus be the final potential predictor of emotion regulation effectiveness examined in this study. Investigation of all four potential predictors, antecedent- and response- focused, provides a comprehensive and nuanced examination of potential kinds of predictors that influence emotion regulation in BPD.

Emotion regulation factor #1: Antecedent-focused behavioural context (sleep quality). There is a substantial body of literature suggesting that sleep is pertinent to healthy emotion and emotion regulation (see Kahn, Sheppes, & Sadeh, 2013, for review). For instance, emerging research suggests that the functional connection between the prefrontal cortex and amygdala is vital for emotion regulation, as the prefrontal cortex provides a “top-down” inhibitory influence on the amygdala (a region highly implicated in negative emotion; Sotres-Bayon, Bush, & LeDoux, 2004). The functional connection between these two regions is impaired by sleep problems such as sleep loss (Yoo, Gujar, Hu, Jolesz, & Walker, 2007).

Theorists have suggested that optimal sleep may therefore serve a “reset” function for this prefrontal-amygdala network, so that it can take on the emotional challenges of the next day effectively (see Gruber & Cassoff, 2014, for review).

Further, beyond sleep loss and fragmentation, general sleep quality may also play a key role in emotion and emotion regulation processes (Gruber & Cassoff, 2014). For example, one study showed that sleep quality (SQ) moderates the relationships between self-reported emotion regulation difficulties and depression or anxiety symptoms, such that emotion regulation difficulties are particularly predictive of higher depression and anxiety symptoms in low quality sleepers (Markarian, Pickett, Deveson, & Kanona, 2013). These findings indicate that the influence of SQ on psychopathology may be exerted *through* its influence on emotion regulation. Moreover, emerging experimental research directly indicates that SQ impairs emotion regulatory abilities. Mauss, Troy, and LeBourgeois (2013) examined rated SQ over the past week and then asked participants to utilize cognitive reappraisal in response to a negative film clip. These authors found that poorer rated SQ resulted in smaller reductions in self-reported sadness when cognitively reappraising in response to the film clip. Another longitudinal study among undergraduate students found that lower rated SQ predicted higher levels of general self-reported difficulties with emotion regulation over a three-year period. These findings were also bidirectional, such that higher levels of general self-reported difficulties with emotion regulation also predicted lower rated SQ (Tavernier & Willoughby, 2014). Taken together, these findings indicate that reduced subjective SQ may negatively influence emotion regulation effectiveness.

Notably, BPD is linked with a range of SQ problems such as difficulty falling asleep, maintaining sleep, and rising earlier than desired (Selby, 2013). Individuals with BPD also exhibit many sleep-related abnormalities via polysomnography such as increased time spent in

stage one and stage two sleep, as well as rapid eye movement sleep, but less time spent in deep sleep, than HCs (see Hafizi, 2013, for review). People with BPD also report reduced SQ relative to HCs (Semiz, Basoglu, Ebrinc, & Cetin, 2008), which is implicated in BPD severity; Plante, Frankenburg, Fitzmaurice, and Zanarini (2013) reported that patients who still have BPD after a 16 year follow up have significantly worse rated SQ compared to those who no longer did. Importantly, evidence from self-report studies suggests that BPD features interact with poor SQ (i.e., difficulty falling asleep, staying asleep, or waking up too early) to predict increased difficulty controlling emotions (Selby, 2013). Based on the extant evidence in HCs highlighting the role of impaired rated SQ in emotion regulation deficits, rated SQ is a likely candidate for influencing the effectiveness with which individuals with BPD can regulate their emotions. However, as indicated above, only a handful of studies have examined whether rated SQ significantly impacts emotion regulation effectiveness among non-clinical samples and/or individuals with BPD. Further, studies to date have only assessed the impact of sleep on self-reported measures of emotion regulation. Given the aforementioned multi-faceted nature of emotion regulation (Gross & Thompson, 2007), it remains unknown which specific domains of emotional functioning are impacted (or not) by SQ.

Further, while the extant literature suggests that SQ may influence emotion regulation, there are also many different ways in which SQ can be impaired, such as experientially (rated SQ), excessive time spent in bed (e.g., Perlis, Giles, Mendelson, Bootzin, & Wyatt, 1997), greater variability in sleep time (Buysee et al., 2010), and, most notably, lower sleep efficiency (SE; reduced time spent sleeping relative to the time spent in bed; Edinger & Carney, 2008). Studies suggest that BPD may be characterized by greater variability in sleep time, lower SE, and excessive amounts of time spent in bed (Huy`nh, Guile, Breton, & Godbout, 2015; Winsper

et al., 2017). However, only one study to date has examined the relationship between SE and emotion regulation capabilities (Vandekerckhove et al., 2012). This study instructed participants to implement either a mindful awareness-based or a cognitive reappraisal-based emotion regulation strategy in response to a failure-based emotion induction, and measured their SE the night following. Participants who were instructed to implement mindful awareness exhibited higher SE than those using cognitive reappraisal. This finding led the authors to conclude that “experiential” emotion regulation strategies such as mindful awareness more effectively downregulate the lasting effects of negative emotion that can permeate subsequent sleep episodes than “analytical” strategies (i.e., cognitive reappraisal; Vandekerckhove et al., 2012). This study also indicated that there is a relationship between emotion regulation and SE, suggesting that low SE may be a predictor of general and differential emotion regulation in BPD. However, the relationship between sleep disturbances and emotion regulation is theorized to be bidirectional (Kahn, Sheppes, & Sadeh, 2013) and, while Vandekerckhove and colleagues (2012) work examined the influence of emotion regulation on SE, no studies have analyzed the reverse direction.

Moreover, it is notable that SE can be problematic if it is particularly low *or* particularly high. While low SE may indicate low quality sleep, extremely high SE indicates a particularly rapid sleep onset time, which is common in circumstances of sleep deprivation (e.g., Perlis, Benson-Jungquist, Smith, & Posner, 2005). While aforementioned works imply a deleterious role of low SQ (low SE) in emotion regulation, sleep deprivation also impairs emotion regulation (e.g., Gruber & Cassoff, 2014). It is therefore unclear whether particularly low or high SE would be most problematic for emotion regulation in BPD. However, as mentioned, much research suggests that individuals with BPD are characterized by lower SE, rather than higher (see

Winsper et al., 2017, for meta-analysis), and insomnia (Selby, 2013) rather than sleep deprivation per se. It is therefore likely that emotion regulation in this group would be particularly impacted by lower SE, as abnormally low SE (e.g., insomnia) may be more characteristic of this population than abnormally high SE (e.g., sleep deprivation). However, despite the lower rates of SE in BPD (Winsper et al., 2017) and the theorized relationship between emotion regulation difficulties and BPD (Linehan, 1993a), no research has examined the relationship between SE and emotion regulation comprehensively across emotion indices in a BPD population.

In sum, a host of theory and research compellingly indicates that SQ (i.e., SE and rated SQ) influence emotion regulatory effectiveness in general. However, it remains unclear whether these variables influence general emotion regulatory effectiveness in BPD, or predict the *differential* effectiveness of emotion regulation strategies (mindful awareness versus distraction) within or across BPD and HC groups. Thus, the first aim of this study was to examine the extent to which SQ (SE or rated SQ) predict the *general* and *differential* (mindful awareness versus distraction) effectiveness of emotion regulation strategies. Although the impact of SQ on emotion regulation is established, there is no theory and research that indicates whether these variables predict differential effectiveness of emotion regulation strategy types. We therefore considered investigating whether SQ predict differential emotion regulatory effectiveness exploratory.

Emotion regulation factor #2: Antecedent-focused biological context (basal vagal tone). Second, in addition to behavioural contexts, emotion processes are also nested within broad antecedent-focused biological contexts. As previously discussed, Linehan's (1993a) model theorizes that emotion dysregulation (abnormal emotional response processes and emotion

regulation deficits) arises from a transaction between a *biological vulnerability* to emotion dysregulation and an invalidating environment. More specifically, individuals with BPD are posited to have emotional response and regulation systems that do not adapt as readily to the emotional demands of their environments, placing them at a higher risk for heightened negative emotional intensity and difficulties in implementing emotion regulation strategies. Many physiological states have emerged as possible indices of biological vulnerability to emotion dysregulation such as serotonin dysfunction (Johnson, Hurley, Benkelfat, Herpertz, & Taber, 2003), dopamine dysfunction (Friedel, 2004), and reduced amygdala and hippocampus volume (Nunes et al., 2009). In addition to these variables, baseline respiratory sinus arrhythmia (RSA) has gained increasing empirical support as an index of biological vulnerability.

Baseline RSA is an index of “vagal tone” and refers to the variation of heart rate (HR) with respiratory patterns of inhalation and exhalation. RSA reflects the mediation of two efferent pathways from the vagus (i.e., the parasympathetic nerve) to the heart (Porges, Doussard-Roosevelt, & Maita, 1994). Specifically, these two pathways are posited to serve opposing functions on cardiac activity and emotional responding. The first pathway originates from the dorsal motor nucleus and decreases HR and, consequently, emotional reactivity. The other pathway originates in the nucleus ambiguus and blocks vagal activity, which results in increases in HR and, subsequently, sympathetic activity and emotional reactivity. Vagal tone is posited to reflect the interacting influence of these two pathways on cardiac activity, such that low basal vagal tone is theorized to be indicative of greater general vulnerability to intense negative emotion. *Increases* in vagal tone relative to baseline, conversely, are purported to reflect increases in the parasympathetic emotion regulation system and consequential *decreases* in emotional reactivity and/or increases in emotion regulation; *decreases* in vagal tone relative to

baseline (i.e., vagal withdrawal) reflect *increases* in emotional reactivity (Beauchaine, 2001; Porges et al., 1994).

There is some preliminary research supporting the theory that basal vagal tone, as measured by baseline RSA, may impact the extent with which one can modulate emotional responding. First, low baseline RSA characterizes several forms of internalizing and externalizing psychopathology including anxiety disorders (e.g., Lyonfields, Borkovec, & Thayer, 1995), mood disorders (e.g., Yaptangco, Crowell, Baucom, Bride, & Hansen, 2015), attention problems (Shibagaki & Furuya, 1997), and Asperger-spectrum disorders (Guy, Souders, Bradstreet, DeLussey, & Herrington, 2014). Accordingly, baseline RSA is now conceptualized as a transdiagnostic index of biological vulnerability to emotion dysregulation (Beauchaine & Thayer, 2015). This is supported by a range of developmental literature, which suggests that lower baseline RSA is associated with greater difficulties with emotional expressivity (see Beauchaine, 2001, for review), and greater self-reported self-regulation problems in children (Hastings et al., 2008). Similarly, in youth, the extent to which baseline RSA increases over three years is associated with lower self-reported emotion regulation difficulties (Vasilev, Crowell, Beauchaine, Mead, & Gatzke-Kopp, 2009).

Baseline RSA also predicts emotional responses to emotional stimuli in adults; lower baseline RSA predicts greater increases in distress in response to worry inductions (Gouin, Deschenes, & Dugas, 2014), in anger in response to stressful tasks (Ellis, Shumake, & Beevers, 2016), and in heart rate in response to trauma stimuli in a posttraumatic stress disorder sample (Sack, Hopper, & Lamprecht, 2004). In depressed individuals, lower baseline RSA predicts greater persistence of anger following a stressful task (Ellis et al., 2016). Further, individuals who are high in rejection sensitivity report having less emotional control and more hostility when

in conflict with romantic partners, but *only if* they also exhibit low baseline RSA (Gyurak & Ayduk, 2008). Moreover, people with higher baseline RSA adopt more functional emotion regulation strategies (specifically cognitive reappraisal) in response to a negative film than others (Volokhov & Demaree, 2010). Higher baseline RSA also predicts reduced spontaneous avoidance of disgust-eliciting images, an emotion regulation strategy that is often conceptualized as maladaptive (Aldao, Dixon-Gordon, & De Los Reyes, 2016). Similarly, another study demonstrated that individuals with lower baseline RSA are less able to modulate facial responses to negative film stimuli when instructed (Demaree, Robinson, Everhart, & Schmeichel, 2004). These findings collectively provide support for a relationship between higher baseline RSA on the engagement of effective emotion regulation strategies.

Thus, while not explicitly tested in BPD, a wide body of research across several populations corroborates the notion that baseline RSA influences the extent to which emotions are provoked and modulated. Although one study suggests that BPD is not characterized by lower baseline RSA (Austin et al., 2007), several others show that it is (Kuo & Linehan, 2009; Kuo et al., 2016; Weinberg, Klonsky, & Hajcak, 2009), indicating a higher emotional vulnerability to emotion dysregulation in this group. Low baseline RSA is thus a plausible biological factor that might influence general emotion regulation effectiveness in BPD.

In addition to influencing broad emotion regulation effectiveness, baseline RSA may also predict the *differential* effectiveness of emotion regulation strategy types. Basic emotion research suggests that, because engagement strategies involve processing information alongside emotion, they are more resource-demanding than quickly terminating the emotion-generative cycle with a disengagement one (Sheppes, Catran, & Meiran, 2009). Given that baseline RSA is theorized to index one's capacity to engage with emotionally challenging situations (Beauchaine, 2001),

individuals with higher baseline RSA may be particularly well-equipped to utilize more challenging strategies, such as engagement ones. Although not explicitly tested, this assertion is somewhat corroborated by aforementioned studies showing that people with higher baseline RSA spontaneously adopt engagement cognitive reappraisal more and disengagement avoidance less, than those with lower baseline RSA in response to negative emotion inductions (Volkhov & Demaree, 2010 and Aldao et al., 2016, respectively). However, whether baseline RSA directly predicts the differential effectiveness, rather than selection, of engagement versus disengagement strategies, has not yet been tested. Further, it remains unclear if baseline RSA predicts general or differential emotion regulation effectiveness in BPD.

Emotion regulation factor #3: Antecedent-focused emotion context (baseline emotional intensity). In addition to behavioural and biological contexts, perhaps the most obvious factors that influence emotion regulation strategy effectiveness are qualities of the emotion, and specifically the intensity of the emotion, that needs to be regulated. Importantly, there are several ways in which emotional intensity can be quantified and measured. As previously discussed, literature robustly demonstrates an association between *heightened baseline emotional intensity* and BPD across several indices such as self-reported specific and general emotions, SCR, salivary cortisol, and salivary alpha-amylase relative to clinical and healthy control groups (Ebner-Priemer et al., 2007; Elices et al., 2012; Feliu-Soler et al., 2013; Gratz, Rosenthal, Tull, Lejuez, & Gunderson, 2010; Kuo & Linehan, 2009; Kuo et al., 2016; Scott et al., 2013). Baseline emotional intensity in BPD may thus be a particularly strong index of emotional intensity that predicts general emotion regulation strategy effectiveness.

Moreover, emotional intensity is also a likely candidate in predicting *differential* effectiveness between engagement versus disengagement strategies. It has been suggested that,

because engagement strategies require cognitive resources to process the emotional content, high emotional intensity may compete for these resources, thereby diminishing the strategy's effectiveness (e.g., Sheppes & Gross, 2011; Sheppes et al., 2011). Thus, as engagement strategies operate later in the generative cycle and entail holding emotional content in working memory, they are purported to be primarily effective under conditions of low to moderate emotional intensity. Conversely, disengagement strategies do not require the processing of emotional content in this way and, in fact, involve shifting attention away from emotional content altogether. Theorists therefore suggest that these strategies might be effective regardless of emotional intensity level since the emotional stimulus or content is negated. Thus, whereas engagement strategies are theorized to be less effective as emotional intensity increases, disengagement strategies may not show a relationship between emotional intensity and effectiveness (Sheppes & Gross, 2011; Sheppes et al., 2011).

Consistent with what is postulated in this model, basic emotion research indicates that HCs select emotion regulation strategies as a function of the intensity of emotionally-evocative stimuli. In studies using an emotion regulation choice paradigm, individuals are trained in an engagement strategy, cognitive reappraisal, and a disengagement strategy, distraction. Individuals are then shown a preview of an emotional image for half of a second, and then asked to choose to regulate their emotions in response to the image using either cognitive reappraisal or distraction. Participants then view the image again for a longer duration and implement their chosen strategy (Sheppes et al., 2011). The results show that the *intensity of the emotional image* (i.e., standardized ratings from the International Affective Picture System; IAPS; Lang, Bradley, & Cuthbert, 2008) predicts the differential choice of engagement versus disengagement strategies; individuals consistently select the engagement strategy more in response to *low*

emotional intensity images (i.e., low valence and arousal IAPS scores) and the disengagement strategy more in response to *high emotional intensity images* (i.e., high valence and arousal IAPS scores). Participants also show a similar selection pattern in response to low versus high intensity electric shocks (Sheppes et al., 2011). This selection preference persists even when participants are offered monetary incentives to select in the opposing way (e.g., to pick disengagement strategies in response to low emotional intensity and to pick engagement strategies in response to high emotional intensity; Sheppes & Gross, 2011; Sheppes et al., 2011). Further, new research also indicates that the differential *effectiveness* of engagement versus disengagement strategies is similarly determined on the basis of stimulus intensity. In one study, HCs were shown images of varying intensities and instructed to either implement engagement reappraisal or disengagement distraction following image exposure. Consistent with theory, the effectiveness of the strategies was comparable following exposure to low intensity images, but distraction was more effective than reappraisal following high intensity image exposure (Sheppes et al., 2014b).

Recently, this work has been extended to BPD populations; in one study, individuals with BPD, HCs, and a major depressive disorder control group were exposed to images of varying intensities and provided with the option to choose either reappraisal or distraction. All groups chose reappraisal more in response to *low intensity images* than distraction, and distraction more in response to *high intensity images*. Moreover, the BPD group reported experiencing both emotion regulation strategies as significantly less *effective* than HCs specifically in response to the high emotional intensity images (Sauer, Sheppes, Lackner, Arens, Tarrasch, & Barnow, 2016). The finding that individuals with BPD reported lower perceived emotion regulatory effectiveness in response to the high intensity images corroborates the notion that emotional intensity may influence general emotion regulation in this group. Furthermore, the

evidence that individuals with BPD in this study chose emotion regulation strategies in accordance with the theory proposed by Sheppes and colleagues (2011) also suggests that emotional intensity may predict *differential* effectiveness of engagement versus disengagement strategies in this group. However, the measurement of emotion regulation in this study was not a measurement of effectiveness per se, but rather an assessment of *perceived* effectiveness (i.e., “how successfully did you employ this strategy?”). While this indicates ways in which their *perceptions* of effectiveness may be influenced by emotional intensity, it remains unclear whether their actual emotion regulatory effectiveness (i.e., change in emotional intensity while implementing an emotion regulation strategy) is altered.

Furthermore, although extant studies importantly point to emotional intensity as a factor that influences the general and differential effectiveness of engagement and disengagement emotion regulation strategies, they are not without limitations. First, these works are based on the assumption that the intensity of the emotional stimulus (the image) parallels the emotional intensity experienced by the individual selecting the strategy. Sheppes and colleagues’ (2011) model emphasizes the extent to which one *experiences* emotional intensity as the key factor that determines the effectiveness of an emotional stimulus. Thus, rather than examining the *emotional stimulus intensity* (i.e., IAPS arousal and valence scores) as the key predictor of general and differential emotion regulation effectiveness, examining emotional intensity *as it is currently experienced within the individual* may be more in keeping with the theoretical model. In addition, examining emotional intensity as experienced within the individual may also be more clinically meaningful as participants could use their current level of emotional experiencing to gauge which kind of strategy will serve them best in that moment. However, whether experienced

emotional intensity modulates emotion regulation effectiveness has not been examined in either general or BPD populations.

In sum, although there are many potential factors that can influence emotion regulation before an emotional response is even provoked, three forms of antecedent-focused factors may be particularly relevant: antecedent-focused behaviour (SQ), antecedent-focused biology (vagal tone), and antecedent-focused emotion (baseline emotional intensity). These factors are also at least somewhat intercorrelated; in HCs, moderate-sized associations have been found between higher SQ and higher vagal tone (Werner, Ford, Mauss, Schabus, Blechert, & Wilhelm, 2015) and higher SQ and lower baseline emotional intensity (see Baglioni et al., 2010, for review). As vagal tone is implicated as a transdiagnostic marker of emotion dysregulation, research has also demonstrated small- to moderate-sized associations between vagal tone and various forms of antecedent- and response-focused emotion, however the findings are somewhat mixed (e.g., Butler, Wilhem, & Gross, 2006; Demaree et al., 2004; Oveis et al., 2009; Pu, Schmeichel, & Demaree, 2010). Although researchers have also investigated the presence of these constructs in isolation in BPD (Koenig, Kemp, Feeling, Thayer, Kaess, 2016; Rosenthal et al., 2008; Winsper et al., 2017), no studies to our knowledge have directly examined their intercorrelations in this population.

Although theory and research supports the notion that all of these factors could predict the general or differential effectiveness of emotion regulation, there are many limitations in the extant literature. Most prominently, there is a lack of direct and comprehensive assessment of the influence of these factors on both general and differential emotion regulation effectiveness in BPD. Further, while theory and research suggests that emotional intensity could meaningfully predict the differential effectiveness of engagement versus disengagement strategies, all of the

literature examining this to date has relied on the intensity of emotional stimuli, rather than individual's experienced emotional intensity, to examine these variables (e.g., Sauer et al., 2016; Shafir et al., 2015; Sheppes et al., 2011; Sheppes et al., 2014ab).

Emotion regulation factor #4: Response-focused emotion (emotional reactivity). In addition to “what individuals walk into the room with” (i.e., antecedent-focused factors), it is also plausible that state-based changes following emotion provocation (i.e., response-focused factors) are influential over general and differential emotion regulation effectiveness. Specifically, in addition to baseline emotional intensity, the magnitude of change in emotional intensity *following* emotion evocation (i.e., emotional reactivity) is a key factor likely to influence emotion regulation effectiveness. Indeed, it is unclear which *specific* form of emotion, antecedent- or response-focused, or both, are influential over emotion regulatory effectiveness; both factors have the potential to yield higher emotional intensity that needs to be regulated. Sheppes and colleagues' (2011) and Sauer and colleagues' (2016) work on emotion regulation choice and emotional intensity would imply that individuals experiencing larger emotional reactivity might be less likely to benefit from engagement strategies, whereas the effectiveness of disengagement strategies might be unaffected. Therefore, individuals may show a greater discrepancy between the effectiveness of engagement and disengagement strategies as emotional reactivity increases.

Many studies have examined whether BPD is characterized by emotional reactivity, with mixed outcomes. Gratz, Dixon-Gordon, Breetz, and Tull (2013) demonstrated that individuals with BPD report larger subjective emotional responses in non-specific distress, but not negative affect, compared to non-BPD controls in response to a social rejection task. Further, individuals with BPD report larger changes in generalized negative affect in response to films with BPD-

relevant content (i.e., sexual abuse; Elices et al., 2012) and higher reactivity in shame in response to a negative evaluation stressor compared to outpatients without a personality disorder (Gratz et al., 2010). Some studies incorporating physiological assessments of emotions corroborate these findings; higher BPD features predict larger changes in self-reported negative affect and SCR following a social rejection stressor in a sample of university students (Dixon-Gordon, Yiu, & Chapman, 2013). Individuals with BPD also show larger decreases in RSA (i.e., heightened emotional reactivity) and heart period in response to negative films compared to HCs (Austin, Riniolo, & Porges, 2007). Ebner-Priemer and colleagues (2005) have also demonstrated that individuals with BPD have higher startle responses compared to HCs, but do not exhibit larger changes in skin conductance levels or HR in a startle tone paradigm.

In contrast, a number of studies have not found evidence of heightened emotional reactivity in BPD. Jacob and colleagues (2009) failed to find differences in reactivity between BPD, MDD, and HC groups in self-reported anxiety, shame, or sadness after an anger induction. Similarly, Staebler, Gebhard, Barnett, and Renneberg (2009) did not find evidence of heightened reactivity in self-reported negative emotions in response to negative films. Physiological assessments of emotional reactivity yield similar findings; there is no difference in reactivity between a BPD group and a “trait” matched non-BPD group (i.e., individuals who score similarly to those with BPD on personality measures but do not meet diagnostic criteria for BPD) and HCs as indicated by changes in salivary alpha amylase, and self-reported negative affect in response to a social stressor (Scott et al., 2013). Similarly, Kuo and Linehan (2009) reported that individuals with BPD do not differ from HCs or social anxiety disorder groups in response to negative films or personalized scripts eliciting sadness, anger, and fear as indicated by self-reported negative emotions, RSA, and SCR. Individuals with BPD also do not differ from HCs in

reactivity according to self-reported negative emotions, HR, SCR, salivary cortisol, or salivary alpha amylase as elicited by negative images (Feliu-Soler et al., 2013; Kuo et al., 2016).

Interestingly, a handful of studies suggest that individuals with BPD are characterized by *less* reactivity than others. Compared to HCs and individuals with avoidant personality disorder, individuals with BPD have shown smaller changes in SCR in response to negative images (Herpertz, Kunert, Schqenger, & Sass, 1999; Herpertz et al., 2000). Similarly, Scott and colleagues (2013) found that, whereas the trait-matched non-BPD and HC groups exhibited salivary cortisol reactivity to a social stressor, the BPD group did not. Two studies have demonstrated less reactivity as indicated by HR in response to films and images (Baschnagel, Coffey, Hawk, Schumacher, & Holloman, 2013; Elices et al., 2012), and another shows that opiate dependent patients with BPD exhibit reduced reactivity in the amygdala and anterior cingulate in response to negative images compared to HCs (Smoski et al., 2011).

There are several reasons why these data may be mixed. These studies have employed widely diverse methodologies to induce reactivity, examined a wide range of emotions, and measured reactivity across a wide range of indices. It is possible that individuals with BPD only exhibit emotional reactivity in response to specific forms of induction, in specific emotions, and/or in specific domains of emotional responding. For example, recent research suggests that individuals with BPD exhibit greater emotional reactivity in response to idiographic (i.e., personalized stories) rather than generalized (i.e., standardized films) emotion inductions (Kuo, Neacsiu, Fitzpatrick, & MacDonald, 2014) and heightened emotional reactivity in response to BPD-relevant themes such as rejection or abandonment, but not in response to generic stressors, compared to controls (Limberg, Barnow, Freyberger, & Hamm, 2011). Collapsing across all emotional reactivity studies in BPD together might thus mask a more complicated and nuanced

picture of emotional reactivity in BPD than originally theorized. Further, while some of these studies controlled for state dissociation (e.g., Ebner-Premier et al., 2005; Kuo & Linehan, 2009; Scott et al., 2013; Smoski et al., 2011), most did not (Austin et al., 2007; Baschnagel et al., 2013; Elices et al., 2012; Dixon-Gordon et al., 2013; Feliu-Soler et al., 2013; Gratz et al., 2010; Gratz et al., 2013; Herpertz et al., 1999; 2000; Jacob et al., 2009; Staebler et al., 2009). Research shows that dissociation is common in BPD populations (Ross, 2007) and that dissociation can dampen some indices of autonomic arousal (Ebner-Premier et al., 2005). Inconsistency in assessing and accounting for state dissociation in reactivity may therefore account for some of the mixed findings. These studies thus also highlight that dissociation could potentially confound investigations of other emotional processes, such as emotion regulation. Indeed, given that dissociation is known to dampen emotional responding, individuals with high levels of dissociation may appear to be more effective at emotion regulation than they are in reality. For this reason, it is also important to account for dissociation in emotion regulation research, which has rarely been done in the literature.

Summary

In sum, although research and theory suggest that improving emotion regulation in BPD is central to enhancing treatments for the disorder, there is very little research delineating specific ways in which emotion regulation can be improved. This dissertation therefore purports two key empirical steps aimed to facilitate more focused targeting of emotion regulation in BPD. The first step is identify which factors influence emotion regulation in general and among individuals with BPD. This would allow treatment providers to identify and target factors that influence emotion regulation effectiveness, yielding improved emotion regulation outcomes (i.e., “working better”). Second, given the vast number of emotion regulation strategies, it is important

to identify which *specific* emotion regulation strategies are optimally effective for a particular individual at a given point in time. Emotion theorists have recently classified emotion regulation strategies into either engagement (involving engaging with emotional content) or disengagement (involving shifting attention away from emotional content; Sheppes & Gross, 2011; Sheppes et al., 2011) strategies. The second step is thus to examine whether these factors also predict the *differential* effectiveness of engagement and disengagement emotion regulation strategies, both generally and in BPD. These findings would allow treatment providers to tailor interventions to client-related factors, providing recommendations for specific types of strategies to utilize under specific conditions, thereby increasing the likelihood that a given strategy will be effective at a given time (i.e., “working smarter”). As summarized in Figure 1, there are four antecedent and response-focused factors that theory and research indicate could be potential predictors of general and differential emotion regulation effectiveness: *antecedent-focused behaviour* (i.e., SE and rated SQ), *antecedent-focused biology* (i.e., baseline RSA), *antecedent-focused emotion* (i.e., baseline emotional intensity), and *response-focused emotion* (i.e., emotional reactivity). While emerging research indicates that these factors are likely to influence emotion regulation, as previously discussed, extant data are limited by the lack of a multi-dimensional assessment of emotion. Inclusion of a more comprehensive assessment of emotion would help delineate whether these factors influence all (e.g., experiential, physiological, behavioural/expressive) or only specific domains of emotions. As well, given the aforementioned demonstrated association between dissociation and emotional responding (Ebner-Premier et al., 2005), state dissociation needs to be controlled for to more precisely isolate the impact of these factors on emotion regulation. As such, in this study, emotion regulation outcomes were evaluated across all three theoretical components of an emotion (experiential, physiological, behavioural/expressive) while

controlling for state dissociation. Finally, no research to date has examined whether these factors differentially influence emotion regulation in BPD versus HCs. We therefore examined whether these four factors influenced general and differential effectiveness of an engagement (i.e., mindful awareness) and disengagement (i.e., distraction) emotion regulation strategy across BPD and HC groups, and whether group status (BPD versus HCs) modulated these relationships.

Chapter IV: The Present Study

Using a multi-method laboratory paradigm, the following questions will be examined¹:

Question 1 (Sleep Quality)

- A. **Antecedent-focused behaviour predicting effectiveness of strategies:** Does *lower SQ* (*reduced SE and rated SQ*) predict *general* emotion regulation effectiveness across BPD and HC groups?
- B. **Antecedent-focused behaviour predicting differential effectiveness of strategies:** Does *lower SQ* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?
- C. **(Secondary) Antecedent-focused behaviour predicting effectiveness of strategies- examining diagnostic group differences:** Does the impact of *lower SQ* on *general* emotion regulation effectiveness vary between BPD versus HC groups?
- D. **(Secondary) Antecedent-focused behaviour predicting differential effectiveness of strategies- examining diagnostic group differences:** Does the impact of *lower SQ* on the *differential effectiveness* of mindful awareness and distraction vary between BPD versus HC groups?

Question 2 (Basal vagal tone)

- A. **Antecedent-focused biology predicting effectiveness of strategies:** Does *baseline RSA* predict *general* emotion regulation effectiveness across BPD and HC groups?

¹ A full list of abbreviations is presented in Appendix G, for reference.

- B. **Antecedent-focused biology predicting differential effectiveness of strategies:** Does *baseline RSA* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?
- C. **(Secondary) Antecedent-focused biology predicting effectiveness of strategies- examining diagnostic group differences:** Does the impact of *baseline RSA* on *general* emotion regulation effectiveness vary between BPD versus HC groups?
- D. **(Secondary) Antecedent-focused biology predicting differential effectiveness of strategies- examining diagnostic group differences:** Does the impact of *baseline RSA* on the *differential effectiveness* of mindful awareness and distraction vary between BPD versus HC groups?

Question 3 (Baseline Emotional Intensity)

- A. **Antecedent-focused emotion predicting effectiveness of strategies:** Does *baseline emotional intensity* predict *general* emotion regulation effectiveness across BPD and HC groups?
- B. **Antecedent-focused emotion predicting differential effectiveness of strategies:** Does *baseline emotional intensity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?
- C. **(Secondary) Antecedent-focused emotion predicting effectiveness of strategies- examining diagnostic group differences:** Does the impact of *baseline emotional intensity* on *general* emotion regulation effectiveness vary between BPD versus HC groups?

- D. **(Secondary) Antecedent-focused emotion predicting differential effectiveness of strategies- examining diagnostic group differences:** Does the impact of *baseline emotional intensity* on the differential effectiveness of mindful awareness and distraction vary between BPD versus HC groups?

Question 4 (Emotional Reactivity)

- A. **Response-focused emotion predicting effectiveness of strategies:** Does *emotional reactivity* predict *general* emotion regulation effectiveness across BPD and HC groups?
- B. **Response-focused emotion predicting differential effectiveness of strategies:** Does *emotional reactivity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?
- C. **(Secondary) Response-focused emotion predicting effectiveness of strategies- examining diagnostic group differences:** Does the impact of *emotional reactivity* on *general* emotion regulation effectiveness vary between BPD versus HC groups?
- D. **(Secondary) Response-focused emotion predicting differential effectiveness of strategies- examining diagnostic group differences:** Does the impact of *emotional reactivity* on the differential effectiveness of mindful awareness and distraction vary between BPD versus HC groups?

Hypotheses

Question 1:

- A. **Antecedent-focused behaviour predicting effectiveness of strategies:** Based on models proposed by basic emotion scientists, we hypothesized that SE and rated SQ would

predict general emotion regulation effectiveness such that lower SE and rated SQ predicts less emotion regulation effectiveness (i.e., less reduction in emotional intensity when implementing emotion regulation strategies).

- B. Antecedent-focused behaviour predicting differential effectiveness of strategies:** As there is no theory or research that indicates whether SQ would predict the *differential* effectiveness of mindful awareness and distraction, we considered this particular examination exploratory and offer no hypotheses.

Question 2:

- A. Antecedent-focused biology predicting effectiveness of strategies:** Based on models proposed by basic emotion scientists, we hypothesized that baseline RSA would predict general emotion regulation effectiveness such that lower baseline RSA predicts less emotion regulation effectiveness (i.e., less reduction in emotional intensity when implementing emotion regulation strategies).
- B. Antecedent-focused biology predicting differential effectiveness of strategies:** Based on theorizing regarding the potential of baseline RSA to increase cognitive capacity, and research indicating a heightened preference towards engagement strategies in high baseline RSA individuals, we also hypothesized that baseline RSA would predict the degree of discrepancies between the effectiveness of mindful awareness and distraction. Specifically, we hypothesized that individuals with lower baseline RSA would benefit more from distraction compared to mindful awareness (i.e., greater reduction in emotional intensity when implementing distraction versus mindful awareness), whereas individuals with higher baseline RSA would not show differential effectiveness across the two strategy types.

Question 3:

- A. **Antecedent-focused emotion predicting effectiveness of strategies:** Based on models proposed by basic emotion scientists, we hypothesized that baseline emotional intensity would predict general emotion regulation effectiveness such that higher baseline emotional intensity predicts less emotion regulation effectiveness (i.e., less reduction in emotional intensity when implementing emotion regulation strategies).
- B. **Antecedent-focused emotion predicting differential effectiveness of strategies:** Based on models proposed by basic emotion scientists and emotion regulation choice research, we also hypothesized that baseline emotional intensity would predict the degree of discrepancies between the effectiveness of mindful awareness and distraction, such that individuals with higher baseline emotional intensity would benefit more from distraction compared to mindful awareness (i.e., greater reduction in emotional intensity when implementing distraction versus mindful awareness), whereas individuals with lower baseline emotional intensity would not show differential effectiveness across the two strategy types.

Question 4:

- A. **Response-focused emotion predicting effectiveness of strategies:** Based on models proposed by basic emotion scientists, we hypothesized that emotional reactivity would predict general emotion regulation effectiveness such that higher emotional reactivity predicts less emotion regulation effectiveness (i.e., less reduction in emotional intensity when implementing emotion regulation strategies).

B. Response-focused emotion predicting differential effectiveness of strategies: Based on models proposed by basic emotion scientists and emotion regulation choice research, we also hypothesized that emotional reactivity would predict the degree of discrepancies between the effectiveness of mindful awareness and distraction, such that individuals with higher emotional reactivity would benefit more from distraction compared to mindful awareness (i.e., greater reduction in emotional intensity when implementing distraction versus mindful awareness), whereas individuals with lower emotional reactivity would not show differential effectiveness across the two strategy types.

Questions C and D (1C, 1D, 2C, 2D, 3C, 3D, 4C, 4D):

(Secondary) Antecedent- and response-focused factors predicting general and differential effectiveness of strategies- examining diagnostic group differences: This study also examined interactions between group status (BPD versus HC) and these constructs on emotion regulation effectiveness in general, and differential effectiveness of specific emotion regulation strategy types. However, no research indicates whether these predictors would differentially affect emotion regulation across BPD or HC groups, and thus these analyses were considered secondary. No hypotheses are offered.

Chapter V: Method

Participants

In total, 80 individuals were recruited, 40 HCs and 40 individuals with BPD.

Power analysis. Power analyses were conducted using SAS 9.3 software. We specifically aimed to identify the sample size required in order to detect a statistically significant two-way interaction (e.g., baseline emotional intensity $\times$ emotion regulation strategy type) with a two-tailed test wherein $p < .05$. In order to simplify the power analyses, the predictor variable was dichotomized into “high” versus “low” (e.g., high versus low baseline emotional intensity) rather than treated as a continuous variable. Given that no research has tested similar two-way interactions, effect sizes were based on theory-driven study hypotheses that there would be approximately medium sized differences between the effectiveness emotion regulation strategies when baseline emotional intensity was high. Hypothetical data were simulated wherein no difference was observed between the effectiveness of mindful awareness and distraction when the predictor variable (e.g., baseline emotional intensity) was low, but a significant difference observed with a medium sized effect (Cohen’s $d = .60$) between the effectiveness of mindful awareness and distraction when the predictor variable (e.g., baseline emotional intensity) was high. See Figure 2 for a graphical representation of this hypothetical interaction. A significant two-way interaction was estimated with a medium effect size of $d = .60$. Power analyses were run with 10,000 simulations assuming 10 repeated measurements (i.e., examining emotion regulation across 30-second epochs over a 5-minute period). On average across the 10,000 simulations, a sample size of $N = 80$ ($n = 40$ per group) yielded 87% power (standard deviation = .34), indicating that a two-way interaction with an effect size of $d = .60$ would result in a p -value under .05 87% of the time. Rules of thumb indicate that acceptable power estimates

typically approximate 80% or higher (Cohen, 1992). Thus, it was determined that a sample size of 40 individuals per group would yield more than sufficient statistical power to detect interaction effects.

Figure 2. Graphical representation of hypothetical interaction between baseline emotional intensity and emotion regulation strategy on emotion regulatory effectiveness for power analysis

In light of these estimates, 40 individuals with BPD between the ages of 18 and 60 were recruited via flyers, postings, and announcements at relevant healthcare settings such as The Mindfulness Clinic, Broadview Psychology, and St. Michael's Hospital. Postings advertising a study on "Difficulty Controlling Emotions" were also posted on relevant online websites such as Borderline Personality Disorder forums, Craigslist.com, and Kijiji.ca. Individuals under the age of 18 were not recruited given cautions made against assigning adolescents and children personality disorder diagnoses (American Psychiatric Association, 2000). Individuals over the

age of 60 were not recruited in light of research showing that at least some of the core BPD criteria (e.g., relationship disturbances) decrease notably over the lifespan (Paris & Zwiig-Frank, 2001), as well as research showing that older adults have physiological profiles distinct from younger or middle aged adults (Antelmi et al., 2004).

Co-morbidity of BPD with other psychological disorders is the rule rather than the exception (Tadic et al., 2009). In order to balance the demands of external and internal validity of the study, we included individuals with BPD meeting criteria for concurrent psychological diagnoses. However, consistent with typical exclusion criteria in studies of BPD, participants were excluded if they met criteria for bipolar I disorder or severe psychotic-spectrum disorders (e.g., schizotypal personality disorder, delusional disorder, schizophreniform disorder, schizophrenia, schizoaffective disorder, substance or medication-induced psychotic disorder, psychotic disorder due to another medical condition), although participants with lifetime diagnoses of brief psychotic disorder, and current diagnoses of mild psychotic disorder not otherwise specified were allowed into the study. In addition, in order to ensure that physiological recordings were not confounded by substance use, individuals with BPD were also excluded if they met criteria for current substance or alcohol dependence. Participants taking regularly prescribed psychiatric medications other than Selective Serotonin Reuptake Inhibitors (SSRIs) were also excluded, given research suggesting that SSRIs exert substantially less effects on cardiac responding than other psychiatric medications (Licht, de Gues, van Dyck, & Penninx, 2010).

Healthy controls (HCs; $n = 40$) were matched to the BPD group on age and sex given research indicating large physiological and emotion process-related (e.g., Gardener, Carr, MacGregor, & Felimingham, 2013) discrepancies across these factors (Antelmi et al., 2004;

Kring & Gordon, 1998). HCs were recruited from the community through fliers and online advertisements (e.g., Craigslist.ca, Kijiji.ca) stating that we were seeking individuals who have never received a psychiatric diagnosis or have taken prescribed psychiatric medications. If HCs met diagnostic criteria for any current psychological diagnosis, they were excluded. Furthermore, if HCs endorsed 4/9 BPD diagnostic criteria or the self-harm/suicidality BPD diagnostic criterion, they were excluded in order to ensure diagnostic distinctions between groups. HCs taking medications for any psychological reasons were excluded in order to further ensure that HCs were not experiencing current psychological difficulties and to avoid confounding psychophysiological recordings (Licht et al., 2010).

Any prospective participants with dementia, mental retardation, neurological illnesses, organic brain syndromes, or a traumatic head or brain injury were also excluded as these conditions were likely to interfere with understanding and the ability to participate in the experimental tasks. In addition, participants were excluded if they were taking other medications or have other medical conditions that were likely to confound physiological recordings or influence alertness. Specifically, they were excluded if they were taking H1 histamine receptor blockers (e.g., Huo, Langley, Szabadi, & Bradshaw, 2007), beta-blockers (e.g., Sandrone et al., 1994), or had epilepsy (e.g., Tomson, Ericson, Ihrman, & Lindblad, 1998), heart or respiratory conditions (e.g., Buccelletti et al., 2009; Lutfi, 2012), or had specific hormonal or metabolic illnesses such as diabetes and metabolic syndromes (e.g., Liao et al., 1998; Malpas & Maling, 1990). Participants were also excluded if they reported having hearing problems as much of study stimuli are presented aurally. Whether participants should be excluded due to other medical illnesses was determined on a case-by-case basis.

Measures of Participant Demographics and Clinical Functioning

Demographic information was collected with a questionnaire assessing a range of demographic factors such as age, sex, ethnicity, and highest level of education.

The McLean Screening Inventory (Zanarini et al., 2003) was administered via phone as a pre-screening interview for probable BPD (among individuals responding to the BPD group advertisements) prior to coming into the laboratory for further assessment. The McLean Screening Inventory is a brief, 10-item measure that asks participants to answer “yes” or “no” with respect to whether they have experienced various BPD-relevant symptoms (e.g., “Have you been extremely moody?”). Answering yes to seven or more of the 10 items indicates probable BPD. Though brief, this instrument is sensitive to the presence of BPD and correctly identifies 81% of cases and 85% of non-cases (Zanarini et al., 2003). Participants were invited to come into the laboratory for further diagnostic assessment if they answered yes to five or more of the questions, so as to ensure that prospective participants were not missed due to overly stringent thresholds at the phone screening stage.

The Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders-IV-TR (SCID-IV-TR; First, Spitzer, Gibbon, & Williams, 1995) was used to examine the presence of what was formerly titled “Axis I” disorders. The SCID-IV-TR has excellent psychometric properties. Though interrater reliability ranges based on the disorder being assessed, it is generally adequate to good (kappa reliabilities range between .60 to .83; Lobbestael, Leurgans, & Arntz, 2011). Furthermore, the SCID-IV-TR has strong convergent validity. For example, there is a strong correlation between the assessment of depression on the SCID-IV-TR and other established self-report measures of depression severity such as the Beck Depression Inventory (Beck, Steer, Ball, & Ranieri, 1996; Sprinkle et al., 2002). An MA-level clinical psychology graduate student (Fitzpatrick) administered all psychodiagnostic assessments

under the supervision of a licensed psychologist (Dr. Janice Kuo). The assessor (Fitzpatrick) was trained to reliability against a gold standard assessor on a larger BPD clinical trial (kappa across SCID-IV-TR modules = 1.00). A break down of participant diagnoses is presented in Table 2.

The International Personality Disorders Examination- BPD Module (IPDE-BPD; Loranger et al., 1994) was used to assess for the presence of BPD. The IPDE-BPD is a reliable and valid measure of BPD pathology, which assesses patterns of attitudes, feelings, and behaviour related to BPD pathology over the past five years and prior to age 25. The IPDE also allows for a dimensional assessment and scoring of the extent and severity of BPD pathology. The IPDE-BPD module has high temporal stability and interrater reliability, with kappas in the range of .82 and .90, respectively (Mann et al., 1999). It also has strong convergent validity, correlating highly with self-report measures of BPD pathology such as the Inventory of Clinical Personality Accentuations BPD subscale (Andresen, 2006; Schroeder, Andresen, Naber, & Huber, 2010). The assessor (Fitzpatrick) was trained to administer this measure to reliability with gold-standard assessors on a BPD clinical trial (prevalence-adjusted bias-adjusted kappa = .88).

The Duke Structured Interview for Sleep Disorders-Insomnia Module (DSISD; Edinger et al., 2009) was used to assess for the presence of insomnia. In this measure, interviewers assess whether participants have ever had difficulty falling asleep, staying asleep, or waking up too early and, if so, whether it has caused a variety of problems in daytime functioning (e.g., fatigue, daytime sleepiness). This measure has strong reliability (Kappa values tend to range between .71 and .86 across modules; Carney, Ulmer, Edinger, Krystal, & Knauss, 2009).

The Difficulties with Emotion Regulation Scale² (DERS; Gratz & Roemer, 2004) was used as a self-report measure of general emotion dysregulation. The DERS asks participants to indicate the extent to which various emotion dysregulation based statements generally apply to them (e.g., “When I’m upset, I become angry with myself for feeling that way”) on a five-point scale ranging from 1 (almost never/0-10% of the time) to 5 (almost always/91-100% of the time). The DERS yields six emotion-dysregulation based subscales: nonacceptance of emotional responses (e.g., “When I’m upset, I feel ashamed with myself for feeling that way”), difficulties engaging in goal-directed behaviour (e.g., “When I’m upset, I have difficulty getting work done”), impulse control difficulties (e.g., “When I’m upset, I become out of control”), lack of emotional awareness (e.g., “When I’m upset, I believe that my feelings are valid and important”-reverse coded), limited access to emotion regulation strategies (e.g., “When I’m upset, it takes me a long time to feel better”), and lack of emotional clarity (e.g., “I have difficulty making sense of out my feelings”). Both the total DERS and the DERS subscales have high internal reliability, with Cronbach alphas for the subscales ranging from .85 to .97 in the present study, and .97 for the total scale (see Table 8). The DERS also has high predictive validity, as it can distinguish between BPD and HC groups (Kuo & Linehan, 2009).

Depression, Anxiety, and Stress Scales (DASS; Lovibond & Lovibond, 1995) was used to measure depression and anxiety severity. The DASS is a 42-item scale with three subscales measuring depression severity, anxiety severity, and stress. Participants rated the extent to which various statements about their past week (e.g., “I felt that I had nothing to look forward to”) apply to them on a scale from 0 (does not apply to me at all) to 3 (applied to me very much or most of the time). Higher scores on each subscale indicate higher levels of depression, anxiety,

² All self-report questionnaires are presented in Appendix A.

and stress, respectively. The DASS subscales have strong psychometric properties with Cronbach alphas for the subscales from this study ranging from .94 to .98 (see Table 8). They also have high discriminant validity. For example, they can significantly distinguish those with and without diagnoses of Major Depressive Disorder (Kemp, Quintana, Felmingham, Matthews, & Jelinek, 2012).

The Dissociative State Scale (DSS; Stiglmayr, Shapiro, Stieglitz, Limberger, & Bohus, 2001) was included as a covariate in all analyses given the established influence of state dissociation on emotion processes in BPD (Ebner-Priemer et al., 2005). The DSS is a 21-item scale that assesses current state dissociation. Participants were asked to indicate their current level of perception in response to a range of dissociation-relevant items such as “Just now, I have the impression that my body does not belong to me” on a ten point scale ranging from 0 (none) to 9 (very strong). Higher scores indicate higher levels of current dissociative experiences. The DSS was designed for use in a BPD sample and has strong psychometric properties. For example, the Cronbach alpha for the DSS administered at the initial baseline in the present study was .93. The DSS also has exemplary divergent validity (i.e., can distinguish between BPD and HC groups; Kuo & Linehan, 2009), and convergent validity (i.e., correlated with measures of “aversive inner tension”; Stiglmayr et al., 2001).

Indices of Emotional Responding: Experiential (self-report)

Participants were provided with a **continuous rating dial** and asked to keep one hand on the dial and consistently adjust the dial to reflect shifts in general negative and positive emotional intensity (Ruef & Levenson, 2007). The dial had 10 markers on it, ranging from 0 (very negative) to 9 (very positive), with neutral demarcated between 4 and 5. Higher scores thus reflected lower levels of negative emotional intensity/higher levels of positive emotional

intensity. This dial allowed for a continuous, moment-by-moment, assessment of negative emotional intensity.

Indices of Emotional Responding: Autonomic Nervous System

The BIOPAC 6-channel acquisition system (BIOPAC Systems Inc., Model MP150, Goleta, CA) was used to collect all psychophysiological indices of emotional responding.

Heart rate (HR) was examined as a physiological index of emotional responding. HR is a psychophysiological index, which has input from both parasympathetic and sympathetic systems, such that it reflects changes in both of these systems (Berntson, Quigley, & Lozano, 2007). A two-electrode configuration with a bioimpedance module serving as a ground reference was used to examine electrocardiography (BIOPAC Systems Inc., MODEL EL503). HR was indexed by intervals between R-spikes in the electrocardiogram. HR data was processed using Mindware Technologies HRV 2.33 software (Mindware Technologies Ltd., 2011A), wherein R-R intervals were calculated across 30-second epochs. All data was visually inspected and double-scored segment by segment within the Mindware application in order to ensure that R-spikes were being correctly identified by the software.

Respiratory sinus arrhythmia (RSA) was examined as an index of vagal tone. As reviewed above, baseline RSA is theorized to reflect general emotional vulnerability to negative emotional intensity. Changes in RSA, conversely, are theorized to reflect changes in emotional reactivity such that decreases in RSA indicate increases in emotional reactivity and increases in RSA indicate decreases in emotional reactivity or enhanced regulation (Beauchaine, 2001; Porges et al., 1994). Initial baseline RSA was thus used as an index of basal vagal tone, and changes in RSA from the interim-baseline to the induction (see procedure) as an index of emotional reactivity. After R-R intervals were identified in accordance with preparing the HR

data, spectral analysis was used in order to decompose the electrocardiogram into three different frequency ranges. RSA was measured via the highest frequency band of spectral analysis (greater than .15 Hz), as cardiac activity below this frequency is posited to reflect sympathetic rather than wholly parasympathetic influence (Berntson et al., 1997). Respiratory patterns were measured via a respiratory band placed around the chest. RSA was calculated using Mindware Technologies HRV 2.33 software (Mindware Technologies Ltd., 2011A). Mindware software applied a validated algorithm to calculate spectral densities within this high frequency band across 30-second epochs.

Skin conductance responses (SCR) were examined as a sympathetic index of emotional responding. SCRs are fluctuations in galvanic skin response on the surface of the skin that have been linked with sympathetic nervous system activation, and with brief fluctuations in emotional responding (Dawson, Schell, & Filion, 2007). Electrolyte gel was placed on the medial phalanges of the middle and index finger of participant's non-dominant hand (Fowles, Christie, Edelberg, Grings, Lykken, & Venables, 1981). SCRs were digitized using low (35 Hz) and high (.05 Hz) pass filters at a rate of 1000 samples per second and a gain of 1000. Mindware Technologies EDA 2.40 program (Mindware Technologies Ltd., 2011B) was used to process the SCR data. A programmable rolling filter was used to detect and edit artifacts. SCR was indexed as the number of responses exceeding 0.05 μ S across 30-second epochs.

Indices of Emotional Responding: Behavioural/Expressive

Facial electromyographic (EMG) activity was examined as a behavioural/expressive index of changes in emotional responding. Increased movements of the *corrugator supercilii* (i.e., a region of muscles above the eyebrow) are linked to facial expressive behaviours associated with negative emotions, namely frowning, and increased movements of the *zygomaticus major*

(i.e., a region of muscles on the cheek) are linked to facial expressive behaviours associated with positive emotions, and namely smiling (Tassinari, Cacioppo, & Geen, 1989). Activity in the corrugator supercilii and zygomaticus major regions have been examined as indices of negative and positive emotional reactions, respectively, in addition to emotion regulatory effectiveness (e.g., Baschnagel et al., 2013; Deveney & Pizzagalli, 2008; Lee, Shackman, Jackson, & Davidson, 2009). Ag/AgCl electrodes were placed on the corrugator supercilii and zygomaticus major regions in accordance with Tassinari, Cacioppo, and Green's (1989) recommendations. Consistent with van Boxtel's (2001) recommendations, EMG signals were digitized using a low (400 Hz) and high (20 Hz) pass filter at a rate of 1000 samples per second, and analyzed across thirty-second epochs. Electromyographic activity is a relative rather than absolute index. That is, its resting values in and of themselves are not meaningful indicators of emotional experience and cannot indicate emotional intensity in one individual compared to another. Rather, greater or more frequent *changes* in electromyographic activity from baseline are indicative of emotional responding. Given that baseline electromyographic activity values in and of themselves do not necessarily indicate varying levels of emotional intensity, this index was only used as a measure of emotional reactivity (change from baseline prior to the imagery to imagery block) and regulation (change during the regulation block), rather than an absolute measure (baseline emotional intensity). Artifacts were detected and edited via PHZLAB (Nespoli, 2016; <https://gabenespoli.github.io/code.html>), a MATLAB toolbox.

Indices of Sleep

The Insomnia Severity Index (ISI; Bastien, Vallieres, & Morin, 2001) was used to measure subjective ratings of insomnia symptoms. The ISI is a 7-item measure assessing the severity of insomnia related issues (e.g., difficulty falling asleep, maintaining sleep, and waking

too early). Participants indicated the severity of the insomnia-related construct on a 0 to 4 scale. For example, in response to the question “how satisfied are you with your sleep?”, participants entered a response ranging from 0 (very satisfied) to 4 (very dissatisfied), and in response to the question “how worried/distressed are you about your current sleep problem?”, participants entered a response ranging from 0 (not at all worried) to 4 (very worried). Higher scores indicated higher severity of insomnia. Scores above 10 typically indicate probable insomnia (Morin, Belleville, Belanger, & Ivers, 2011). Research supports this measure’s psychometric properties, as it has high internal reliability ($\alpha = .90$ in the present study) and convergent validity such that the ISI correlates with other sleep-related variables such as sleep onset latency obtained via sleep diaries (Morin, Belleville, Belanger, & Ivers, 2011).

The Consensus Sleep Diary (CSD; Carney et al., 2012) was used to measure daily sleep behaviours and experiences. The CSD is a brief, daily measure that asked participants to provide a variety of information about their last sleep episode such as the time they went to bed, fell asleep, woke, got out of bed, and the number and durations of times that they woke throughout the night. Participants also entered a rating of the quality of each night’s sleep on a five-point scale ranging from very poor to very good. Participants were asked to complete the CSD each morning immediately after rising from bed, as this time of day provides the most reliable estimates (Carney et al., 2012). As with past studies examining SQ and emotion regulation (Mauss et al., 2013), participants were asked to complete this log every day for seven days prior to the day of the experiment. The CSD was used to provide a measure of rated SQ and SE. Similar to past research, rated SQ was measured as participant’s daily ratings of SQ over the course of the week (Pilcher, Schoeling, & Prosansky, 2000). SE is a numerical estimate that is calculated by dividing the total time spent sleeping by the time spent in bed. Lower SE indicates

that participants spent substantially more time in bed than they do actually sleeping, and higher SE indicates that participants spent almost all of their time in bed asleep (consistent with shorter sleep onset latencies).

Epworth Sleepiness Scale (ESS; Johns, 1991; 1992) was administered as a general assessment of the level of sleepiness of the sample. The ESS is an eight-item scale, which asked participants to rate their chances of falling asleep in various situations (e.g., “sitting quietly after a lunch without alcohol”) on a scale from 0 (would never doze) to 3 (high chance of dozing). Scores above 10 indicate excessive daytime sleepiness, with scores between 11-12 denoting mild, 13-15 indicating moderate, and 16-24 reflecting severe excessive daytime sleepiness (Johns, n.d.) The ESS is summed such that higher scores indicate higher levels of daytime sleepiness. The ESS has high convergent validity. For example, it’s scores correlate with the severity of objective sleep apnea syndrome, a disorder which can produce excessive sleepiness (Johns, 1993). In the present study, the internal reliability was acceptable with a Cronbach alpha of .78.

The Morningness-Eveningness Questionnaire (MEQ; Horne & Ostberg, 1976) is a measure of circadian rhythms and was administered in order to further characterize the nature of the sample. The MEQ is a 19-item measure which asked participants about a variety of parameters (e.g., “at what time of day do you think that you reach your “feeling best” peak?”) that indicate a tendency towards “morningness” versus “eveningness” using scales that vary in terms of their number of points and scoring. Scores were summed to indicate type where scores above 70 indicated a definite morning type, scores ranging from 59-69 indicated a moderate morning type, scores from 42-58 indicated no type, scores from 31-41 indicated a moderate evening type, and scores from 16-30 indicated a definite evening type (Horne & Ostberg, 1976). The MEQ has robust psychometric properties, with a Cronbach alpha of .88 in the present study

and high convergent validity, correlating highly with related scales such as Smith, Reilly, and Midkiff's (1989) Composite Scale of Morningness (Caci, Deschaux, Adan, & Natale, 2009).

Emotion Induction Stimuli (Imagery Scripts)

Methods of emotion induction in BPD vary greatly (Kuo et al., 2014). As discussed, a recent study comparing methods of emotion induction in BPD indicated that the BPD group showed heightened reactivity *only* in response to the rejection or abandonment scripts (Limberg et al., 2011). Based on these findings, and given that fear of abandonment is a core criteria of BPD (American Psychiatric Association, 2013), we elected to use rejection-themed scripts as emotion inductions for the present study. We therefore drew upon the available emotion inductions that involve rejection themes in the literature, with a particular emphasis on the ones utilized in Limberg and colleagues' (2011) work. However, the scenes used in Limberg and colleagues (2011) were very short (i.e., one sentence). Though one longer rejection script exists (Robins, 1988), three similar scripts were required for the present study given that it involves a repeated measures component with three conditions. Therefore, we developed four 2-minute rejection-based scripts that were piloted, and based on pilot results, we selected three to use in the present study.

Script development and piloting. The three scripts involve rejection from three distinct scenarios: rejection from a mother, friends, and romantic partner. In developing these scripts, we were conscious of maintaining as much consistency as possible across scripts in order to maximize internal validity. Accordingly, we followed a procedure based on Pitman, Orr, Forgue, de Jong, and Clairborn (1987), and ensured that the number of thoughts (e.g., "you think to yourself 'how could they do this?'"") and physiological sensations (e.g., "your heart beats faster") across each script was constant. Importantly, we also attempted to control for emotional intensity

across scripts guided by emotion coding and categorizations specified by Strauss and Allen (2008). Strauss and Allen (2008) examined 463 emotion words and asked participants to categorize each word (e.g., anxiety, anger, sadness words), and to rate its emotional intensity. In order to standardize the specific emotions elicited as well as their intensity across scripts, we first selected the four most intensely rated words from anger, anxiety, fear, and sadness categories. In addition, eight of the most intense words from the blended category (i.e., the category containing words that do not fall into a discrete emotion group such as “pain”) were also chosen. It is notable that some highly intense words are not emotion words per se (e.g., “murder”), and thus were omitted from the scripts in lieu of other intense emotion words (e.g., “misery”). These words were then randomly assigned to each script such that each script had one anger, anxiety, fear, and sadness word each, and two blended words, resulting in six emotion words in total. Last, each script explicitly stated that participants felt “rejection” or “rejected”.

All four potential scripts were piloted on a group of undergraduates ($N = 55$) wherein ratings of emotional intensity across a range of emotions (indexed via visual analogue scales) before and after script presentation were examined. The three scripts selected were equivalent in the extent to which they elicited general negative emotional intensity from before to after script presentation, $F(2, 108) = 2.07, p = .13$. See Appendix C for all three scripts.

Counterbalancing of scripts and regulation instruction. Counterbalancing occurred in relation to two factors: first, all scripts were paired with each emotion regulation instruction (REACT, MINDFUL AWARENESS, DISTRACT), in order to ensure that results were not confounded by specific script type. Thus, for the first factor, each script was assigned to each emotion regulation strategy, resulting in three different versions of the experiment. Second, order of emotion regulation strategy-script pairing was counterbalanced, in order to minimize the

influence of practice effects, boredom effects, or other time-based variables. However, the REACT condition was always presented before the two active emotion regulation strategies (MINDFUL AWARENESS, DISTRACT) in order to minimize possible contamination from implementing these two regulation strategies during the REACT condition in which participants were instructed to react using their usual/natural emotion regulatory tendencies. Thus, for the second factor, there are two different possible “orders” (e.g., react → mindful awareness → distraction or react → distraction → mindful awareness). Taken together, six different versions of the experimental task were possible.

Procedure

This study used a mixed design with both between and within-subjects components, and took place over the course of two laboratory visits and one week of sleep diary recording in the interim. A visual schematic of the entire procedural layout is presented in Figure 3. Interested participants were contacted by research assistants and briefly screened for inclusion and exclusion criteria including the administration of the McLean Screening Inventory (Zanarini et al., 2003) over the phone. If participants were eligible following the phone screening process, they were invited to come into the laboratory for Day One. On Day One, participants were administered the formal diagnostic interviews by the present author (Fitzpatrick). If participants were eligible to participate in the study, then they were scheduled for their second visit to the laboratory (“Day Nine”), which took place at least seven days following day one to allow for completion of the CSD. Accordingly, participants were provided with the CSD, instructed on how to complete it, and asked to begin filling out the CSD seven days prior (i.e., days two to eight) to their scheduled laboratory visit (“Day Nine”). This was done so that the sleep data

reflected the last week of sleep prior to experimental procedures. Participants were given a reminder phone call or email on the day before they were to begin completing this measure.

Figure 3. Visual schematic of entire study procedure

Baseline measurements. All other measures took place on Day Nine. In order to limit potential physiological effects of other substances, participants were instructed to avoid the ingestion of stimulants such as caffeine and tobacco on the day of their laboratory visit (Kuo & Linehan, 2009). A sample visual schematic of Day Nine is presented in Figure 4. First, participants completed all self-report measures. Next, electrodes for physiological recordings were attached and adjusted as necessary to ensure physiological readings were clean and clear. Participants were then instructed in the use of the continuous rating dial, and physiological recording began. Participants first completed a 10-minute initial baseline wherein they sat quietly with no stimuli (i.e., computer screen turned off) during which baseline RSA and baseline

emotional intensity (i.e., SCR) was assessed. During this time, participants used the continuous rating dial and completed the DSS immediately afterwards. In order to ensure a stable index of RSA and emotional intensity, only the last 5 minutes of the initial baseline period was included in all subsequent analyses (Jennings, Kamarck, Stewart, Eddy, & Johnson, 1992).

Laboratory imagery and regulation task. The laboratory task consisted of four blocks. In Block 1 (*instruction block*), participants were trained in the one of three emotion regulation conditions (REACT, MINDFUL AWARENESS, DISTRACT), depending on the counterbalancing order. Research assistants used a standardized script to train participants in each emotion regulation strategy (see Appendix B), but deviated from the script as necessary to answer participant's questions or to ensure understanding and clarity. The MINDFUL AWARENESS script was derived from a combination of scripts by Kuo and colleagues (2016) and Erisman and Roemer (2010) and instructed participants to nonjudgmentally notice any emotional experiences that arise without evaluating them, rejecting them, amplifying them or attempting to change them in any way. The DISTRACT script was derived from past studies and instructed participants to distract themselves from the content of the script by thinking of something that is emotionally neutral (Kuo et al., 2016; Paul, Simon, Kniesche, Kathmann, & Endrass, 2013; Sheppes & Meiran, 2008; Sheppes, Catran, & Meiran, 2009; Thiruchselvam, Blechert, Sheppes, Rydstrom, & Gross, 2011; Uusberg, Thiruchselvam, & Gross, 2014; Yoon & Joormann, 2012). Participants were specifically told to think of something emotionally neutral in this instance in order to avoid confounding the comparison of emotion regulation strategies with an inadvertent positive emotion induction that may come when distracting using positively-valenced thoughts. The REACT condition provided the possibility of controlling for the reduction in negative emotion that comes with the passage of time (Davidson, 1998), rather than

an active emotion regulation strategy implementation in all study analyses. In the REACT block, participants were instructed to “act as they normally would” (Kuo et al., 2016), after the emotion induction script ended. Research assistants asked participants to verbally repeat instructions back to them in order to ensure understanding, and clarified misunderstandings as they arose. Participants were instructed to begin to use this strategy when a visual cue appears on the computer screen prompting them to either “REACT”, use “MINDFUL AWARENESS”, or “DISTRACT”.

In the Block 2 (*interim-baseline block*) participants sat quietly for five minutes while baseline measurements were taken again. Immediately following Block 2, in Block 3 (*imagery block*), participants began the emotion regulation task. In this block, participants listened to the first of the three scripts and were instructed to listen to the script and imagine themselves in the scenario depicted. The script terminated after approximately two minutes. Next, in Block 4 (*regulation block*), a prompt on the screen appeared to cue the participant to engage in the emotion regulation strategy determined by the counterbalancing order: “REACT” was always first, followed by either “MINDFUL AWARENESS”, or “DISTRACT”. Participants implemented the strategy for two and a half minutes. This format is consistent with other emotion reactivity and regulation paradigms in BPD (e.g., Jacob et al., 2011), such that measurements of emotional reactivity can be garnered without the influence of emotion regulation strategies. The DSS was administered at the end of block 4, with continuous rating dial data and physiological recordings collected throughout.

Participants then repeated this procedure and underwent the next set of instructions, interim-baseline, imagery, and regulation blocks with the next emotion regulation condition based on the counterbalancing order. In order to assess for adherence to emotion regulatory

instructions, participants were asked the extent to which they attempted to use the mindful awareness and distraction strategies when instructed ranging from 0% of the time to 100% of the time. Following these ratings, physiological equipment was detached and participants were debriefed and compensated.

Figure 4. Example visual schematic of day nine of study

Note. DSS = Dissociative State Scale (Stiglmayr et al., 2001). Assessments of the amount of effort that participant's put into each emotion regulation strategy followed the DSS for mindful awareness and distraction trials.

Data Analytic Strategy

Data Preparation

As previously mentioned, all data were examined in 30-second epochs. However, the stories played in the imagery block clip lengths ranged from two minutes and four seconds to two minutes and nine seconds. The number of epochs for the stories was therefore four, thirty-second epochs, and a fifth epoch of between four and nine seconds. Some psychophysiological

data such as RSA cannot be reliably collected and analyzed in such short time spans (Berntson, Quigley, & Lozano, 2007). Therefore, these “tail ends” were combined and averaged with the last thirty-second epochs, such that the fourth epochs for the imagery blocks ranged in length from 34 to 39 seconds.

Descriptive Analyses and Covariate Identification

Preliminary analyses were conducted in order to characterize the study sample and understand the relations among study variables. First, correlations with continuous demographic (i.e., age, number of current medications) and clinically-relevant and primary study outcomes (i.e., average emotional intensity during the regulation phase for each index) were run. Next, independent samples t-tests (for continuous variables such as age and depression severity) and chi-square tests (for categorical variables such as sex and ethnicity) were conducted to determine whether demographic and clinically-relevant variables differed significantly across BPD and HC groups. If demographic or clinically-relevant variables were statistically significantly distinct across groups, and theory suggested that their influence may confound study hypotheses, then primary study analyses were run twice: once with these variables as covariates and once without, to determine whether they significantly influenced the primary study findings.

Across all analyses, dissociation (DSS) immediately after block 4 (*regulation block*) was entered as a covariate. In addition, natural reductions in emotional intensity that occurred during the regulation block of the REACT condition, as indexed by average emotional intensity during the last epoch of the REACT phase minus the first, was also entered as a covariate. This recovery variable (called “recovery”) controlled for decreases in emotional intensity that occur with the passage of time rather than an active emotion regulation strategy. Last, given the overlap between lower SQ and depression (Luca, Luca, & Calandra, 2013), and depression and BPD

(Zanarini et al., 1998), depression severity was included as a covariate in all analyses involving sleep-related predictors (question 1).

Generalized Estimating Equations Analyses

Generalized Estimating Equations (GEE; Burton, Gurrin, & Sly, 1998; Diggle, Heagerty, Liang, & Zeger, 2002; Hubbard et al., 2010) was used to analyze the data with SPSS version 20 software. GEE is an extension of generalized linear modelling approaches and, like these approaches, maximizes statistical power by allowing for examinations of outcome variables over continuous time courses. As a semi-parametric data analytic methodology, GEE utilizes within-cluster similarity of residuals to yield regression parameter estimates. Moreover, similar to other generalized linear modelling approaches, GEE examines predictors that are nested within varying levels and retains information from participants with missing data using the all available pairs method rather than deleting that participant's data all together. Unlike multi-level modelling approaches which utilize maximum likelihood estimation methods, GEE derives point estimates for each individual and then does a second additional estimate appropriate for the covariance structure of the repeated measures. There were several reasons for the selection of GEE over other generalized linear modelling approaches. First, GEE does not have any distributional assumptions, and as such it is robust when used with non-normal data (Hubbard et al., 2010). Moreover, because GEE utilizes a semi-parametric approach to modeling covariance structures, it yields robust parameter estimates even in circumstances where covariance structures are misspecified or the strength of correlations between repeated measures differs across individuals (Burton et al., 1998). For each GEE analysis, autoregressive and exchangeable covariance structures were examined and the one with the lowest Quasilikelihood under the Independence Model Criterion (QIC) value was selected. Of note, SCR is a count variable

because it reflects the number of non-specific skin conductance fluctuations relative to baseline per epoch. Often, the number of fluctuations per epoch is zero, and as a result, SCR data tends to be skewed and zero-inflated. In these circumstances, negative binomial distributions are optimal in most accurately reflecting the type and distribution of the data (Atkins & Gallop, 2007; Hilbe, 2011). Therefore, all GEE analyses involving SCR data were specified as utilizing negative binomial distributions.

Manipulation check. GEE was also used to verify whether the emotion inductions effectively elicited emotional intensity across participant groups. Emotional intensity throughout the interim-baselines and the imagery that followed was entered as a continuous outcome. Block (interim-baseline versus imagery) was entered as the predictor in order to examine whether emotional intensity significantly changed following imagery presentation. These analyses were thus repeated for every index of this outcome (e.g., rating dial, HR, RSA, SCR, corrugator supercilii and zygomaticus major activity). DSS scores were entered as a covariate. Statistically significant effects of block indicate that the emotion induction is either reducing or increasing emotional intensity.

Examination of strategy adherence across groups. In addition to manipulation checks, independent samples t-tests were also conducted to determine whether BPD and HC groups differed in the extent to which they attempted to follow instructions for each emotion regulation strategy condition. Two independent samples t-tests were therefore conducted, one examining fidelity to the mindful awareness instruction, and one to the distraction instruction. Group status was entered as the between-subjects predictor.

Primary analyses outcomes. For all primary study analyses, the outcome was the change in emotional intensity over time throughout Block 4, or the regulation block, as indexed

by changes in slope across rating dial, HR, RSA, SCR and corrugator supercilii and zygomaticus major activity over the 30-second epochs of that phase.

Identifying Predictors of Emotion Regulatory Effectiveness

Question 1 (antecedent-focused behaviour). Question 1A examined whether *lower SQ* (*reduced SE and rated SQ*) predicted general emotion regulation effectiveness across BPD and HC groups. Question 1B examined whether the impact of *lower SQ* on emotion regulatory effectiveness varied between mindful awareness and distraction across BPD and HC groups. *Sleep efficiency* and *rated sleep quality* were defined as the average scores across the week of daily sleep diary collection prior to the day of the experiment.

Question 2 (antecedent-focused biology). Question 2A examined whether *baseline RSA* predicted general emotion regulation effectiveness across BPD and HC groups. Question 2B examined whether the impact of *baseline RSA* on emotion regulatory effectiveness varied between mindful awareness and distraction across BPD and HC groups. *Baseline RSA* was measured as the average RSA during the last 5-minutes of the initial baseline.

Question 3 (antecedent-focused emotion). Question 3A examined whether *baseline emotional intensity* predicted general emotion regulation effectiveness across BPD and HC groups. Question 3B examined whether the impact *baseline emotional intensity* on emotion regulatory effectiveness varied between mindful awareness and distraction across BPD and HC groups. *Baseline emotional intensity* was measured as the average emotional intensity during the last 5-minutes of the initial baseline as indexed via rating dial-based negative emotion, HR, and SCR (i.e., indices of intensity)³.

³ As previously mentioned, EMG data was used to index emotional reactivity but not baseline intensity, given the nature of this index as relative rather than absolute.

Question 4 (response-focused emotion). Question 4A examined whether *emotional reactivity* predicted general emotion regulation effectiveness across BPD and HC groups. Question 4B examined whether the impact of emotional reactivity on emotion regulatory effectiveness varied between mindful awareness and distraction across BPD and HC groups. *Emotional reactivity* was computed as the difference between average emotional intensity from Block 2 (*interim-baseline*) occurring immediately before Block 3 (*imagery block*) to the average emotional intensity during Block 3 (*imagery block*) of the emotion induction as indicated via rating dial-based negative emotion, HR, SCR, RSA, and corrugator supercilii and zygomaticus major activity.

General Statistical Model Structure

Question 1A & 1B, (antecedent-focused behavior), 2A & 2B, (antecedent-focused biology), 3A & 3B (antecedent-focused emotion), 4A & 4B (response-focused emotion). One analysis was run for each predictor (SE, rated SQ, baseline RSA, baseline emotional intensity, emotional reactivity) and each index of emotion regulatory effectiveness (rating dial, HR, RSA, SCR, and corrugator supercilii activity and zygomaticus major activity) as the outcome. In these models, time (i.e., epochs across the regulation block) was entered as a within-subjects predictor. This predictor indicated whether there are significant reductions in emotional intensity throughout the regulation block (i.e., regulation outcome). The DSS and recovery covariates were then entered. For analyses involving sleep-related predictors (Question 1), depression severity was also included as a covariate. Primary predictors for question 1A/1B (SE/rated SQ), 2A/2B (baseline RSA), 3A/3B (baseline emotional intensity), or 4A/4B (emotional reactivity) were then entered.

Following this, interactions to test questions 1A, 2A, 3A, 4A, 1B, 2B, 3B, and 4B were entered. As mentioned, question 1A, 2A, 3A, and 4A pertained to whether or not antecedent-focused behaviour (i.e., SE, rated SQ), antecedent-focused biology (i.e., baseline RSA), antecedent-focused emotion (i.e., baseline emotional intensity), or response-focused emotion (i.e., emotional reactivity), respectively, predict the *general* emotion regulation effectiveness across strategies and groups. To examine this question, time $\times$ primary predictor interactions were entered into the model (e.g., “time $\times$ emotional reactivity” interactions for question 4A). These two-way interactions tested the hypotheses stated in 1A, 2A, 3A, and 4A by indicating whether these predictors influenced the rate of reduction in general emotion regulatory effectiveness over time.

Question 1B, 2B, 3B, and 4B pertained to whether or not response-focused emotion (i.e., emotional reactivity), antecedent-focused emotion (i.e., baseline emotional intensity), antecedent-focused biology (i.e., baseline RSA), and antecedent-focused lower SQ (i.e., SE and rated SQ), respectively, predicted the *differential* effectiveness of one type of emotion regulation strategy (engagement mindful awareness versus disengagement distraction) over the other, across groups. In order to examine this question, three-way time $\times$ primary predictor $\times$ emotion regulation strategy (i.e., mindful awareness versus distraction) interactions were entered into the model (e.g., “time $\times$ emotional reactivity $\times$ emotion regulation strategy” interactions for question 4B). These three-way interactions tested the hypotheses stated in 1B, 2B, 3B, and 4B by indicating whether these predictors *differentially* influenced the rate of reduction in emotion regulatory effectiveness over time between emotion regulation strategy types. All additional subsidiary two-way interactions required to build this three-way interaction were also entered

into the model (e.g., time $\times$ emotional reactivity, time $\times$ emotion regulation strategy, emotion regulation strategy $\times$ emotional reactivity).

Examining Diagnostic Group Differences (Secondary questions 1C, 2C, 3C, and 4C).

Questions 1C, 2C, 3C, and 4C involved identifying whether the aforementioned predictors influence general emotion regulatory effectiveness differentially across groups. In order to answer these questions, the same GEE analyses undertaken for questions 1A, 2A, 3A, and 4A were run again with the addition of group status as a predictor⁴. In addition to aforementioned covariates, these models thus included time, primary predictors, and also the group status (BPD versus HC) predictor. Furthermore, in addition to the aforementioned interactions, lower-level interactions between group $\times$ time and group $\times$ (study predictors) were added (e.g., two-way interactions for the analyses pertaining to question 4C with respect to emotional reactivity were: “time $\times$ emotional reactivity,” “group $\times$ time,” “group $\times$ emotional reactivity”). Finally, three way group $\times$ time $\times$ (study predictors) were added to the model (e.g., “group $\times$ time $\times$ emotional reactivity”). These three-way interactions indicated whether the study predictors differentially influenced general emotion regulatory effectiveness between BPD and HC groups.

Secondary questions 1D, 2D, 3D, and 4D. Questions 1D, 2D, 3D, and 4D involved identifying whether the potential *differential* influence of the aforementioned primary predictors on emotion regulatory effectiveness across emotion regulation strategies varied between groups.

⁴ When a categorical variable such as group status are included in a GEE model, one category is designated as the “reference” and all effect estimates and standard errors for main effects and interactions pertain to that category only (e.g., the main effect of time refers only to the change in the outcome over time in the one reference group, such as the HC group). Analyses addressing questions 1A, 1B, 2A, 2B, 3A, 3B, 4A, and 4B were thus run without group so that emotion regulatory effectiveness *across* groups could be examined. For these secondary analyses, when group was entered into the model, only the study-relevant interactions involving group status were interpreted because the other interactions had already been examined in the more parsimonious models created for questions 1A, 1B, 2A, 2B, 3A, 3B, 4A, and 4B.

In order to examine this question, in addition to the interactions added to address questions 1C, 2C, 3C, and 4C, four-way predictor $\times$ group $\times$ emotion regulation strategy $\times$ time interactions were added to the models with group status (e.g., “emotional reactivity $\times$ group $\times$ emotion regulation strategy $\times$ time”). All subsidiary two- and three-way interactions required to build this higher-order four-way interaction were also added (e.g., two-way interactions for the analyses pertaining to question 4D with respect to emotional reactivity were: “time $\times$ emotional reactivity,” “group $\times$ time,” “group $\times$ emotional reactivity,” “emotion regulation strategy $\times$ group,” “emotion regulation strategy $\times$ time,” “emotion regulation strategy $\times$ emotional reactivity,” “group $\times$ time $\times$ emotion regulation strategy,” “group $\times$ time $\times$ emotional reactivity,” “group $\times$ emotion regulation strategy $\times$ emotional reactivity” and “time $\times$ emotion regulation strategy $\times$ emotional reactivity”). The four-way interaction examined whether the *differential* impact of study predictors on emotion regulatory effectiveness over time between emotion regulation strategies, varied in BPD and HC groups. The three-way interaction designed to answer questions 1C, 2C, 3C, and 4C, and the four-way interaction designed to answer questions 1D, 2D, 3D, and 4D, were the only interactions interpreted from these models. Otherwise, effects from the simpler models, without group status, were retained and interpreted.

For all GEE analyses, continuous predictors were mean centered. All statistically significant or non-statistically significant main effects and interactions were thus as such when the other main effects in the model are set to their mean. For all analyses, mindful awareness was designated as the reference category. For all analyses involving group status, HCs were designated as the reference category.

Consideration of corrections for multiple tests. We considered applying statistical corrections to account for the number of tests being run such as family-wise Bonferroni

corrections or correcting for the false discovery rate (Benjamini & Hochberg, 1995). However, upon surveying a wide body of literature and commentary on the practice of correcting for multiple statistical tests, we elected to abstain from doing so. Several statisticians and researchers have critiqued the practice of adjusting for statistical tests; Rothman (1990) concludes that

“The theoretical basis for advocating a routine adjustment for multiple comparisons is the “universal null hypothesis” that “chance” serves as the first-order explanation of observed phenomena. This hypothesis undermines the basic premises of empirical research, which holds that nature follows regular laws that may be studied through observations. A policy of not making adjustments for multiple comparisons is preferable because it will lead to fewer error of interpretation when the data are actual observations” (pp.43).

Nakagawa (2004) similarly asserts that

“the average behavioral scientist performing a statistical test has a greater probability of making a Type II error (or β) (i.e., not rejecting H_0 when H_0 is false; note that statistical power is equals to $1 - \beta$) than if they had flipped a coin, when an experiment effect is of medium size (i.e., $r = .30$, $d = .50$)” (pp.1044).

Other researchers have expressed similar concerns about the likelihood that statistical corrections will inflate Type II error more than they will reduce Type I error (e.g., Cabin & Mitchell, 2000; Moran, 2003; O’Keefe, 2003). Further, such a risk of inflating Type II error when applying corrections is particularly high in psychological research, which typically focuses on phenomena with low to moderate sized effects (Rossi, 1990).

In addition, Moran (2003) demonstrated that Bonferroni corrections fail to account for the fact that the likelihood that statistically significant results are due to Type I error decreases as the number of related statistically significant tests increases (i.e., multiple tests demonstrating statistical significance of related phenomena is less likely to be spurious than one test). Although these outcomes are less likely to be due to Type I error, they are not necessarily more or less likely to have small p-values (i.e., p-values that are statistically significant but relatively large such as $p = .04$ are common and not more or less indicative of Type I error). However, such higher numbers of tests yield more stringent Bonferroni corrections. Thus, circumstances in

which multiple related tests are significant decrease the probability of Type I error, but the application of a Bonferroni correction in these circumstances inflates the probability of a Type II error. Alternative methods to Bonferroni corrections exist that are less subject to, although not entirely protected from, this particular issue (e.g., controlling for the false discovery rate instead of family wise error; Benjamini & Hochberg, 1995). However, even with less stringent approaches than Bonferroni corrections, theorists have still raised concerns that decisions regarding how many tests to control for are arbitrary, which can create a recapitulating cycle of undermining statistically significant test results (O’Keefe, 2003). For example, using a particularly rigid application of correcting for multiple tests, it is possible that running additional post-hoc analyses on a statistically significant interaction could then retroactively require a more stringent p-value for the initial interaction, rendering it non-significant and thus the follow-up post-hoc analyses unnecessary. Based on these considerations, the nature of the research questions in this study, and the statistical power in this study, it was our assessment that the application of correction might increase Type II error risk more than abstaining from it would increase Type I error risk. Consequently, we did not apply any adjustments to correct for multiple tests.

Chapter VI: Results

Data Preparation and Descriptive Analyses

Missing data. 2.18% of data was missing. A Little's Missing Completely at Random Test was run for each group of study outcome variables (one each for variables involved in rating dial, HR, RSA, SCR, EMG, and questionnaire-based analyses). None of the Little's Missing Completely at Random Tests were statistically significant (ps range from .24 to 1; see Table 1 for full analytic results), indicating that data were missing randomly.

Table 1
Missing Completely at Random Tests for Each Outcome

	df	χ^2	p -value
Rating dial	273	209.94	1.00
Heart rate	287	170.45	1.00
Respiratory sinus arrhythmia	287	263.15	.84
Skin conductance responses	272	269.86	.53
EMG data (corrugator supercilli and zygomaticus major)	484	505.79	.24
Questionnaire data	<i>No missing values</i>		

Note. EMG = electromyography. All data used in analyses involving each specific outcome (including predictors and covariates) were included in that particular test.

In addition to missing data, some data was removed from study analyses: One sleep log was not utilized because the participant completed it two weeks prior to the experiment date, instead of one. In addition, some psychophysiological and rating dial data were not retained in the analyses because participant behaviour during the time it was collected indicated that they were not adherent to the study protocol (e.g., participants putting their heads down on the desk and going to sleep during the experiment). Specifically, 1.25% of the initial baseline data was discarded. 5% of the data collected from the interim-baselines, 6.25% of the data collected during the imagery block, and 8.75% of the data collected during the regulation blocks were eliminated. Put another way, this process resulted in eliminating 1.68% of the HR, RSA, SCR, and EMG data, and 2.01% of the rating dial data.

Sample characteristics. Table 7 presents demographic breakdowns of the two groups, in addition to results of independent samples t-tests examining differences between the groups on these variables. Table 2 presents the current and lifetime (past) diagnoses within the BPD group.

Table 2

Breakdown of participant diagnoses within the BPD group

	Current	Past
Major Depressive Disorder	30%	50%
Dysthymic Disorder	22.5%	
Bipolar II Disorder	5%	0%
Other Bipolar Disorder	0%	5%
Substance induced mood disorder	2.5%	0%
Brief psychotic disorder	0%	2.5%
Psychotic disorder not otherwise specified	2.5%	0%
Alcohol abuse	12.5%	2.5%
Alcohol dependence	0%	27.5%
Substance abuse	5%	5%
Substance dependence	0%	20%
Panic Disorder	15%	5%
Agoraphobia	10%	0%
Agoraphobia without a history of panic disorder	5%	2.5%
Social anxiety disorder	45%	12.5%
Specific phobia	17.5%	5%
Obsessive compulsive disorder	32.5%	17.5%
Posttraumatic stress disorder	15%	7.5%
Generalized anxiety disorder	40%	0%
Anorexia nervosa	5%	5%
Bulimia nervosa	5%	7.5%
Binge eating disorder	2.5%	0%
Eating disorder not otherwise specified	5%	0%
Insomnia	77.5%	2.5%

Note. Due to study methodology changes, five participant diagnoses were based on DSM-5 diagnostic criteria using the Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders-5 (SCID-5; First, Williams, Karg, & Spitzer, 2015). The SCID-5 allows for a similar or identical assessment of all psychological disorders assessed in the study, with the exception of the substance/alcohol use disorders, which, unlike in the SCID-IV-TR are not delineated into substance abuse and dependence categories in the SCID-5. Only one participant who was administered the SCID-5 endorsed any problematic alcohol or substance use, and endorsed criteria that would qualify for a DSM-IV-TR diagnosis of substance dependence. This data was thus included in the above frequency counts for substance dependence and abuse. Insomnia diagnoses were based off of the Duke Structured Interview for Sleep Disorders-

Insomnia Module (Edinger et al., 2009) for all individuals except those who received the SCID-5, whose insomnia diagnoses were based off the SCID-5.

Examinations of distributions and data transformations. Table 8 presents means, standard deviations, and internal reliability for all questionnaires across groups. Tables 3 to 5 present bivariate correlations between all continuous study variables. Table 6 presents means and standard deviations across groups for primary study outcomes (i.e., average emotional intensity throughout the regulation block for each index) and predictors across groups. Rating dial, HR, and RSA outcomes had approximately normal distributions (i.e., skew statistics of data during the regulation block averaged across emotion regulation strategy conditions ranged from -.23 to .36). As is typical of SCR data (Dawson et al., 2007), ours was moderately positively skewed with an excess of zeros (skew statistic of data during the regulation blocks averaged across conditions = 1.56). Such skewed and zero-inflated count data are accommodated by analyses that specify negative binomial distributions (Atkins & Gallop, 2007; Hilbe, 2011). Given that this was the distribution specified in SCR analyses, these were not transformed or modified.

Both corrugator supercilii and zygomaticus major variables were also skewed (skew statistics of data during the regulation blocks averaged across conditions ranged from 3.79 to 4.32). In order to standardize variability across participants, and in keeping with previous studies utilizing EMG data (Livingstone, Vezer, McGarry, Lang, & Russo, 2016), both corrugator supercilii and zygomaticus major variables were converted to z-scores. These z-scores retained the same degree of skew, but they were not transformed because GEE is robust under conditions of non-normality (Hubbard et al., 2010).

Table 3

Bivariate correlations between questionnaire-based data

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Sleep efficiency	--											
2. Rated sleep quality	.50***	--										
3. Age	.03	-.06	--									
4. Number of medications	-.16	-.25*	-.02	--								
5. Emotion dysregulation (DERS)	-.28*	-.38**	-.02	.32**	--							
6. Stress (DASS)	-.28*	-.45***	-.08	.32**	.84***	--						
7. Anxiety (DASS)	-.30*	-.39**	-.10	.20	.69***	.86***	--					
8. Depression (DASS)	-.34**	-.46***	-.06	.21	.76***	.83***	.84***	--				
9. Dissociation (DSS)	-.15	-.11	.06	.03	.48***	.54***	.68***	.56***	--			
10. Insomnia severity (ISI)	-.40**	-.54***	.13	.43***	.69***	.67***	.58***	.64***	.44***	--		
11. Sleepiness severity (ESS)	-.18	-.29*	-.01	.19	.40***	.34**	.27*	.37**	.25*	.42***	--	
12. Morningness-Eveningness (MEQ)	.11	.13	.22	-.39***	-.25*	-.38**	-.31**	-.28*	-.23*	-.31**	-.13	--

Note. Sleep efficiency and rated sleep quality variables reflect averages of these variables across the week prior to the experiment. Dissociation scores reflect averages collected during all study phases. BSL-23 = Borderline Symptom List-23; DERS= Difficulties with Emotion Regulation Scale; DASS= Depression, Anxiety, and Stress Scales; ISI = Insomnia Severity Index; ESS = Epworth Sleepiness Scale; MEQ = Morningness-Eveningness Questionnaire; DSS = Dissociative State Scale.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 4

Correlations between questionnaire-based data and rating dial, heart rate, and respiratory sinus arrhythmia data

	Initial Baseline (RD)	Imagery (RD)	Regulation block (RD)	Initial Baseline (HR)	Imagery (HR)	Regulation block (HR)	Initial Baseline (RSA)	Imagery (RSA)	Regulation block (RSA)
Sleep efficiency	.16	.01	.02	-.04	-.06	-.10	.13	-.04	.17
Rated sleep quality	.26*	-.04	.12	-.15	.05	-.16	.29*	-.13	.25*
Age	.33**	-.27*	.18	.01	.25*	.01	-.14	-.15*	-.15
Number of medications	-.16	-.001	-.20	.36**	-.05	.36**	-.42***	.01	-.41***
Emotion dysregulation (DERS)	-.30**	.004	-.32**	.20	-.04	.28*	-.14	-.03	-.14
Stress (DASS)	-.26**	.02	-.26*	.17	-.02	.25*	-.17	-.04	-.13
Anxiety (DASS)	-.33**	.03	-.30**	.15	-.01	.22*	-.10	.06	-.07
Depression (DASS)	-.39**	.09	-.35**	.20	-.04	.27*	-.17	.04	-.14
Dissociation (DSS)	-.19	-.02	-.15	.08	-.004	.12	-.02	.18	-.04
Insomnia severity (ISI)	-.36**	-.06	-.13	.14	-.09	.21	-.25*	.18	-.25*
Sleepiness severity (ESS)	-.20	.02	-.07	.28*	-.28*	.27*	-.24*	.11	-.18

Morningness-Eveningness (MEQ)	.37**	.17	.19	-.02	.25*	-.04	.04	-.17	.04
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Note. Regulation block variables are averaged across emotion regulation strategy conditions. Baseline/basal variables reflect the average emotional intensity/RSA during the last five-minutes of the initial baseline. Imagery values reflect the average emotional intensity during the imagery block minus the average emotional intensity from the interim-baseline occurring immediately before it, averaged across emotion regulation strategy conditions. Sleep efficiency and rated sleep quality variables reflect averages of these variables across the week prior to the experiment. Dissociation scores averages collected during all study phases (regulation blocks and initial baseline). BSL-23 = Borderline Symptom List-23; DERS= Difficulties with Emotion Regulation Scale; DASS= Depression, Anxiety, and Stress Scales; ISI = Insomnia Severity Index; ESS = Epworth Sleepiness Scale; MEQ = Morningness-Eveningness Questionnaire; DSS = Dissociative State Scale; RD = Rating dial; HR = Heart rate; RSA = Respiratory sinus arrhythmia

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 5

Correlations between questionnaire-based data and skin conductance response, corrugator supercilii, and zygomaticus major data

	Initial Baseline (SCR)	Imagery (SCR)	Regulation block (SCR)	Initial Baseline (EMG COR)	Imagery (EMG COR)	Regulation block (EMG COR)	Initial Baseline (EMG ZYG)	Imagery (EMG ZYG)	Regulation block (EMG ZYG)
Sleep efficiency	.05	.07	.04	.07	.09	-.02	-.16	.15	-.13
Rated sleep quality	-.08	-.01	.14	-.04	.23	.03	-.29*	.03	-.33**
Age	.20	-.01	.08	-.11	-.03	-.06	-.01	.05	.06
Number of medications	-.14	.02	-.06	-.05	-.23*	.08	.13	.03	.46***
Emotion dysregulation (DERS)	.11	.07	.06	.13	-.23*	.17	.15	-.14	.18
Stress (DASS)	.11	.07	.04	.19	-.30**	.24*	.11	-.11	.22*
Anxiety (DASS)	.06	-.01	-.05	.05	-.22*	.12	.08	-.07	.16
Depression (DASS)	.18	.05	.15	.18	-.32**	.21	.07	-.18	.19
Dissociation (DSS)	.16	.05	.10	.16	-.21	.18	.06	-.02	.12
Insomnia severity (ISI)	.16	.004	.15	.08	-.26*	.10	.16	-.04	.27*
Sleepiness severity (ESS)	.20	-.18	.20	.004	-.04	.11	.11	-.10	.29**
Morningness-Eveningness (MEQ)	.03	.20	.13	.05	.04	-.05	-.05	.06	-.16

Note. Regulation block variables are averaged across emotion regulation strategy conditions. Baseline variables reflect the average emotional intensity from the last five-minutes of the initial baseline. Imagery values reflect the average emotional intensity during the imagery block minus the average emotional intensity from the interim baseline occurring immediately before it, averaged across emotion regulation strategy conditions. Sleep efficiency and rated sleep quality variables reflect averages of these variables across the week prior to the experiment. Dissociation scores averages collected during all study phases (regulation blocks and initial baseline). BSL-23 = Borderline Symptom List-23; DERS= Difficulties with Emotion Regulation Scale; DASS= Depression, Anxiety, and Stress Scales; ISI = Insomnia Severity Index; ESS = Epworth Sleepiness Scale; MEQ = Morningness-Eveningness Questionnaire; DSS =

Dissociative State Scale; SCR = Skin conductance; EMG COR = Electromyography corrugator Supercilii; EMG ZYG = Electromyography zygomaticus major

* $p < .05$; ** $p < .01$; *** $p < .00$

Table 6

Primary study variable means, standard deviations, and group differences

				BPD	HC
Consensus sleep diary					
	Sleep efficiency***			.81 (.11)	.90 (.07)
	Rated sleep quality***			2.15 (.66)	2.87 (.66)
Rating dial					
	Initial Baseline**			4.38 (1.22)	5.34 (1.37)
	Imagery			-1.26 (1.06)	-1.17 (1.16)
	Regulation	React*		3.11 (1.70)	4.28 (1.50)
		Mindfulness		3.19 (1.96)	3.67 (1.74)
		Distraction		3.35 (1.87)	3.79 (1.79)
Heart rate					
	Initial Baseline			75.41 (11.86)	71.28 (7.93)
	Imagery			-1.30 (2.68)	-1.26 (2.96)
	Regulation	React		75.11 (10.29)	70.75 (7.78)
		Mindfulness*		75.32 (9.86)	71.41 (7.87)
		Distraction*		75.45 (10.25)	70.56 (7.75)
Skin conductance responses					
	Initial Baseline*			1.50 (1.72)	.77 (.91)
	Imagery			.35 (2.59)	.30 (1.18)
	Regulation	React		1.84 (1.72)	1.46 (1.12)
		Mindfulness		1.76 (1.20)	1.26 (1.40)
		Distraction		1.87 (1.76)	1.40 (1.48)
Respiratory sinus arrhythmia					
	Initial Baseline			6.20 (1.30)	6.62 (.99)
	Imagery			-.06 (.48)	.00 (.47)
	Regulation	React		6.38 (1.05)	6.57 (1.04)
		Mindfulness		6.46 (1.17)	6.55 (.94)
		Distraction		6.25 (1.12)	6.59 (1.04)
EMG: Corrugator Supercilii					
	Imagery**			-.003 (.01)	.01 (.02)
	Regulation	React		-.001 (.002)	-.01 (.03)
		Mindfulness		.002 (.02)	-.001 (.01)
		Distraction		.001 (.01)	-.002 (.01)
EMG: Zygomaticus major					
	Imagery			-.002 (.01)	-.0003 (.01)
	Regulation	React		.001 (.01)	.0001 (.01)
		Mindfulness		.01 (.03)	.002 (.02)
		Distraction		.002 (.01)	-.001 (.01)

Note. Baseline/basal variables reflect the average emotional intensity and RSA from the last five-minutes of the initial baseline. Imagery values reflect the average emotional intensity during the imagery block minus the average emotional intensity from the interim baseline occurring immediately before it, averaged across emotion regulation strategy conditions. Regulation values reflect the average emotional intensity across the regulation block. EMG = Electromyography.

* $p < .05$; ** $p < .01$; *** $p < .001$

Identifying potential covariates: Differences in demographic and clinically-relevant variables across groups. Table 7 depicts the results of independent samples t-tests and chi-square tests of differences between groups on demographic variables. Table 8 depicts the results of independent samples t-tests and chi-square tests of differences between groups on clinically-relevant variables. There were no statistically significant differences between groups across any demographic factors other than marital status and number of medications currently prescribed. Specifically, a greater number of participants in the BPD group were married, and a smaller number were single than in the HC group, and individuals in the BPD group reported taking significantly more medications. There is no theoretical basis or data to our knowledge that indicates that marital status would significantly confound our study analyses. In order to avoid specifying too many parameters in already complex statistical models, we elected to refrain from including marital status as a potential covariate. In terms of the number of current medications, despite individuals with BPD's higher number of medications, there were no statistically significant differences between groups in terms of the number of medications they reported having taken on the day of the experiment, $t(78) = .46$, $p = .65$. Five participants (two individuals with BPD and three HCs) reported taking medications/substances on the day of the experiment, and they were cigarettes, SSRIs, thyroid medication, anti-acid medication, and ibuprofen. However, given that some medications can influence emotional responding (e.g., Huo et al., 2007; Sandrone et al., 1994), and the number of medications that participants are taking may indicate group differences in other potentially confounding factors such as severity or occurrence of physical fitness/illness, we therefore identified this variable as a potential covariate.

As expected, individuals with BPD reported statistically significantly higher levels of emotion dysregulation, depression severity, anxiety severity, stress, insomnia severity, sleepiness, sleep efficiency, and rated sleep quality than HCs. In addition, there was also a statistically significant difference between the two groups in morningness-eveningness, such that scores indicated that, on average, the BPD group was on the cusp between being a

“moderate evening type” and having neither an evening nor a morning type, whereas HC scores indicated that this group did not fall into either evening or morning type.

As with marital status, no theory or research to our knowledge indicated that morningness-eveningness would exert significantly confounding effects on primary study analyses. Given this lack of theoretical support, and the importance of avoiding specifying too many parameters in already complex statistical models, we did not include this variable as a covariate. However, it is possible that sleep analyses might be confounded by other sleep difficulties such as excessive daytime sleepiness. We therefore elected to include this variable as a covariate in study analyses.

Thus, in addition to the covariates already present within primary study analyses (depression severity and dissociation), we identified two other covariates to be included in our analyses: current number of medications and daytime sleepiness. All primary study analyses were thus run with and without the current number of medications and daytime sleepiness.

Table 7

Parametric and Non-parametric Tests of Demographic Variables Between Groups

		BPD	HC	Tests for differences across groups
Age		$M = 25.35$ ($SD = 6.77$)	$M = 24.70$ ($SD = 6.88$)	$t(78) = -.43$
Number of current medications		$M = .23$ ($SD = .48$)	$M = .00$ ($SD = .00$)	$t(39) = -2.97^{**}$
Sex				$X^2(1) = .08$
Gender	Male	17.5%	20%	$X^2(4) = 3.07$
	Female	82.5%	80%	
	Male	17.5%	20%	
	Female	77.5%	77.5%	
	Transgender	0%	2.5%	
	Gender queer	2.5%	0%	
Ethnicity	Other	2.5%	0%	$X^2(11) = 16.58$
	White/Caucasian/European Origin	40%	15%	
	Aboriginal-Canadian/First Nations/Metis/Inuit	2.5%	0%	
	Black-Canadian/Black/Caribbean Origin	5%	10%	

Highest level of Education	Chinese/Chinese-Canadian	22.5%	30%	$\chi^2(6) = 9.27$
	Korean/Korean-Canadian	2.5%	2.5%	
	Other Asian/Asian-Canadian	12.5%	22.5%	
	Mexican/Mexican-Canadian	0%	5%	
	Other Hispanic/Latino	0%	5%	
	Middle Eastern	0%	5%	
	East Indian	2.5%		
	Bi-racial/Multi-racial	2.5%	2.5%	
	Other	10%	2.5%	
Marital status	Some high school	2.5%	0%	$\chi^2(6) = 16.93^{**}$
	High school	12.5%	17.5%	
	Some college/University	55%	27.5%	
	College diploma	0%	5%	
	Undergraduate degree	20%	37.5%	
	Masters degree	7.5%	10%	
	Doctoral degree	2.5%	2.5%	
	Single	35%	70%	
	Dating/Never married	47.5%	15%	
Sexual orientation	Separated/Divorced	7.5%	0%	$\chi^2(4) = 5.60$
	Married/Common law/Life partner	7.5%	12.5%	
	Other	2.5%	0%	
	Missing	0%	2.5%	
	Heterosexual/straight	65%	82.5%	
	Bisexual	25%	10%	
	Gay/lesbian	2.5%	0%	
	Other	7.5%	5%	
	Missing	0%	2.5%	

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 8

Means, standard deviations, Cronbach alphas, and between-group independent samples t -tests for all questionnaire data

	Cronbach alpha	BPD	HC	Independent t-tests
BSL-23	.97	1.86 (.82)	.13 (.16)	$t(41.82) = -13.17^{***}$
DERS	.97	122.28 (17.27)	62.33 (18.28)	$t(78) = -15.08^{***}$
DASS				
Depression	.98	19.85 (10.29)	1.5 (2.35)	$t(43.07) = -10.99^{***}$
Anxiety	.94	12.68 (7.99)	1.13 (1.36)	$t(41.26) = -9.01^{***}$
Stress	.97	23.63 (9.07)	3.23 (3.70)	$t(51.62) = -13.18^{***}$
ISI	.88	17.28 (4.87)	8.08 (3.40)	$t(69.74) = -9.80^{***}$
ESS	.78	9.05 (4.38)	6.05 (3.52)	$t(78) = -3.38^{**}$
MEQ	.88	41.4 (10.47)	49.33 (12.03)	$t(78) = 3.14^{**}$
DSS	.93	6.78 (10.68)	33.63 (27.85)	$t(50.22) = -5.69^{***}$
CSD				
Time got into bed		12:19 AM	12:14 AM	$t(77) = -.28$
Time tried to go to sleep		1:06 AM	12:40 AM	$t(77) = -1.02$
Sleep onset latency (min)		32.71 (26.68)	16.72 (14.10)	$t(57.38) = -3.32^{**}$
Total sleep time (hrs)		7.17 (1.59)	7.33 (.80)	$t(55.58) = .59$

Total time in bed (hours)	9.49 (1.88)	8.56 (1.05)	$t(59.18) = -2.69^{**}$
Wake after sleep onset latency (min)	32.02 (23.75)	22.07 (19.61)	$t(77) = -2.04^*$
Total wake time (hrs)	1.55 (.84)	.81 (.56)	$t(66.29) = -4.61^{***}$
Wake time	9:15 AM	8:28 AM	$t(58.25) = -1.96$
Rise time	9:46 AM	8:51 AM	$t(59.25) = -2.33^*$
Bedtime variability (hrs)	4.40 (4.41)	2.28 (1.70)	$t(77) = -2.16$
Rise time variability (hrs)	3.88 (1.46)	3.25 (1.53)	$t(77) = -1.87$
Sleep efficiency (night before only)	.80 (.22)	.91 (.08)	$t(38.55) = 2.72^*$
Rated sleep quality (night before only)	2.19 (.98)	3.00 (.84)	$t(64) = 3.60^{**}$

Note. BSL-23 = Borderline Symptom List-23; DERS= Difficulties with Emotion Regulation Scale; DASS= Depression, Anxiety, and Stress Scales; ISI = Insomnia Severity Index; ESS = Epworth Sleepiness Scale; MEQ = Morningness-Eveningness Questionnaire; DSS = Dissociative State Scale; CSD = Consensus Sleep Diary. Bedtime and rise time variability is the latest bedtime or risetime, respectively, from the week of data collection minus the earliest.

* $p < .05$; ** $p < .01$; *** $p < .001$

Manipulation Check Analyses

Table 9 presents the results of GEE manipulation check analyses examining change from before (interim-baseline block) to after the imagery scripts (imagery block). There were significant main effects of block (interim-baseline versus imagery block) across rating dial, HR, RSA, and SCR indices. Specifically, participants exhibited reductions in self-reported positive emotion/increases in negative emotion from the interim-baseline to imagery block. Participants also experienced decreases in HR and RSA, and increases in SCR, from the interim-baseline to the imagery block. There were no statistically significant changes in EMG activity (corrugator supercilii or zygomaticus major activity) from the interim-baseline to the imagery block. These findings indicate that the scripts were successful in eliciting increased negative emotional intensity across experiential (self-report), sympathetic, and parasympathetic domains.

Table 9

Generalized estimating equations manipulation check analyses examining change in emotional intensity from interim-baselines to during imagery blocks

		β	SE	df	χ^2
Rating dial	Intercept	4.69	.15	1	1020.89***
	Dissociation	-.002	.01	1	.13
	Block (interim-baseline versus imagery block)	-1.23	.12	1	96.19***
Heart rate	Intercept	73.11	1.07	1	4638.01***
	Dissociation	.01	.03	1	.15
	Block (interim-baseline versus imagery block)	-1.02	.34	1	9.13**

Respiratory sinus arrhythmia	block)				
	Intercept	6.43	.12	1	3021.57***
	Dissociation	.001	.004	1	.07
	Block (interim-baseline versus imagery block)	-.12	.06	1	5.08*
Skin conductance responses	Intercept	.39	.09	1	20.17***
	Dissociation	.001	.003	1	.04
	Block (interim-baseline versus imagery block)	.17	.08	1	3.82*
Corrugator supercilii (z-score)	Intercept	.01	.10	1	.01
	Dissociation	.01	.004	1	1.97
	Block (interim-baseline versus imagery block)	.02	.02	1	.51
Zygomaticus major (z-score)	Intercept	.02	.10	1	.03
	Dissociation	-.003	.004	1	.75
	Block (interim-baseline versus imagery block)	-.03	.02	1	2.31

* $p < .05$; ** $p < .01$; *** $p < .001$

Examination of strategy adherence across groups. Independent samples t-tests indicated that the BPD and HC groups did not differ in their adherence to the emotion regulation strategy instructions that they reported in implementing mindful awareness or distraction strategies, $t(77) = .62, p = .54$, and $t(76) = .23, p = .82$, respectively.

Results: Primary Study Analyses

As stated above, all primary study analyses were run twice: with and without the added covariates of current number of medications (all analyses) and sleepiness (question 1 only). The statistical significance of the interactions relevant to study questions/hypotheses did not change when these covariates were included and so the simpler models, without them, were retained and are presented below.

Question 1- Antecedent-Focused Behaviour (SE and rated SQ) Predicting Effectiveness of Strategies: Rating dial

Results examining whether SE and rated SQ predicted changes in *general* emotion regulatory effectiveness (Question 1A), and whether it did so *differentially* between emotion

regulation strategies (Question 1B), as indexed via rating dial are presented in Tables 10 and 11, respectively.

Table 10

Generalized Estimating Equations Analyses Examining whether Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Rating Dial

	B (SE)	χ^2	df	p-value
Intercept	2.61 (.25)	168.6	1	.000***
Time	.26 (.05)	40.82	1	.000***
Emotion regulation strategy	.15 (.23)	.42	1	.52
Dissociation	-.01 (.01)	1.28	1	.26
Depression	-.02 (.02)	1.21	1	.27
Recovery	.22 (.14)	2.73	1	.10
Sleep efficiency	-1.14 (.53)	23.44	1	.000***
Emotion regulation strategy $\times$ Time	-.03 (.05)	.30	1	.59
Time $\times$ Sleep efficiency	.07 (.27)	1.35	1	.25
Emotion regulation strategy $\times$ Sleep efficiency	-1.37 (.51)	7.23	1	.01*
Emotion regulation strategy $\times$ Sleep efficiency $\times$ Time	.32 (.17)	168.6	1	.06

Note. Dissociation, recovery, and sleep efficiency variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 11

Generalized Estimating Equations Analyses Examining whether Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Rating Dial

	B (SE)	χ^2	df	p-value
Intercept	2.62 (.24)	161.61	1	.000***
Time	.27 (.05)	41.13	1	.000***
Emotion regulation strategy	.14 (.24)	.35	1	.55
Dissociation	-.01 (.01)	1.05	1	.31
Depression	-.03 (.02)	1.82	1	.18
Recovery	.19 (.14)	1.97	1	.16
Rated sleep quality	-.67 (.28)	4.62	1	.03*
Emotion regulation strategy $\times$ Time	-.03 (.05)	.35	1	.55
Time $\times$ Rated sleep quality	.04 (.05)	2.10	1	.15
Emotion regulation strategy $\times$ Rated sleep quality	.24 (.28)	.73	1	.39
Emotion regulation strategy $\times$ Rated sleep quality $\times$ Time	.05 (.07)	.70	1	.40

Note. Dissociation, recovery, and sleep quality variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 1A: Rating dial. Question 1A is: “Does *lower SQ* predict *general*

effectiveness across BPD and HC groups?” There were no statistically significant interactions between time $\times$ SE or time $\times$ rated SQ, indicating that these predictors did not influence emotion regulatory effectiveness across groups and strategies.

Question 1B: Rating dial. Question 1B is: “Does *lower SQ* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” The time $\times$ SE $\times$ emotion regulation strategy and time $\times$ rated SQ $\times$ emotion regulation strategy interactions were not statistically significant, indicating that the influence of these predictors on emotion regulatory effectiveness did not vary between emotion regulation strategies.

Question 1C (secondary group analyses): Rating dial. Question 1C is a secondary question examining whether the impact of lower SQ on the general effectiveness emotion regulation strategies as indexed by the rating dial differed between BPD and HC groups. The group $\times$ time $\times$ rated SQ interaction was not statistically significant, $\chi^2(1) = .04, p = .85$. This indicated that the influence of rated SQ on emotion regulatory effectiveness did not vary between groups. However, there was a statistically significant group $\times$ time $\times$ SE three-way interaction $\chi^2(1) = 5.31, p = .02$. Post-hoc contrasts indicated a statistically significant time $\times$ SE interaction in the HC group, ($\beta = .30, SE = .10$), $\chi^2(1) = 9.65, p = .002$, such that higher SE predicted greater increases in self-reported positivity/decreases in self-reported negativity over time (i.e., improved emotion regulatory effectiveness). However, the time $\times$ SE interaction in the BPD group was not statistically significant, ($\beta = -.42, SE = .39$), $\chi^2(1) = 1.17, p = .28$, indicating that SE did not influence emotion regulatory effectiveness in this group. Figure 5 depicts this interaction.

Figure 5. Graphical representation of the three way group $\times$ time $\times$ sleep efficiency interaction predicting changes in rating dial activity

Note. Sleep efficiency was dichotomized using a median split for the purposes of graphical illustration.

Question 1D (secondary group analyses): Rating dial. Question 1D is a secondary question examining whether the potential *differential* impact of lower SQ on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. Group $\times$ time $\times$ SE $\times$ emotion regulation strategy and group $\times$ time $\times$ rated SQ $\times$ emotion regulation strategy four-way interactions were not statistically significant, $\chi^2(1) = .12, p = .73, \chi^2(1) = .52, p = .47$, respectively. This indicated that the potential *differential* impact of SQ on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 1- Antecedent-Focused Behaviour (SE and rated SQ) Predicting Effectiveness of Strategies: Heart rate

Results examining whether SE and rated SQ predicted changes in *general* emotion regulatory effectiveness (Question 1A), and whether it did so *differentially* between emotion regulation strategies (Question 1B), as indexed via HR are presented in Tables 12 and 13, respectively.

Table 12

Generalized Estimating Equations Analyses Examining whether Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Heart Rate

	B (SE)	χ^2	df	p-value
Intercept	73.32 (1.11)	4489.11	1	.000***
Time	-.08 (.14)	.21	1	.65
Emotion regulation strategy	-1.01 (.56)	3.22	1	.07
Dissociation	-.03 (.03)	.98	1	.32
Depression	.18 (.13)	1.93	1	.17
Recovery	-.24 (.24)	.99	1	.32
Sleep efficiency	-1.24 (2.78)	.31	1	.58
Emotion regulation strategy $\times$ Time	.26 (.17)	2.44	1	.12
Time $\times$ Sleep efficiency	.32 (.36)	.49	1	.48
Emotion regulation strategy $\times$ Sleep efficiency	-.33 (1.19)	.08	1	.78
Emotion regulation strategy $\times$ Sleep efficiency $\times$ Time	-.28 (.39)	.53	1	.47

Note. Dissociation, recovery, and sleep efficiency variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 13

Generalized Estimating Equations Analyses Examining whether Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Heart Rate

	B (SE)	χ^2	df	p-value
Intercept	73.29 (1.14)	4297.32	1	.000***
Time	-.07 (.14)	.30	1	.58
Emotion regulation strategy	-1.08 (.56)	3.7	1	.05*
Dissociation	-.03 (.03)	1.14	1	.29
Depression	.15 (.15)	1.03	1	.31
Recovery	-.26 (.24)	1.11	1	.29
Rated sleep quality	-.69 (1.69)	.24	1	.63
Emotion regulation strategy $\times$ Time	.26 (.17)	2.38	1	.12
Time $\times$ Rated sleep quality	-.07 (.21)	.20	1	.65
Emotion regulation strategy $\times$ Rated sleep quality	-.26 (.66)	.16	1	.69
Emotion regulation strategy $\times$ Rated sleep quality $\times$ Time	-.02 (.24)	.004	1	.95

Note. Dissociation, recovery, and rated sleep quality variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 1A: Heart rate. Question 1A is: “Does *lower SQ* predict general emotion regulation effectiveness across BPD and HC groups?” There were no statistically significant interactions between time $\times$ SE or time $\times$ rated SQ, indicating that these predictors did not influence emotion regulatory effectiveness across groups and strategies.

Question 1B: Heart rate. Question 1B is: “Does *lower SQ* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” The time $\times$ SE $\times$ emotion

regulation strategy and time $\times$ rated SQ $\times$ emotion regulation strategy interactions were not statistically significant, indicating that the influence of these predictors on emotion regulatory effectiveness did not vary between emotion regulation strategies.

Question 1C (secondary group analyses): Heart rate. Question 1C is a secondary question examining whether the impact of lower SQ on the general effectiveness of emotion regulation strategies as indexed by HR differed between BPD and HC groups. Group $\times$ time $\times$ SE and group $\times$ time $\times$ rated SQ three-way interactions were not statistically significant, $\chi^2(1) = .11, p = .74$ and $\chi^2(1) = .02, p = .89$, respectively. This indicated that the influence of these predictors on emotion regulatory effectiveness did not vary between groups.

Question 1D (secondary group analyses): Heart rate. Question 1D is a secondary question examining whether the potential *differential* impact of lower SQ on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. Group $\times$ time $\times$ SE $\times$ emotion regulation strategy and group $\times$ time $\times$ rated SQ $\times$ emotion regulation strategy four-way interactions were not statistically significant, $\chi^2(1) = 1.28, p = .26$ and $\chi^2(1) = .03, p = .86$, respectively. This indicated that the potential *differential* impact of SQ on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 1- Antecedent-Focused Behaviour (SE and rated SQ) Predicting Effectiveness of Strategies: Respiratory sinus arrhythmia

Results examining whether SE and rated SQ predicted changes in *general* emotion regulatory effectiveness (Question 1A), and whether it did so *differentially* between emotion regulation strategies (Question 1B), as indexed via RSA are presented in Tables 14 and 15, respectively.

Table 14
Generalized Estimating Equations Analyses Examining whether Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Respiratory Sinus Arrhythmia

	B (SE)	χ^2	df	p-value
Intercept	6.68 (.15)	3119.14	1	.000***

Time	-.05 (.03)	2.36	1	.13
Emotion regulation strategy	-.16 (.14)	1.30	1	.25
Dissociation	.01 (.01)	1.30	1	.26
Depression	-.01 (.02)	.13	1	.72
Recovery	.02 (.14)	.03	1	.87
Sleep efficiency	.55 (.38)	2.63	1	.11
Emotion regulation strategy × Time	.03 (.04)	.34	1	.56
Time × Sleep efficiency	-.05 (.07)	.33	1	.57
Emotion regulation strategy × Sleep efficiency	.05 (.21)	.06	1	.80
Emotion regulation strategy × Sleep efficiency × Time	.03 (.09)	.14	1	.71

Note. Dissociation, recovery, and sleep efficiency variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 15

Generalized Estimating Equations Analyses Examining whether Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Respiratory Sinus Arrhythmia

	B (SE)	χ^2	df	p-value
Intercept	6.67 (.14)	3221.42	1	.000***
Time	-.04 (.03)	2.02	1	.16
Emotion regulation strategy	-.15 (.14)	1.16	1	.28
Dissociation	.01 (.01)	1.13	1	.29
Depression	.01 (.02)	.26	1	.61
Recovery	-.02 (.12)	.02	1	.89
Rated sleep quality	.61 (.20)	8.15	1	.004**
Emotion regulation strategy × Time	.02 (.04)	.33	1	.57
Time × Rated sleep quality	-.07 (.04)	.72	1	.40
Emotion regulation strategy × Rated sleep quality	-.15 (.14)	1.03	1	.31
Emotion regulation strategy × Rated sleep quality × Time	.08 (.05)	2.30	1	.13

Note. Dissociation, recovery, and rated sleep quality variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 1A: Respiratory sinus arrhythmia. Question 1A is: “Does *lower SQ* (*reduced SE and rated SQ*) predict general emotion regulation effectiveness across BPD and HC groups?” There were no statistically significant interactions between time × SE or time × rated SQ, indicating that these predictors did not influence emotion regulatory effectiveness across groups and strategies.

Question 1B: Respiratory sinus arrhythmia. Question 1B is: “Does *lower SQ* (*reduced SE and rated SQ*) predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” The time × SE × emotion regulation strategy and time × rated SQ × emotion

regulation strategy interactions were not statistically significant, indicating that the influence of these predictors on emotion regulatory effectiveness did not between emotion regulation strategies.

Question 1C (secondary group analyses): Respiratory sinus arrhythmia. Question 1C is a secondary question examining whether the impact of lower SQ on the general effectiveness of emotion regulation strategies as indexed by RSA differed between BPD and HC groups. Group $\times$ time $\times$ SE and group $\times$ time $\times$ rated SQ three-way interactions were not statistically significant, $\chi^2(1) = 1.25, p = .26$ and $\chi^2(1) = .06, p = .80$, respectively. This indicated that the influence of these predictors on emotion regulatory effectiveness did not vary between groups.

Question 1D (secondary group analyses): Respiratory sinus arrhythmia. Question 1D is a secondary question examining whether the potential *differential* impact of lower SQ on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. Group $\times$ time $\times$ SE $\times$ emotion regulation strategy and group $\times$ time $\times$ rated SQ $\times$ emotion regulation strategy four-way interactions were not statistically significant, $\chi^2(1) = .17, p = .68$, and $\chi^2(1) = 2.70, p = .10$, respectively. This indicated that the potential *differential* impact of SQ on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 1- Antecedent-Focused Behaviour (SE and rated SQ) Predicting Effectiveness of Strategies: Skin conductance responses

Results examining whether SE and rated SQ predicted changes in *general* emotion regulatory effectiveness (Question 1A), and whether it did so *differentially* between emotion regulation strategies (Question 1B), as indexed via SCR are presented in Tables 16 and 17, respectively.

Table 16
Generalized Estimating Equations Analyses Examining whether Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Skin Conductance Responses

	B (SE)	χ^2	df	p-value
Intercept	.62 (.13)	38.29	1	.000***
Time	-.08 (.04)	6.41	1	.01*
Emotion regulation strategy	.11 (.12)	.88	1	.35
Dissociation	-.001 (.003)	.10	1	.75
Depression	.01 (.01)	.65	1	.42
Recovery	-.03 (.04)	.44	1	.51
Sleep efficiency	-.49 (.56)	.07	1	.80
Emotion regulation strategy $\times$ Time	.01 (.05)	.05	1	.83
Time $\times$ Sleep efficiency	.06 (.21)	2.11	1	.15
Emotion regulation strategy $\times$ Sleep efficiency	1.20 (.55)	4.84	1	.03*
Emotion regulation strategy $\times$ Sleep efficiency $\times$ Time	-.77 (.30)	6.47	1	.01*

Note. Dissociation, recovery, and sleep efficiency variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 17

Generalized Estimating Equations Analyses Examining whether Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Skin Conductance Responses

	B (SE)	χ^2	df	p-value
Intercept	.52 (.13)	23.22	1	.000***
Time	-.05 (.04)	2.36	1	.12
Emotion regulation strategy	.08 (.15)	.29	1	.59
Dissociation	.000 (.004)	.004	1	.95
Depression	.02 (.01)	3.24	1	.07
Recovery	-.02 (.04)	.22	1	.64
Rated sleep quality	.15 (.18)	7.64	1	.01*
Emotion regulation strategy $\times$ Time	.004 (.05)	.01	1	.93
Time $\times$ Rated sleep quality	.03 (.05)	2.89	1	.09
Emotion regulation strategy $\times$ Rated sleep quality	.42 (.19)	4.87	1	.03*
Emotion regulation strategy $\times$ Rated sleep quality $\times$ Time	-.19 (.06)	8.45	1	.004**

Note. Dissociation, recovery, and rated sleep quality variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 1A: Skin conductance responses. Question 1A is: “Does *lower SQ* (*reduced SE and rated SQ*) predict general emotion regulation effectiveness across BPD and HC groups?” There were no statistically significant interactions between time $\times$ SE or time $\times$ rated SQ, indicating that these predictors did not influence emotion regulatory effectiveness across groups and strategies.

Question 1B: Skin conductance responses. Question 1B is: “Does *lower SQ* (*reduced SE and rated SQ*) predict *differential* effectiveness of one type of emotion regulation

over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?”

There was a statistically significant time $\times$ SE $\times$ emotion regulation strategy interaction. Post-hoc contrasts indicated a statistically significant time $\times$ SE interaction in the distraction condition, ($\beta = -.72$, $SE = .33$), $\chi^2(1) = 4.81$, $p = .03$, such that higher SE predicted greater decreases in SCR over time (i.e., improved emotion regulatory effectiveness). However, the time $\times$ SE interaction in the mindful awareness condition was not statistically significant, ($\beta = .06$, $SE = .20$), $\chi^2(1) = .08$, $p = .78$, indicating that SE did not influence emotion regulatory effectiveness of mindful awareness over time. Figure 6 depicts this interaction.

Figure 6. Graphical representation of the three way group $\times$ time $\times$ sleep efficiency interaction predicting changes in skin conductance responses
Note. Sleep efficiency was dichotomized using a median split for the purposes of graphical illustration.

In addition, there was a statistically significant time $\times$ rated SQ $\times$ emotion regulation strategy interaction. Post-hoc contrasts indicated a statistically significant time $\times$ rated SQ

interaction in the distraction condition, ($\beta = -.16$, $SE = .05$), $\chi^2(1) = 10.93$, $p = .001$, such that higher rated SQ predicted greater decreases in SCR over time (i.e., improved emotion regulatory effectiveness). However, the time $\times$ rated SQ interaction in the mindful awareness condition was not statistically significant, ($\beta = .03$, $SE = .05$), $\chi^2(1) = .34$, $p = .56$, indicating that rated SQ did not influence emotion regulatory effectiveness of mindful awareness over time. Figure 7 depicts this interaction.

Figure 7. Graphical representation of the three way group $\times$ time $\times$ rated sleep quality sleep quality interaction predicting changes in skin conductance responses
Note. Rated sleep quality was dichotomized using a median split for the purposes of graphical illustration.

Question 1C (secondary group analyses): Skin conductance responses. Question

1C is a secondary question examining whether the impact of lower SQ on general effectiveness of emotion regulation strategies as indexed by SCR differed between BPD and HC groups. Group $\times$ time $\times$ SE and group $\times$ time $\times$ rated SQ three-way interactions were not

statistically significant, $\chi^2(1) = 3.40, p = .07$, and $\chi^2(1) = 1.78, p = .18$, respectively. This indicated that the influence of these predictors on emotion regulatory effectiveness did not vary between groups.

Question 1D (secondary group analyses): Skin conductance responses. Question 1D is a secondary question examining whether the potential *differential* impact of lower SQ on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. Group $\times$ time $\times$ SE $\times$ emotion regulation strategy and group $\times$ time $\times$ rated SQ $\times$ emotion regulation strategy four-way interactions were not statistically significant, $\chi^2(1) = .73, p = .39$ and $\chi^2(1) = .26, p = .61$, respectively. This indicated that the potential *differential* impact of SQ on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 1- Antecedent-Focused Behaviour (SE and rated SQ) Predicting Effectiveness of Strategies: Corrugator supercilii activity

Results examining whether SE and rated SQ predicted changes in *general* emotion regulatory effectiveness (Question 1A), and whether it did so *differentially* between emotion regulation strategies (Question 1B), as indexed via corrugator supercilii activity are presented in Tables 18 and 19, respectively.

Table 18
Generalized Estimating Equations Analyses Examining whether Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Corrugator Supercilii Activity

	B (SE)	χ^2	df	p-value
Intercept	.04 (.12)	.01	1	.93
Time	.01 (.01)	.77	1	.38
Emotion regulation strategy	-.09 (.05)	3.94	1	.05*
Dissociation	.002 (.004)	.2	1	.65
Depression	.02 (.01)	2.71	1	.10
Recovery	.94 (2.98)	.1	1	.75
Sleep efficiency	.92 (.19)	35.32	1	.000***
Emotion regulation strategy $\times$ Time	-.01 (.004)	1.31	1	.25
Time $\times$ Sleep efficiency	-.01 (.01)	24.19	1	.000***
Emotion regulation strategy $\times$ Sleep efficiency	.04 (.14)	.08	1	.78
Emotion regulation strategy $\times$ Sleep efficiency $\times$ Time	-.01 (.01)	7.94	1	.01*

Note. Electromyography predictors and outcomes were z-scores. Dissociation, recovery, and sleep efficiency variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 19

Generalized Estimating Equations Analyses Examining whether Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Corrugator Supercilii Activity

	B (SE)	χ^2	df	p-value
Intercept	.04 (.13)	.002	1	.97
Time	.01 (.01)	.58	1	.45
Emotion regulation strategy	-.10 (.05)	3.93	1	.05*
Dissociation	.000 (.004)	.02	1	.90
Depression	.01 (.01)	2.11	1	.15
Recovery	.62 (2.98)	.04	1	.84
Rated sleep quality	-.01 (.15)	.19	1	.66
Emotion regulation strategy $\times$ Time	-.01 (.01)	2.69	1	.10
Time $\times$ Rated sleep quality	.003 (.01)	.01	1	.91
Emotion regulation strategy $\times$ Rated sleep quality	.12 (.08)	2.46	1	.12
Emotion regulation strategy $\times$ Rated sleep quality $\times$ Time	-.01 (.003)	4.23	1	.04*

Note. Electromyography predictors and outcomes were z-scores. Dissociation, recovery, and rated sleep quality variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 1A: Corrugator supercilii activity. Question 1A is: “Does *lower SQ*

(*reduced SE and rated SQ*) predict general emotion regulation effectiveness across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ rated SQ, indicating that rated SQ did not influence emotion regulatory effectiveness across groups and strategies. However, there was a statistically significant time $\times$ SE interaction, such that higher sleep efficiency predicted greater reductions in corrugator supercilii activity over time (i.e., improved emotion regulatory effectiveness).

Question 1B: Corrugator supercilii activity. Question 1B is: “Does *lower SQ*

(*reduced SE and rated SQ*) predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was a statistically significant time $\times$ SE $\times$ emotion regulation strategy interaction. Post-hoc contrasts indicated that there were statistically significant time $\times$ SE interactions in both the mindful awareness and distraction conditions, ($\beta = -.01$, $SE = .01$), $\chi^2(1) = 8.50$, $p = .004$, and ($\beta = -.03$, $SE = .01$), $\chi^2(1) = 30.64$, $p < .001$, respectively.

Examination of the standardized magnitudes of effect demonstrate that the influence of SE on reductions in corrugator supercilii activity over time was larger in the distraction condition than the mindful awareness condition ($\beta = -.03$ and $-.02$, respectively). This indicated that, while higher SE resulted in improved emotion regulatory effectiveness for both emotion regulation strategy conditions, it had a stronger facilitating effect for distraction. Figure 8 depicts this interaction.

Figure 8. Graphical representation of the three way time $\times$ sleep efficiency $\times$ emotion regulation strategy interaction predicting changes in corrugator supercilii activity
Note. Sleep efficiency was dichotomized using a median split for the purposes of graphical illustration.

In addition, there was also a statistically significant time $\times$ rated SQ $\times$ emotion regulation strategy interaction. Post-hoc contrasts indicated that the influence of rated SQ on emotion regulatory effectiveness of mindful awareness was positive such that, as rated SQ increased, corrugator supercilii activity increased over time (i.e., diminished emotion regulatory effectiveness; $\beta = .003$, $SE = .01$, $\chi^2(1) = .28$, $p = .60$). However, the reverse pattern was evident in the distraction condition such that, as rated SQ increased, corrugator

supercilii activity decreased over time (i.e., improved emotion regulatory effectiveness; $\beta = -.004$, $SE = .11$, $\chi^2(1) = .85$, $p = .36$). Figure 9 depicts this interaction.

Figure 9. Graphical representation of the three way time $\times$ rated sleep quality $\times$ emotion regulation strategy interaction predicting changes in corrugator supercilii activity
Note. Sleep efficiency was dichotomized using a median split for the purposes of graphical illustration.

Question 1C (secondary group analyses): Corrugator supercilii activity. Question 1C is a secondary question examining whether the impact of lower SQ on the general effectiveness of emotion regulation strategies as indexed by corrugator supercilii activity differed between BPD and HC groups. Group $\times$ time $\times$ SE and group $\times$ time $\times$ rated SQ three-way interactions were not statistically significant, $\chi^2(1) = .72$, $p = .40$ and $\chi^2(1) = 1.12$, $p = .29$, respectively. This indicated that the influence of these predictors on emotion regulatory effectiveness did not vary between groups.

Question 1D (secondary group analyses): Corrugator supercilii activity. Question 1D is a secondary question examining whether the potential *differential* impact of lower SQ

on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. Group $\times$ time $\times$ SE $\times$ emotion regulation strategy and group $\times$ time $\times$ rated SQ $\times$ emotion regulation strategy four-way interactions were not statistically significant, $\chi^2(1) = .02$, $p = .87$ and $\chi^2(1) = 1.90$, $p = .17$, respectively. This indicated that the potential *differential* impact of SQ on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 1- Antecedent-Focused Behaviour (SE and rated SQ) Predicting Effectiveness of Strategies: Zygomaticus major activity

Results examining whether SE and rated SQ predicted changes in *general* emotion regulatory effectiveness (Question 1A), and whether it did so *differentially* between emotion regulation strategies (Question 1B), as indexed via zygomaticus major activity are presented in Tables 20 and 21, respectively.

Table 20
Generalized Estimating Equations Analyses Examining whether Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Zygomaticus Major Activity

	B (SE)	χ^2	df	p-value
Intercept	-.19 (.06)	16.82	1	.000***
Time	-.004 (.004)	.19	1	.67
Emotion regulation strategy	-.06 (.05)	1.29	1	.26
Dissociation	-.004 (.003)	1.38	1	.24
Depression	.01 (.01)	.63	1	.43
Recovery	-1.88 (.21)	83.82	1	.000***
Sleep efficiency	.09 (.07)	.62	1	.43
Emotion regulation strategy $\times$ Time	.01 (.01)	1.52	1	.22
Time $\times$ Sleep efficiency	-.01 (.01)	2.80	1	.10
Emotion regulation strategy $\times$ Sleep efficiency	-.10 (.12)	.25	1	.62
Emotion regulation strategy $\times$ Sleep efficiency $\times$ Time	-.02 (.02)	.94	1	.33

Note. Electromyography predictors and outcomes were z-scores. Dissociation, recovery, and sleep efficiency variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 21
Generalized Estimating Equations Analyses Examining whether Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Zygomaticus Major Activity

	B (SE)	χ^2	df	p-value
Intercept	-.19 (.06)	15.96	1	.000***
Time	-.004 (.01)	.21	1	.65

Emotion regulation strategy	-.06 (.05)	1.32	1	.25
Dissociation	-.004 (.003)	1.56	1	.21
Depression	.01 (.01)	.40	1	.53
Recovery	-1.87 (.20)	83.67	1	.000***
Rated sleep quality	.02 (.11)	.01	1	.93
Emotion regulation strategy × Time	.01 (.01)	1.52	1	.22
Time × Rated sleep quality	-.003 (.01)	.57	1	.45
Emotion regulation strategy × Rated sleep quality	-.05 (.09)	.27	1	.60
Emotion regulation strategy × Rated sleep quality × Time	-.01 (.02)	.22	1	.64

Note. Electromyography predictors and outcomes were z-scores. Dissociation, recovery, and rated sleep quality variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 1A: Zygomaticus major activity. Question 1A is: “Does *lower SQ* (*reduced SE and rated SQ*) predict general emotion regulation effectiveness across BPD and HC groups?” There were no statistically significant interactions between time × SE or time × rated SQ, indicating that these predictors did not influence emotion regulatory effectiveness across groups and strategies.

Question 1B: Zygomaticus major activity. Question 1B is: “Does *lower SQ* (*reduced SE and rated SQ*) predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” The time × SE × emotion regulation strategy and time × *rated SQ* × emotion regulation strategy interactions were not statistically significant, indicating that the influence of these predictors on emotion regulatory effectiveness did not vary between emotion regulation strategies.

Question 1C (secondary group analyses): Zygomaticus major activity. Question 1C is a secondary question examining whether the impact of lower SQ on the general effectiveness of emotion regulation strategies as indexed by zygomaticus major activity differed between BPD and HC groups. Group × time × SE and group × time × rated SQ three-way interactions were not statistically significant, $\chi^2(1) = .69, p = .41$ and $\chi^2(1) = .35, p = .55$, respectively. This indicated that the influence of these predictors on emotion regulatory effectiveness did not vary between groups.

Question 1D (secondary group analyses): Zygomaticus major activity. Question 1D is a secondary question examining whether the potential *differential* impact of lower SQ on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. Group $\times$ time $\times$ SE $\times$ emotion regulation strategy and group $\times$ time $\times$ rated SQ $\times$ emotion regulation strategy four-way interactions were not statistically significant, $\chi^2(1) = .96, p = .33$, and $\chi^2(1) = 3.04, p = .08$, respectively. This indicated that the potential *differential* impact of SQ on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Post-hoc Analyses

As is evident, the analyses involving SQ revealed a diffuse pattern of findings, many of which were not statistically significant. The findings that were statistically significant indicated that the influence of SE and rated SQ on emotion regulation may be specific to distraction and, for SE specifically, the HC group. In order to better contextualize and meaningfully interpret these findings, two sets of post-hoc analyses were run to examine whether alternative markers of poor SQ are more influential of emotion regulation in BPD. First, we elected to examine whether the same pattern of findings would emerge with *recent* SQ variables. That is, we examined whether SE and rated SQ *the night before* the experiment predicted general and differential emotion regulation, and whether they did so differentially across groups, in the same way that week-long SE and rated SQ did or did not. These analyses allowed us to further qualify which specific forms of SQ are important to emotion regulation; more longstanding/chronic versus recent. The same analyses undertaken for question 1 were therefore run again with SE and rated SQ from the night before the experiment (rather than averaged across the week before the experiment) entered as study predictors.

Second, primary study findings indicated that emotion regulation in BPD and HC groups were either comparably influenced by SE and rated SQ, or that the BPD group was unaffected by SE when the HC group was. Given these findings, we elected to conduct additional post-hoc analyses in order to better understand whether there are alternative indices

of low SQ that are more likely to influence general and differential emotion regulation in BPD. Two additional problems that characterize insomnia and can interfere with SQ are excessive time spent in bed (e.g., Perlis et al., 1997) and variability in sleep times (Buysse et al., 2010). We therefore also elected to examine whether these variables influence general and differential emotion regulation, particularly in the BPD group. Time in bed was indicated by the average time spent in bed across the week leading up to the experiment. Variability in sleep times were indicated by subtracting the earliest rise time (i.e., time participants got out of bed) from the week leading up to the experiment from the latest (i.e., rise time variability). All question 1 analyses were therefore also run again with time in bed and rise time variability as study predictors.

Post-hoc Analyses: Recent Sleep Quality Predicting Effectiveness of Strategies

Table 8 presents means, standard deviations, and tests of group differences for all CSD variables that were not examined in the primary study analyses, including time in bed, rise time variability, and night before SE and rated SQ. See Tables 37 to 48 in Appendix D for all data pertaining to examinations of the impact of recent (night before) SQ on the effectiveness of strategies. See Tables 49 and 50 in Appendix D for all data pertaining to the moderating effect of group status on the relationship between recent (night before) SQ and general or differential emotion regulatory effectiveness.

Question 1A. Question 1A is: “Does recent (night before) *SQ* (*reduced SE and rated SQ*) predict general emotion regulation effectiveness across BPD and HC groups?” Across all indices, there were no statistically significant interactions between time $\times$ SE (night before) or time $\times$ rated SQ (night before), indicating that these predictors do not influence emotion regulatory effectiveness across groups and strategies.

Question 1B. Question 1B is: “Does recent (night before) *SQ* (*reduced SE and rated SQ*) predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” Across all indices, the time $\times$ SE (night before) $\times$ emotion regulation strategy

interaction was not statistically significant, indicating that the influence of recent SE (night before) on emotion regulatory effectiveness did not vary across emotion regulation strategies. Further, across HR, SCR, and zygomaticus major indices, the time $\times$ rated SQ (night before) $\times$ emotion regulation strategy interaction was not statistically significant, indicating that the influence of recent rated SQ (night before) on emotion regulatory effectiveness did not vary across emotion regulation strategies. However, there were statistically significant the time $\times$ rated SQ (night before) $\times$ emotion regulation strategy interactions for the rating dial, RSA, and corrugator supercilii indices.

Rating dial. For the rating dial index, post-hoc contrasts indicated that the influence of rated SQ (night before) on emotion regulatory effectiveness of mindful awareness was negative such that, as rated SQ (night before) increased, there were greater decreases in self-reported positivity/increases in self-reported negativity (i.e., diminished emotion regulatory effectiveness; $\beta = -.04$, $SE = .05$). However, the reverse pattern was evident in the distraction condition such that, as rated SQ (night before) increased, there were greater increases in self-reported positivity/decreases in self-reported negativity over time (i.e., improved emotion regulatory effectiveness; $\beta = .06$, $SE = .05$).

Respiratory sinus arrhythmia. Similarly, for the RSA index, post-hoc contrasts indicated that there was a statistically significant time $\times$ rated SQ (night before) interaction within the mindful awareness condition ($\beta = -.10$, $SE = .04$), $\chi^2(1) = 5.41$, $p = .02$, such that higher rated SQ (night before) predicted greater decrease in RSA over time/increased emotional arousal (i.e., diminished emotion regulatory effectiveness). Conversely, there was not a statistically significant time $\times$ rated SQ (night before) interaction in the distraction condition, ($\beta = .02$, $SE = .03$), $\chi^2(1) = .55$, $p = .46$, indicating that rated SQ (night before) did not influence the emotion regulatory effectiveness of distraction.

Corrugator supercilii activity. Also similarly, for the corrugator supercilii index, post-hoc contrasts indicated that the influence of rated SQ (night before) on emotion regulatory effectiveness of mindful awareness was positive such that, as rated SQ (night before)

increased, there were corresponding increases in corrugator supercilii activity over time (i.e., diminished emotion regulatory effectiveness; $\beta = .01$, $SE = .01$). However, the reverse pattern was evident in the distraction condition such that, as rated SQ (night before) increased, there were corresponding decreases in corrugator supercilii activity over time (i.e., improved emotion regulatory effectiveness; $\beta = -.002$, $SE = .01$).

Question 1C. Question 1C is a secondary question examining whether the impact of recent (night before) SQ on the general effectiveness of emotion regulation strategies differed between BPD and HC groups. Across all indices, group $\times$ time $\times$ rated SQ (night before) three-way interactions were not statistically significant (see Table 50 in Appendix D). This indicates that the influence of recent rated SQ (night before) on emotion regulatory effectiveness did not vary between groups. Similarly, across all but one indices, group $\times$ time $\times$ SE (night before) three-way interactions were not statistically significant (see Table 49 in Appendix D). This indicates that the influence of recent SE (night before) on emotion regulatory effectiveness did not vary between groups. However, there was a statistically significant group $\times$ time $\times$ SE (night before) three-way interaction for the corrugator supercilii index. Post-hoc contrasts indicated that there was a statistically significant time $\times$ SE (night before) interaction within the HC group ($\beta = .08$, $SE = .04$), $\chi^2(1) = 4.28$, $p = .04$, such that higher SE (night before) predicted corresponding increases in corrugator supercilli over time (i.e., diminished emotion regulatory effectiveness). However, the time $\times$ SE (night before) interaction within the BPD group was not statistically significant ($\beta = -.03$, $SE = .02$), $\chi^2(1) = 1.63$, $p = .20$. This indicates that, whereas higher SE (night before) diminishes emotion regulatory effectiveness in HCs, it does not influence emotion regulatory effectiveness in individuals with BPD.

Question 1D. Question 1D is a secondary question examining whether the potential *differential* impact of recent (night before) SQ on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. Across all indices, group $\times$ time $\times$ rated SQ (night before) $\times$ emotion regulation strategy four-way interactions were not

statistically significant, indicating that the potential *differential* impact of recent rated SQ (night before) on the effectiveness of mindful awareness versus distraction does not vary between BPD and HC groups (See Table 50 in Appendix D). Similarly, across all but one index, group $\times$ time $\times$ SE (night before) $\times$ emotion regulation strategy four-way interactions were not statistically significant, indicating that the potential *differential* impact of recent SE (night before) on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups (see Table 49 in Appendix D). However, there was a statistically significant group $\times$ time $\times$ SE (night before) $\times$ emotion regulation strategy four-way interaction for the RSA index. Post-hoc contrasts indicated that there were no statistically significant differences of the effect of SE (night before) on change in RSA over time between mindful awareness versus distraction conditions in the BPD group, ($\beta = -.05$, $SE = .19$), $\chi^2(1) = .06$, $p = .81$. However, there was a statistically significant difference between the effect of SE on change in RSA over time between mindful awareness versus distraction conditions in the HC group, ($\beta = -1.87$ $SE = .67$), $\chi^2(1) = 7.69$, $p < .01$, such that SE predicted greater decreases in RSA over time in the mindful awareness condition ($\beta = -.93$) compared to distraction ($\beta = .93$). Put another way, whereas the influence of recent SE (or lack thereof) on emotion regulatory effectiveness was comparable across mindful awareness and distraction conditions for those with BPD, it diminished emotion regulation moreso for mindful awareness than for distraction in HCs.

Posthoc Analyses: Time in Bed Predicting the Effectiveness of Strategies

See Tables 51 to 56 in Appendix E for all data pertaining to examinations of the impact of time in bed on the effectiveness of strategies. See Table 58 in Appendix D for all data pertaining to the moderating effect of group status on the relationship of time in bed and general or differential emotion regulatory effectiveness.

Question 1A. Question 1A is: “Does *time in bed* predict general emotion regulation effectiveness across BPD and HC groups?” Across all indices, there were no statistically

significant time $\times$ time in bed interactions, indicating that time in bed did not influence emotion regulatory effectiveness across groups and strategies.

Question 1B. Question 1B is: “Does *time in bed* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” Across all indices, there were no statistically significant time $\times$ time in bed $\times$ emotion regulation strategy interactions, indicating that the influence of time in bed on emotion regulatory effectiveness did not vary across emotion regulation strategies.

Question 1C. Question 1C is a secondary question examining whether the impact of time in bed on the general effectiveness of emotion regulation strategies differed between BPD and HC groups. Across all indices, group $\times$ time $\times$ time in bed three-way interactions were not statistically significant (see Table 57 in Appendix E). This indicates that the influence of time in bed on emotion regulatory effectiveness did not vary between groups.

Question 1D. Question 1D is a secondary question examining whether the potential *differential* impact of time in bed on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. Across all indices, group $\times$ time $\times$ time in bed $\times$ emotion regulation strategy four-way interactions were not statistically significant, indicating that the potential *differential* impact of time in bed on the effectiveness of mindful awareness versus distraction did not vary between BPD and HC groups (see Table 57 in Appendix E).

Post-hoc Analyses: Rise Time Variability Predicting the Effectiveness of Strategies

See Tables 58 to 63 in Appendix F for all data pertaining to examinations of the impact of time in bed on the effectiveness of strategies. See Table 64 in Appendix F for all data pertaining to the moderating effect of group status on the relationship between rise time variability and general or differential emotion regulatory effectiveness.

Question 1A. Question 1A is: “Does *rise time variability* predict general emotion regulation effectiveness across BPD and HC groups?” Across all indices, there were no

statistically significant time $\times$ rise time variability interactions, indicating that rise time variability did not influence emotion regulatory effectiveness across groups and strategies.

Question 1B. Question 1B is: “Does *rise time variability* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” Across all but one indices, there were no statistically significant time $\times$ rise time variability $\times$ emotion regulation strategy interactions, indicating that the influence of rise time variability on emotion regulatory effectiveness did not vary across emotion regulation strategies. However, there was a statistically significant three-way time $\times$ rise time variability $\times$ emotion regulation strategy interaction for the SCR index. Post-hoc contrasts indicated that the influence of rise time variability on emotion regulatory effectiveness of mindful awareness was positive such that, as rise time variability increased, there were fewer decreases in SCR (i.e., diminished emotion regulatory effectiveness; $\beta = .06$, $SE = .02$, $p = .001$). However, there was not a statistically significant effect of rise time variability on SCR in the distraction condition (i.e., $\beta = -.01$, $SE = .03$, $p = .81$).

Question 1C. Question 1C is a secondary question examining whether the impact of rise time variability on the general effectiveness of emotion regulation strategies differed between BPD and HC groups. Across all but one indices, group $\times$ time $\times$ rise time variability three-way interactions were not statistically significant (Table 63 in Appendix F). However, there was a statistically significant group $\times$ time $\times$ rise time variability three-way interaction for the SCR index. Post-hoc contrasts indicated that, across both groups, higher rise time variability predicted less decreases in SCR over time (i.e., diminished emotion regulatory effectiveness). However, for the BPD group, higher rise time variability predicted a stronger effect, such that higher rise time variability diminished emotion regulatory effectiveness more in this group ($\beta = .08$, $SE = .04$). This indicates that, whereas both groups showed impaired emotion regulatory effectiveness as a result of higher rise time variability, there is greater impairment in the BPD group.

Question 1D. Question 1D is a secondary question examining whether the potential *differential* impact of rise time variability on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. Across all RSA, SCR, corrugator supercilii and zygomaticus major indices, group $\times$ time $\times$ rise time variability $\times$ emotion regulation strategy four-way interactions were not statistically significant, indicating that the potential *differential* impact of rise time variability on the effectiveness of mindful awareness versus distraction did not vary between BPD and HC groups (Table 63 in Appendix F). However, there were a statistically significant group $\times$ time $\times$ rise time variability $\times$ emotion regulation strategy four-way interactions for the rating dial and HR indices.

Rating dial. Post-hoc contrasts indicated that there was a statistically significant difference between the effect of rise time variability on change in rating dial activity over time across mindful awareness versus distraction conditions in the HC group, ($\beta = -.09$, $SE = .04$), $\chi^2(1) = 4.79$, $p < .05$, such that higher rise time variability predicted greater increases in rating dial activity over time in the mindful awareness condition (improved emotion regulatory effectiveness), but fewer increases/greater decreases in rating dial activity over time in the distraction condition (diminished emotion regulatory effectiveness). However, there was not a statistically significant difference between the effect of rise time variability on change in rating dial activity over time across mindful awareness versus distraction conditions in the BPD group, ($\beta = .06$, $SE = .05$), $\chi^2(1) = 1.53$, $p < .22$.

Heart Rate. Post-hoc contrasts indicated that there was a statistically significant difference between the effect of rise time variability on change in HR over time across mindful awareness versus distraction conditions in the HC group, ($\beta = -.41$, $SE = .13$), $\chi^2(1) = 10.45$, $p = .001$, such that higher rise time variability predicted greater decreases in HR over time in the distraction condition (improved emotion regulatory effectiveness), but did not impact or exacerbated emotion regulation effectiveness in the mindful awareness condition. However, there was not a statistically significant difference between the effect of rise time

variability on change in rating dial activity over time across mindful awareness versus distraction conditions in the BPD group, ($\beta = -.15$, $SE = .12$), $\chi^2(1) = 1.29$, $p = .26$.

Question 2- Antecedent-Focused Biology (Baseline RSA) Predicting Effectiveness of

Strategies: Rating dial

Results examining whether baseline RSA predicted changes in *general* emotion regulatory effectiveness (Question 2A), and whether it did so *differentially* between emotion regulation strategies (Question 2B), as indexed via rating dial are presented in Table 22.

Table 22

Generalized Estimating Equations Analyses Examining whether Baseline RSA Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Rating Dial

	B (SE)	χ^2	df	p-value
Intercept	2.59 (.24)	152.61	1	.000***
Time	.26 (.05)	41.20	1	.000***
Emotion regulation strategy	.14 (.23)	.36	1	.55
Dissociation	-.02 (.01)	2.75	1	.10
Recovery	.14 (.15)	.83	1	.36
Baseline RSA	-.28 (.22)	.78	1	.38
Emotion regulation strategy $\times$ Time	-.03 (.05)	.32	1	.57
Time $\times$ Baseline RSA	.03 (.04)	4.79	1	.03*
Emotion regulation strategy $\times$ Baseline RSA	.20 (.21)	.94	1	.33
Emotion regulation strategy $\times$ Baseline RSA $\times$ Time	.05 (.04)	1.58	1	.21

Note. Dissociation, recovery, and baseline RSA variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 2A: Rating dial. Question 2A is: “Does *baseline RSA* predict general emotion regulation effectiveness across BPD and HC groups?” There was a statistically significant interaction of time $\times$ baseline RSA, such that higher baseline RSA predicted greater increases in rating dial scores over time (improved emotion regulatory effectiveness).

Question 2B: Rating dial. Question 2B is: “Does *baseline RSA* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was not a statistically significant time $\times$ baseline RSA $\times$ emotion regulation strategy interaction, indicating that baseline RSA did not influence emotion regulatory effectiveness between strategies.

Question 2C (secondary group analyses): Rating dial. Question 2C is a secondary question examining whether the impact of baseline RSA on the general effectiveness of emotion regulation strategies as indexed by rating dial differed between BPD and HC groups. The group $\times$ time $\times$ baseline RSA three-way interaction was not statistically significant, $\chi^2(1) = 2.09, p = .15$. This indicated that the influence of baseline RSA on emotion regulatory effectiveness did not vary between groups.

Question 2D (secondary group analyses): Rating dial. Question 2D is a secondary question examining whether the potential *differential* impact of baseline RSA on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ baseline RSA $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = .98, p = .32$. This indicated that the potential *differential* impact of baseline RSA on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 2- Antecedent-Focused Biology (Baseline RSA) Predicting Effectiveness of Strategies: Heart rate

Results examining whether baseline RSA predicted changes in *general* emotion regulatory effectiveness (Question 2A), and whether it did so *differentially* between emotion regulation strategies (Question 2B), as indexed via HR are presented in Table 23.

Table 23
Generalized Estimating Equations Analyses Examining whether Baseline RSA Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Heart Rate

	B (SE)	χ^2	df	p-value
Intercept	73.70 (1.08)	5087.23	1	.000***
Time	-.10 (.15)	.01	1	.91
Emotion regulation strategy	-.66 (.60)	1.19	1	.28
Dissociation	.01 (.04)	.11	1	.75
Recovery	.06 (.25)	.05	1	.82
Baseline RSA	-3.57 (1.34)	7.53	1	.01*
Emotion regulation strategy $\times$ Time	.17 (.18)	.90	1	.34
Time $\times$ Baseline RSA	-.10 (.14)	2.10	1	.15
Emotion regulation strategy $\times$ Baseline RSA	.16 (.58)	.07	1	.79
Emotion regulation strategy $\times$ Baseline RSA $\times$ Time	-.10 (.17)	.33	1	.57

Note. Dissociation, recovery, and baseline RSA variables were mean centered. Mindful awareness was designated as the reference category.

Question 2A: Heart rate. Question 2A is: “Does *baseline RSA* predict general emotion regulation effectiveness across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ baseline RSA, indicating that baseline RSA did not influence emotion regulatory effectiveness across groups and strategies.

Question 2B: Heart rate. Question 2B is: “Does *baseline RSA* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was not a statistically significant time $\times$ baseline RSA $\times$ emotion regulation strategy interaction, indicating that baseline RSA did not influence emotion regulatory effectiveness between strategies.

Question 2C (secondary group analyses): Heart rate. Question 2C is a secondary question examining whether the impact of baseline RSA on the general effectiveness of emotion regulation strategies as indexed by HR differed between BPD and HC groups. The group $\times$ time $\times$ baseline RSA three-way interaction was not statistically significant, $\chi^2(1) = .79, p = .38$. This indicated that the influence of baseline RSA on emotion regulatory effectiveness did not vary between groups.

Question 2D (secondary group analyses): Heart rate. Question 2D is a secondary question examining whether the potential *differential* impact of baseline RSA on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ baseline RSA $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = .54, p = .46$. This indicated that the potential *differential* impact of baseline RSA on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 2- Antecedent-Focused Biology (Baseline RSA) Predicting Effectiveness of Strategies: Respiratory sinus arrhythmia

Results examining whether baseline RSA predicted changes in *general* emotion regulatory effectiveness (Question 2A), and whether it did so *differentially* between emotion regulation strategies (Question 2B), as indexed via RSA are presented in Table 24.

Table 24

Generalized Estimating Equations Analyses Examining whether Baseline RSA Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Respiratory Sinus Arrhythmia

	B (SE)	χ^2	df	p-value
Intercept	6.69 (.11)	6698.48	1	.000***
Time	-.06 (.03)	4.53	1	.03*
Emotion regulation strategy	-.20 (.14)	1.95	1	.16
Dissociation	.002 (.002)	1.11	1	.29
Recovery	-.03 (.05)	.47	1	.49
Baseline RSA	.73 (.11)	65.3	1	.000***
Emotion regulation strategy $\times$ Time	.04 (.04)	1.00	1	.32
Time $\times$ Baseline RSA	.03 (.04)	5.06	1	.02*
Emotion regulation strategy $\times$ Baseline RSA	-.09 (.14)	.39	1	.53
Emotion regulation strategy $\times$ Baseline RSA $\times$ Time	.04 (.04)	.98	1	.32

Note. Dissociation, recovery, and baseline RSA variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 2A: Respiratory sinus arrhythmia. Question 2A is: “Does *baseline RSA* predict general emotion regulation effectiveness across BPD and HC groups?” There was a statistically significant interaction of time $\times$ baseline RSA, such that higher baseline RSA predicted greater increases in RSA over time (i.e., improved emotion regulatory effectiveness).

Question 2B: Respiratory sinus arrhythmia. Question 2B is: “Does *baseline RSA* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was not a statistically significant time $\times$ baseline RSA $\times$ emotion regulation strategy interaction, indicating that baseline RSA did not influence emotion regulatory effectiveness between strategies.

Question 2C (secondary group analyses): Respiratory sinus arrhythmia. Question 2C is a secondary question examining whether the impact of baseline RSA on the general effectiveness of emotion regulation strategies as indexed by RSA differed between BPD and HC groups. The group $\times$ time $\times$ baseline RSA three-way interaction was not statistically

significant, $\chi^2(1) = 2.25, p = .13$. This indicates that the influence of baseline RSA on emotion regulatory effectiveness did not vary between groups.

Question 2D (secondary group analyses): Respiratory sinus arrhythmia. Question 2D is a secondary question examining whether the potential *differential* impact of baseline RSA on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ baseline RSA $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = .27, p = .60$. This indicated that the potential *differential* impact of baseline RSA on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 2- Antecedent-Focused Biology (Baseline RSA) Predicting Effectiveness of Strategies: Skin conductance responses

Results examining whether baseline RSA predicted changes in general emotion regulatory effectiveness (Question 2A), and whether it did so *differentially* between emotion regulation strategies (Question 2B), as indexed via SCR are presented in Table 25.

Table 25
Generalized Estimating Equations Analyses Examining whether Baseline RSA Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Skin Conductance Responses

	B (SE)	χ^2	df	p-value
Intercept	.52 (.13)	22.84	1	.000***
Time	-.04 (.04)	2.00	1	.16
Emotion regulation strategy	.08 (.15)	.29	1	.59
Dissociation	.003 (.004)	.64	1	.43
Recovery	-.02 (.04)	.20	1	.66
Baseline RSA	.06 (.11)	.01	1	.93
Emotion regulation strategy $\times$ Time	.003 (.05)	.00	1	.96
Time $\times$ Baseline RSA	-.14 (.12)	1.43	1	.23
Emotion regulation strategy $\times$ Baseline RSA	-.03 (.04)	.30	1	.58
Emotion regulation strategy $\times$ Baseline RSA $\times$ Time	.04 (.05)	.70	1	.40

Note. Dissociation, recovery, and baseline RSA were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 2A: Skin conductance responses. Question 2A is: “Does *baseline RSA* predict general emotion regulation effectiveness across BPD and HC groups?” There was not

a statistically significant interaction of time $\times$ baseline RSA, indicating that baseline RSA did not influence emotion regulatory effectiveness across groups and strategies.

Question 2B: Skin conductance responses. Question 2B is: “Does *baseline RSA* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was not a statistically significant time $\times$ baseline RSA $\times$ emotion regulation strategy interaction, indicating that baseline RSA did not influence emotion regulatory effectiveness across groups and between strategies.

Question 2C (secondary group analyses): Skin conductance responses. Question 2C is a secondary question examining whether the impact of baseline RSA on the general effectiveness of emotion regulation strategies as indexed by rating dial differed between BPD and HC groups. The group $\times$ time $\times$ baseline RSA three-way interaction was not statistically significant, $\chi^2(1) = .001, p = .98$. This indicated that the influence of baseline RSA on emotion regulatory effectiveness did not vary between groups.

Question 2D (secondary group analyses): Skin conductance responses. Question 2D is a secondary question examining whether the potential *differential* impact of baseline RSA on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ baseline RSA $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = .96, p = .33$. This indicated that the potential *differential* impact of baseline RSA on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 2- Antecedent-Focused Biology (Baseline RSA) Predicting Effectiveness of Strategies: Corrugator supercilii

Results examining whether baseline RSA predicted changes in *general* emotion regulatory effectiveness (Question 2A), and whether it did so *differentially* between emotion regulation strategies (Question 2B), as indexed via corrugator supercilii are presented in Table 26.

Table 26

Generalized Estimating Equations Analyses Examining whether Baseline RSA Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Corrugator Supercilii Activity

	B (SE)	χ^2	df	p-value
Intercept	.02 (.12)	.05	1	.83
Time	.01 (.01)	1.33	1	.25
Emotion regulation strategy	-.10 (.05)	4.40	1	.04*
Dissociation	.002 (.003)	.25	1	.62
Recovery	.12 (3.47)	.00	1	.97
Baseline RSA	-.03 (.13)	.01	1	.94
Emotion regulation strategy $\times$ Time	-.001 (.001)	.02	1	.88
Time $\times$ Baseline RSA	.000 (.003)	.43	1	.51
Emotion regulation strategy $\times$ Baseline RSA	.07 (.08)	.72	1	.40
Emotion regulation strategy $\times$ Baseline RSA $\times$ Time	-.003 (.01)	.26	1	.61

Note. Dissociation, recovery, and baseline RSA were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 2A: Corrugator supercilii activity. Question 2A is: “Does *baseline RSA* predict general emotion regulation effectiveness across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ baseline RSA, indicating that baseline RSA did not influence emotion regulatory effectiveness across groups and strategies.

Question 2B: Corrugator supercilii activity. Question 2B is: “Does *baseline RSA* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was not a statistically significant time $\times$ baseline RSA $\times$ emotion regulation strategy interaction, indicating that baseline RSA did not influence emotion regulatory effectiveness across groups and between strategies.

Question 2C (secondary group analyses): Corrugator supercilii activity. Question 2C is a secondary question examining whether the impact of baseline RSA on the general effectiveness of emotion regulation strategies as indexed by corrugator supercilii activity differed between BPD and HC groups. The group $\times$ time $\times$ baseline RSA three-way interaction was not statistically significant, $\chi^2(1) = .09$, $p = .76$. This indicated that the influence of baseline RSA on emotion regulatory effectiveness did not vary between groups.

Question 2D (secondary group analyses): Corrugator supercilii activity. Question 2D is a secondary question examining whether the potential *differential* impact of antecedent-baseline RSA on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ baseline RSA $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = .13, p = .72$. This indicated that the potential *differential* impact of baseline RSA on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 2- Antecedent-Focused Biology (Baseline RSA) Predicting Effectiveness of Strategies: Zygomaticus major activity

Results examining whether baseline RSA predicted changes in *general* emotion regulatory effectiveness (Question 2A), and whether it did so *differentially* between emotion regulation strategies (Question 2B), as indexed via zygomaticus major activity are presented in Table 27.

Table 27

Generalized Estimating Equations Analyses Examining whether Baseline RSA Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Zygomaticus Major Activity

	B (SE)	χ^2	df	p-value
Intercept	-.20 (.06)	18.69	1	.000***
Time	-.004 (.004)	.18	1	.68
Emotion regulation strategy	-.05 (.05)	1.45	1	.23
Dissociation	-.003 (.002)	1.33	1	.25
Recovery	-1.90 (.21)	86.21	1	.000***
Baseline RSA	.04 (.07)	.2	1	.66
Emotion regulation strategy $\times$ Time	.01 (.01)	1.53	1	.22
Time $\times$ Baseline RSA	-.002 (.01)	.16	1	.69
Emotion regulation strategy $\times$ Baseline RSA	-.15 (.06)	5.86	1	.02*
Emotion regulation strategy $\times$ Baseline RSA $\times$ Time	.01 (.01)	.52	1	.47

Note. Dissociation, recovery, and baseline RSA were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 2A: Zygomaticus major activity. Question 2A is: “Does *baseline RSA* predict general emotion regulation effectiveness across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ baseline RSA, indicating that baseline RSA did not influence emotion regulatory effectiveness across groups and strategies.

Question 2B: Zygomaticus major activity. Question 2B is: “Does *baseline RSA* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ baseline RSA $\times$ emotion regulation strategy interaction indicating that baseline RSA did not influence emotion regulatory effectiveness across groups and between strategies.

Question 2C (secondary group analyses): Zygomaticus major activity. Question 2C is a secondary question examining whether the impact of baseline RSA on the general effectiveness of emotion regulation strategies as indexed by zygomaticus major activity differed between BPD and HC groups. The group $\times$ time $\times$ baseline RSA three-way interaction was not statistically significant, $\chi^2(1) = .47, p = .49$. This indicated that the influence of baseline RSA on emotion regulatory effectiveness did not vary between groups.

Question 2D (secondary group analyses): Zygomaticus major activity. Question 2D is a secondary question examining whether the potential *differential* impact of baseline RSA on the effectiveness on mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ baseline RSA $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = .84, p = .36$. This indicated that the potential *differential* impact of baseline RSA on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 3- Antecedent-Focused Emotion Predicting Effectiveness of Strategies: Rating dial

Results examining whether baseline emotional intensity predicted changes in *general* emotion regulatory effectiveness (Question 3A), and whether it did so *differentially* between emotion regulation strategies (Question 3B), as indexed via rating dial are presented in Table 28.

Table 28

Generalized Estimating Equations Analyses Examining whether Baseline Emotional Intensity Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Rating Dial

	B (SE)	χ^2	df	p-value
Intercept	2.62 (.25)	159.27	1	.000***
Time	.25 (.05)	37.85	1	.000***
Emotion regulation strategy	.14 (.25)	.30	1	.58
Dissociation	-.02 (.01)	2.61	1	.11
Recovery	-.06 (.16)	.13	1	.72
Baseline emotional intensity	.31 (.21)	2.04	1	.15
Emotion regulation strategy $\times$ Time	-.03 (.06)	.26	1	.61
Time $\times$ Baseline emotional intensity	-.01 (.04)	.72	1	.40
Emotion regulation strategy $\times$ Baseline emotional intensity	-.06 (.23)	.06	1	.81
Emotion regulation strategy $\times$ Baseline emotional intensity $\times$ Time	.06 (.05)	1.77	1	.18

Note. Dissociation, recovery, and baseline emotional intensity variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 3A: Rating dial. Question 3A is: “Does *baseline emotional intensity* predict general emotion regulation effectiveness across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ baseline emotional intensity, indicating that baseline emotional intensity did not influence emotion regulatory effectiveness across groups and strategies.

Question 3B: Rating dial. Question 3B is: “Does *baseline emotional intensity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was not a statistically significant time $\times$ baseline emotional intensity $\times$ emotion regulation strategy interaction, indicating that baseline emotional intensity did not influence emotion regulatory effectiveness across groups and between strategies.

Question 3C (secondary group analyses): Rating dial. Question 3C is a secondary question examining whether the impact of baseline emotional intensity on the general effectiveness of emotion regulation strategies as indexed by the rating dial differed between BPD and HC groups. The group $\times$ time $\times$ baseline emotional intensity three-way interaction was not statistically significant, $\chi^2(1) = .01$, $p = .92$. This indicated that the influence of baseline emotional intensity on emotion regulatory effectiveness did not vary between groups.

Question 3D (secondary group analyses): Rating dial. Question 3D is a secondary question examining whether the potential *differential* impact of baseline emotional intensity on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ baseline emotional intensity $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = .15, p = .70$. This indicated that the potential *differential* impact of baseline emotional intensity on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 3- Antecedent-Focused Emotion Predicting Effectiveness of Strategies: Heart rate

Results examining whether baseline emotional intensity predicted changes in *general* emotion regulatory effectiveness (Question 3A), and whether it did so *differentially* between emotion regulation strategies (Question 3B), as indexed via HR are presented in Table 29.

Table 29

Generalized Estimating Equations Analyses Examining whether Baseline Emotional Intensity Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Heart Rate

	B (SE)	χ^2	df	p-value
Intercept	73.56 (.63)	17637.12	1	.000***
Time	-.07 (.14)	.21	1	.65
Emotion regulation strategy	-1.06 (.55)	3.76	1	.05
Dissociation	.001 (.01)	.01	1	.95
Recovery	-.02 (.11)	.03	1	.86
Baseline emotional intensity	.81 (.05)	315.96	1	.000***
Emotion regulation strategy $\times$ Time	.23 (.17)	2.00	1	.16
Time $\times$ Baseline emotional intensity	.01 (.01)	.55	1	.46
Emotion regulation strategy $\times$ Baseline emotional intensity	.04 (.05)	.79	1	.37
Emotion regulation strategy $\times$ Baseline emotional intensity $\times$ Time	-.001 (.01)	.004	1	.95

Note. Dissociation, recovery, and baseline emotional intensity variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 3A: Heart rate. Question 3A is: “Does *baseline emotional intensity* predict general emotion regulation effectiveness across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ baseline emotional intensity, indicating that

baseline emotional intensity did not influence emotion regulatory effectiveness across groups and strategies.

Question 3B: Heart rate. Question 3B is: “Does *baseline emotional intensity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was not a statistically significant time $\times$ baseline emotional intensity $\times$ emotion regulation strategy interaction, indicating that baseline emotional intensity did not influence emotion regulatory effectiveness across groups and between strategies.

Question 3C (secondary group analyses): Heart rate. Question 3C is a secondary question examining whether the impact of baseline emotional intensity on the general effectiveness of emotion regulation strategies as indexed by HR differed between BPD and HC groups. The group $\times$ time $\times$ baseline emotional intensity three-way interaction was not statistically significant, $\chi^2(1) = .56, p = .47$. This indicated that the influence of baseline emotional intensity on emotion regulatory effectiveness did not vary between groups.

Question 3D (secondary group analyses): Heart rate. Question 3D is a secondary question examining whether the potential *differential* impact of baseline emotional intensity on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ baseline emotional intensity $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = 3.30, p = .07$. This indicated that the potential *differential* impact of baseline emotional intensity on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 3- Antecedent-Focused Emotion Predicting Effectiveness of Strategies: Skin conductance responses

Results examining whether baseline emotional intensity predicted changes in *general* emotion regulatory effectiveness (Question 3A), and whether it did so *differentially* between emotion regulation strategies (Question 3B), as indexed via SCR are presented in Table 30.

Table 30

Generalized Estimating Equations Analyses Examining whether Baseline Emotional Intensity Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Skin Conductance Responses

	B (SE)	χ^2	df	p-value
Intercept	.46 (.13)	16.63	1	.000***
Time	-.05 (.04)	1.76	1	.19
Emotion regulation strategy	.003 (.15)	.001	1	.98
Dissociation	-.001 (.003)	.17	1	.68
Recovery	-.05 (.02)	4.05	1	.04
Baseline emotional intensity	.22 (.06)	31.13	1	.000***
Emotion regulation strategy $\times$ Time	.01 (.06)	.02	1	.90
Time $\times$ Baseline emotional intensity	.01 (.02)	.31	1	.58
Emotion regulation strategy $\times$ Baseline emotional intensity	.08 (.07)	1.31	1	.25
Emotion regulation strategy $\times$ Baseline emotional intensity $\times$ Time	-.01 (.02)	.04	1	.85

Note. Dissociation, recovery, and baseline emotional intensity variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 3A: Skin conductance responses. Question 3A is: “Does *baseline emotional intensity* predict general emotion regulation effectiveness across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ baseline emotional intensity, indicating that baseline emotional intensity did not influence emotion regulatory effectiveness across groups and strategies.

Question 3B: Skin conductance responses. Question 3B is: “Does *baseline emotional intensity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ baseline emotional intensity $\times$ emotion regulation strategy interaction, indicating that baseline emotional intensity did not influence emotion regulatory effectiveness across groups and between strategies.

Question 3C (secondary group analyses): Skin conductance responses. Question 3C is a secondary question examining whether the impact of baseline emotional intensity on the general effectiveness of emotion regulation strategies as indexed by SCR differed between BPD and HC groups. The group $\times$ time $\times$ baseline emotional intensity three-way interaction was not statistically significant, $\chi^2(1) = 3.22$, $p = .07$. This indicated that the influence of baseline emotional intensity on emotion regulatory effectiveness did not vary between groups.

Question 3D (secondary group analyses): Skin conductance responses. Question

3D is a secondary question examining whether the potential *differential* impact of baseline emotional intensity on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ baseline emotional intensity $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = .65, p = .42$. This indicated that the potential *differential* impact of baseline emotional intensity on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 4- Response-Focused Emotion Predicting Effectiveness of Strategies: Rating dial

Results examining whether emotional reactivity predicted changes in *general* emotion regulatory effectiveness (Question 4A), and whether it did so *differentially* between emotion regulation strategies (Question 4B), as indexed via rating dial are presented in Table 31.

Table 31

Generalized Estimating Equations Analyses Examining whether Emotional Reactivity Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Rating Dial

	B (SE)	χ^2	df	p-value
Intercept	2.56 (.22)	185.85	1	.000***
Time	.26 (.04)	91.54	1	.000***
Emotion regulation strategy	.14 (.21)	.42	1	.52
Dissociation	-.02 (.01)	3.52	1	.06
Recovery	-.03 (.18)	.03	1	.87
Emotion reactivity	.92 (.20)	24.75	1	.000***
Emotion regulation strategy $\times$ Time	-.03 (.05)	.25	1	.62
Time $\times$ Emotional reactivity	-.24 (.04)	59.86	1	.000***
Emotion regulation strategy $\times$ Emotional reactivity	-.11 (.21)	.27	1	.60
Emotion regulation strategy $\times$ Emotional reactivity $\times$ Time	.08 (.05)	2.69	1	.10

Note. Dissociation, recovery, and emotional reactivity variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 4A: Rating dial. Question 4A is: “Does *emotional reactivity* predict general emotion regulation effectiveness across BPD and HC groups?” There was a statistically significant interaction of time $\times$ emotional reactivity such that greater emotional reactivity

predicted greater increases in positive emotion/decrease in negative emotion across time (i.e., improved emotion regulatory effectiveness).⁵

Question 4B: Rating dial. Question 4B is: “Does *emotional reactivity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” The time × emotional reactivity × emotion regulation strategy interaction was not statistically significant, indicating that the influence of this predictor on emotion regulatory effectiveness did not vary between emotion regulation strategies.

Question 4C (secondary group analyses): Rating dial. Question 4C is a secondary question examining whether the impact of emotional reactivity on the general effectiveness of emotion regulation strategies as indexed by the rating dial differed between BPD and HC groups. The group × time × emotional reactivity three-way interaction was not statistically significant, $\chi^2(1) = .89, p = .34$. This indicated that the influence of this predictor on emotion regulatory effectiveness did not vary between groups.

Question 4D (secondary group analyses): Rating dial. Question 4D is a secondary question examining whether the potential *differential* impact of emotional reactivity on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group × time × emotional reactivity × emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = .15, p = .70$. This indicated that the potential *differential* impact of emotional reactivity on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 4- Response-Focused Emotion Predicting Effectiveness of Strategies: Heart rate

⁵ As previously mentioned, the rating dial has 10 markers on it, ranging from 0 (very negative) to 9 (very positive), with neutral demarcated between 4 and 5. Therefore, higher scores indicate higher levels of self-reported positivity, and lower scores indicate higher levels of self-reported negativity. Increased “emotion regulatory effectiveness” is therefore indicated by increases in rating dial scores over time.

Results examining whether emotional reactivity predicted changes in *general* emotion regulatory effectiveness (Question 4A), and whether it did so *differentially* between emotion regulation strategies (Question 4B), as indexed via HR are presented in Table 32.

Table 32

Generalized Estimating Equations Analyses Examining whether Emotional Reactivity Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Heart Rate

	B (SE)	χ^2	df	p-value
Intercept	73.62 (1.17)	4364.58	1	.000***
Time	-.11 (.13)	.20	1	.60
Emotion regulation strategy	-.52 (.66)	.62	1	.43
Dissociation	-.01 (.04)	.07	1	.79
Recovery	-.14 (.29)	.23	1	.63
Emotion reactivity	.23 (.24)	3.25	1	.07
Emotion regulation strategy $\times$ Time	.13 (.19)	.45	1	.50
Time $\times$ Emotional reactivity	-.12 (.06)	14.32	1	.000***
Emotion regulation strategy $\times$ Emotional reactivity	.25 (.29)	.74	1	.39
Emotion regulation strategy $\times$ Emotional reactivity $\times$ Time	-.02 (.09)	.05	1	.83

Note. Dissociation, recovery, and emotional reactivity variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 4A: Heart rate. Question 4A is: “Does *emotional reactivity* predict general emotion regulation effectiveness across BPD and HC groups?” There was a statistically significant interaction of time $\times$ emotional reactivity such that higher emotional reactivity predicted greater decrease in HR over time (i.e., improved emotion regulatory effectiveness).

Question 4B: Heart rate. Question 4B is: “Does *emotional reactivity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” The time $\times$ emotional reactivity $\times$ emotion regulation strategy interaction was not statistically significant, indicating that the influence of this predictor on emotion regulatory effectiveness did not vary between emotion regulation strategies.

Question 4C (secondary group analyses): Heart rate. Question 4C is a secondary question examining whether the impact of emotional reactivity on the general effectiveness emotion regulation strategies as indexed by HR differed between BPD and HC groups. The

group $\times$ time $\times$ emotional reactivity three-way interaction was not statistically significant, $\chi^2(1) = .88, p = .35$, respectively. This indicated that the influence of this predictor on emotion regulatory effectiveness did not vary between groups.

Question 4D (secondary group analyses): Heart rate. Question 4D is a secondary question examining whether the potential *differential* impact of emotional reactivity on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ emotional reactivity $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = 1.96, p = .16$. This indicated that the potential *differential* impact of emotional reactivity on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 4- Response-Focused Emotion Predicting Effectiveness of Strategies:

Respiratory sinus arrhythmia

Results examining whether emotional reactivity predicted *general* changes in emotion regulatory effectiveness (Question 4A), and whether it did so *differentially* between emotion regulation strategies (Question 4B), as indexed via RSA are presented in Table 33.

Table 33
Generalized Estimating Equations Analyses Examining whether Emotional Reactivity Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Respiratory Sinus Arrhythmia

	B (SE)	χ^2	df	p-value
Intercept	6.69 (.15)	3098.57	1	.000***
Time	-.05 (.03)	2.81	1	.09
Emotion regulation strategy	-.19 (.14)	1.7	1	.19
Dissociation	.004 (.004)	1.08	1	.30
Recovery	.003 (.12)	.00	1	.98
Emotion reactivity	-.18 (.24)	2.52	1	.11
Emotion regulation strategy $\times$ Time	.04 (.04)	.64	1	.43
Time $\times$ Emotional reactivity	.01 (.06)	.08	1	.78
Emotion regulation strategy $\times$ Emotional reactivity	-.06 (.34)	.04	1	.85
Emotion regulation strategy $\times$ Emotional reactivity $\times$ Time	.002 (.09)	.000	1	.98

Note. Dissociation, recovery, and emotional reactivity variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 4A: Respiratory sinus arrhythmia. Question 4A is: “Does *emotional reactivity* predict general emotion regulation effectiveness across BPD and HC groups?”

There was not a statistically significant interaction of time $\times$ emotional reactivity, indicating that this variable did not statistically significantly influence emotion regulatory effectiveness.

Question 4B: Respiratory sinus arrhythmia. Question 4B is: “Does *emotional reactivity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” The time $\times$ emotional reactivity $\times$ emotion regulation strategy interaction was not statistically significant, indicating that the influence of this predictor on emotion regulatory effectiveness did not vary between emotion regulation strategies.

Question 4C (secondary group analyses): Respiratory sinus arrhythmia. Question 4C is a secondary question examining whether the impact of emotional reactivity on the general effectiveness of emotion regulation strategies as indexed by RSA differed between BPD and HC groups. The group $\times$ time $\times$ emotional reactivity three-way interaction was not statistically significant, $\chi^2(1) = 2.02, p = .16$. This indicated that the influence of this predictor on emotion regulatory effectiveness did not vary between groups.

Question 4D (secondary group analyses): Respiratory sinus arrhythmia. Question 4D is a secondary question examining whether the potential *differential* impact of emotional reactivity on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ emotional reactivity $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = 3.09, p = .08$. This indicated that the potential *differential* impact of emotional reactivity on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 4- Response-Focused Emotion Predicting Effectiveness of Strategies: Skin conductance responses

Results examining whether emotional reactivity predicted changes in *general* emotion regulatory effectiveness (Question 4A), and whether it did so *differentially* between emotion regulation strategies (Question 4B), as indexed via SCR are presented in Table 34.

Table 34

Generalized Estimating Equations Analyses Examining whether Emotional Reactivity Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Skin Conductance Responses

	B (SE)	χ^2	df	p-value
Intercept	.62 (.12)	38.94	1	.000***
Time	-.08 (.04)	5.00	1	.03*
Emotion regulation strategy	.12 (.13)	.78	1	.38
Dissociation	.002 (.003)	.53	1	.47
Recovery	-.03 (.03)	.9	1	.34
Emotion reactivity	.02 (.04)	1.66	1	.20
Emotion regulation strategy × Time	.02 (.05)	.21	1	.65
Time × Emotional reactivity	.01 (.02)	.12	1	.73
Emotion regulation strategy × Emotional reactivity	.11 (.10)	1.22	1	.27
Emotion regulation strategy × Emotional reactivity × Time	.003 (.04)	.01	1	.94

Note. Dissociation, recovery, and emotional reactivity variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 4A: Skin conductance responses. Question 4A is: “Does *emotional reactivity* predict general emotion regulation effectiveness across BPD and HC groups?”

There was not a statistically significant interaction of time × emotional reactivity, indicating that this predictor did not influence emotion regulatory effectiveness across groups and strategies.

Question 4B: Skin conductance responses. Question 4B is: “Does *emotional reactivity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” The time × emotional reactivity × emotion regulation strategy interaction was not statistically significant, indicating that the influence of this predictor on emotion regulatory effectiveness did not vary between emotion regulation strategies.

Question 4C (secondary group analyses): Skin conductance responses. Question 4C is a secondary question examining whether the impact of emotional reactivity on the

general effectiveness of emotion regulation strategies as indexed by the SCR differed between BPD and HC groups. The group $\times$ time $\times$ emotional reactivity three-way interaction was not statistically significant, $\chi^2(1) = 1.76, p = .19$. This indicated that the influence of this predictor on emotion regulatory effectiveness did not vary between groups.

Question 4D (secondary group analyses): Skin conductance responses. Question 4D is a secondary question examining whether the potential *differential* impact of emotional reactivity on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ emotional reactivity $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = 1.01, p = .32$. This indicated that the potential *differential* impact of emotional reactivity on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 4- Response-Focused Emotion Predicting Effectiveness of Strategies:

Corrugator supercilii activity (EMG)

Results examining whether emotional reactivity predicted changes in *general* emotion regulatory effectiveness (Question 4A), and whether it did so *differentially* between emotion regulation strategies (Question 4B), as indexed via corrugator supercilii are presented in Table 35.

Table 35

Generalized Estimating Equations Analyses Examining whether Emotional Reactivity Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Corrugator Supercilii

	B (SE)	χ^2	df	p-value
Intercept	.03 (.12)	.08	1	.77
Time	.01 (.01)	2.24	1	.14
Emotion regulation strategy	-.11 (.05)	5.62	1	.02*
Dissociation	.002 (.004)	.33	1	.57
Recovery	.04 (2.97)	.000	1	.99
Emotion reactivity	.07 (.37)	1.16	1	.28
Emotion regulation strategy $\times$ Time	.000 (.004)	.01	1	.91
Time $\times$ Emotional reactivity	.13 (.08)	1.34	1	.25
Emotion regulation strategy $\times$ Emotional reactivity	-.64 (.41)	2.49	1	.12
Emotion regulation strategy $\times$ Emotional reactivity $\times$ Time	-.05 (.13)	.13	1	.72

Note. Electromyography predictors and outcomes were z-scores. Dissociation and recovery variables were mean centered. Mindful awareness was designated as the reference category.

Question 4A: Corrugator supercilii. Question 4A is: “Does *emotional reactivity* predict general emotion regulation effectiveness across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ emotional reactivity, indicating that emotional reactivity did not influence emotion regulatory effectiveness across groups and strategies.

Question 4B: Corrugator supercilii. Question 4B is: “Does *emotional reactivity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” The time $\times$ emotional reactivity $\times$ emotion regulation strategy interaction was not statistically significant, indicating that the influence of emotional reactivity on emotion regulatory effectiveness did not vary between emotion regulation strategies.

Question 4C (secondary group analyses): Corrugator supercilii. Question 4C is a secondary question examining whether the impact of emotional reactivity on the general effectiveness of emotion regulation strategies as indexed by corrugator supercilii differed between BPD and HC groups. The group $\times$ time $\times$ emotional reactivity three-way interaction was statistically significant, $\chi^2(1) = 3.71, p = .05$. Post-hoc contrasts indicated a statistically significant time $\times$ emotional reactivity interaction in the HC group, ($\beta = .28, SE = .08$), $\chi^2(1) = 12.61, p < .001$, such that higher emotional reactivity predicted increases in corrugator supercilii activity over time (i.e., diminished emotion regulatory effectiveness). However, the time $\times$ emotional reactivity interaction in the BPD group was not statistically significant, ($\beta = -.08, SE = .16$), $\chi^2(1) = 2.50, p = .62$, indicating that emotional reactivity did not influence emotion regulatory effectiveness in this group. Figure 10 depicts this interaction.

Figure 10. Graphical representation of the three way group $\times$ time $\times$ emotional reactivity interaction predicting changes in corrugator supercilli activity

Note. Emotional reactivity was dichotomized using a median split for the purposes of graphical illustration.

Question 4D (secondary group analyses): Corrugator supercilli. Question 4D is a secondary question examining whether the potential *differential* impact of emotional reactivity on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ emotional reactivity $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = 1.10, p = .29$. This indicated that the potential *differential* impact of emotional reactivity on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Question 4- Response-Focused Emotion Predicting Effectiveness of Strategies:

Zygomaticus major activity (EMG)

Results examining whether emotional reactivity predicted changes in *general* emotion regulatory effectiveness (Question 4A), and whether it did so *differentially* between emotion regulation strategies (Question 4B), as indexed via zygomaticus major are presented in Table 36.

Table 36

Generalized Estimating Equations Analyses Examining whether Emotional Reactivity Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Zygomaticus Major

	B (SE)	χ^2	df	p-value
Intercept	-.20 (.06)	15.14	1	.000***
Time	-.004 (.004)	.16	1	.69
Emotion regulation strategy	-.04 (.04)	1.03	1	.31
Dissociation	-.001 (.004)	.05	1	.82
Recovery	-1.93 (.24)	64.86	1	.000***
Emotion reactivity	.13 (.35)	1.84	1	.18
Emotion regulation strategy $\times$ Time	.01 (.01)	1.34	1	.25
Time $\times$ Emotional reactivity	-.02 (.02)	.28	1	.60
Emotion regulation strategy $\times$ Emotional reactivity	.24 (.58)	.17	1	.68
Emotion regulation strategy $\times$ Emotional reactivity $\times$ Time	.03 (.05)	.49	1	.49

Note. Electromyography predictors and outcomes were z-scores. Dissociation and recovery variables were mean centered. Mindful awareness was designated as the reference category.

* $p < .05$; ** $p < .01$; *** $p < .001$

Question 4A: Zygomaticus major. Question 4A is: “Does *emotional reactivity* predict general emotion regulation effectiveness across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ emotional reactivity, indicating that emotional reactivity did not influence emotion regulatory effectiveness across groups and strategies.

Question 4B: Zygomaticus major. Question 4B is: “Does *emotional reactivity* predict *differential* effectiveness of one type of emotion regulation over another (engagement mindful awareness versus disengagement distraction) across BPD and HC groups?” There was not a statistically significant interaction of time $\times$ emotional reactivity $\times$ emotion regulation strategy interaction, indicating that the influence of emotional reactivity on emotion regulatory effectiveness did not vary between emotion regulation strategies.

Question 4C (secondary group analyses): Zygomaticus major. Question 4C is a secondary question examining whether the impact of emotional reactivity on the general effectiveness of emotion regulation strategies as indexed by zygomaticus major activity between BPD and HC groups. The group $\times$ time $\times$ emotional reactivity three-way interaction was not statistically significant, $\chi^2(1) = 2.23$, $p = .14$. This indicates that the influence of emotional reactivity on emotion regulatory effectiveness did not vary between groups.

Question 4D (secondary group analyses): Zygomaticus major. Question 4D is a secondary question examining whether the potential *differential* impact of emotional reactivity on the effectiveness of mindful awareness versus distraction varied between BPD and HC groups. The group $\times$ time $\times$ emotional reactivity $\times$ emotion regulation strategy four-way interaction was not statistically significant, $\chi^2(1) = 1.05, p = .31$. This indicated that the potential *differential* impact of emotional reactivity on the effectiveness on mindful awareness versus distraction did not vary between BPD and HC groups.

Chapter VII: Discussion

This dissertation was developed in light of the pressing need to refine BPD treatments. While difficulties with emotion regulation is purported to be a core of BPD (Linehan, 1993a), research suggests that individuals with BPD can implement emotion regulation strategies as effectively as HCs (e.g., Chapman et al., 2009; Kuo et al., 2016; Lang et al., 2012; Marissen et al., 2010; Ruocco et al., 2010; Schulze et al., 2011). However, given the evidence suggesting that individuals with BPD demonstrate elevated baseline emotional intensity (Elices et al., 2012; Gratz et al., 2010; Kuo & Linehan, 2009; Kuo et al., 2016; Scott et al., 2013), implementing an emotion regulation strategy as effectively as HCs is likely insufficient, as negative emotional intensity remains elevated at post-regulation (Gratz et al., 2010; Kuo et al., 2016). Accordingly, this dissertation used a two-step approach to identify ways in which emotion regulation in BPD could be further optimized: first, we aimed to help emotion regulation “work better” by attempting to identify factors that influence the general effectiveness of emotion regulation so that these factors could be targeted directly to improve emotion regulation in BPD. Second, we aimed to help emotion regulation “work smarter” by attempting to identify whether these individual factors predict which specific type of emotion regulation strategy (engagement versus disengagement) will be most effective for a particular individual at a particular point in time. This step was undertaken so that treatment providers could use this information to match clients to the emotion regulation strategy that is most likely to be effective for them in the particular moment that they need it. We examined four candidate factors that exist both prior (i.e., antecedent-focused) and subsequent (i.e., response-focused) to the elicitation of an emotion: antecedent-focused behaviour (SQ- SE and rated SQ), antecedent-focused biology (baseline RSA), antecedent-focused emotion (baseline emotional intensity), and response-focused emotion (emotional reactivity).

The primary strength of this work is that it is the first to examine the influence of a wide range of several distinct factors (behaviour, biology, emotion) on both general and differential emotion regulation effectiveness, and whether these influences are modulated by

BPD group status. Importantly, no prior examinations have distinguished between antecedent- and response-focused factors, and examined both in relation to emotion regulation. This knowledge is particularly important because there are an infinite number of factors that could potentially influence general and differential emotion regulation effectiveness. Distinguishing between antecedent- and response-focused factors provides a useful framework that distils these potential factors into two meaningful categories. These distinct categories are meaningful because they fundamentally require different forms of intervention. For example, increasing emotion regulation by improving antecedent-focused factors may require targeting through repeated, consistent, therapeutic intervention (e.g., targeting SQ through insomnia treatments, or implementing regular ongoing mindfulness practices to improve vagal tone). Conversely, improving emotion regulation by targeting more labile response-focused factors is more likely to require individuals to engage in specific and *acute* behaviours or skills in the moments that an emotion is provoked, rather than ongoing intervention per se. This framework thus points to different forms of intervention that may be required to improve emotion regulation (i.e., ongoing therapeutic intervention, skills training, or both), and indicates which *specific* forms of antecedent- and response-focused factors are pertinent to target in their own respective ways.

Moreover, this work is the first to experimentally examine the relationship between SQ and basal vagal tone with emotion regulation processes in BPD. Additionally, given that emotion is multi-faceted with several independent domains (Gross & Thompson, 2007), it is crucial to study emotion regulation comprehensively across multiple indices. This study was novel in its use of comprehensive assessment of emotion regulation processes in BPD across experiential, parasympathetic, sympathetic, *and* behavioural/expressive domains. Indeed, a substantial limitation in the literature to date is that many emotion regulation studies in BPD rely heavily on self-report (e.g., Chapman et al., 2009) or, more commonly, employ some psychophysiological assessments of emotion but not others (e.g., studying sympathetic responding but neglecting parasympathetic or behavioural/expressive responding;

Baczkowski et al., 2016; Koenigsberg et al., 2009; Kuo et al., 2016; Marissen et al., 2010; Ruocco et al., 2010). Indeed, a comprehensive assessment of the multiple domains of an emotion is required to more precisely understand the mechanisms through which emotion regulation, and the factors that influence it, works. Such information allows treatment providers to precisely target the *domains* of emotion that are particularly problematic to a client at a particular point in time by understanding which variables impact those specific areas. It also allows treatment providers to understand which domains are *not* impacted by their therapeutic interventions, and thus may warrant additional, specialized attention. A key contribution of this study to the literature thus involves its rigorous assessment of emotion across all domains.

The Impact of Antecedent-Focus Predictors on Emotion Regulation

Emotion Regulation Factor #1: Antecedent-Focused Behavioural Context (Sleep Quality)

The first potential predictor of general and differential emotion regulation effectiveness identified was SQ (i.e., lower SE and rated SQ). Consistent with past evidence (e.g., Kahn et al., 2013; Gruber & Cassoff, 2014; Mauss et al., 2013; Tavernier & Willoughby, 2014; Yoo et al., 2007), we hypothesized that lower SE and rated SQ would be associated with diminished emotion regulatory effectiveness across strategies and groups. For the most part, this hypothesis was not supported. Findings indicated that SQ did not influence the general effectiveness of emotion regulation, with a few exceptions.

The lack of statistically significant findings indicates that the SQ measured in the present study does not impact emotion regulatory effectiveness. Our post-hoc analyses similarly indicated that recent (night before) SE and rated SQ do not influence general emotion regulation effectiveness across groups and strategies. It is also possible that SQ indices such as SE and rated SQ do, in fact, influence emotion regulation generally, but do so indirectly through their effect on other processes. For example, lower SE and rated SQ have been associated with psychopathology in several studies (e.g., Arfken, Joseph, Sandhu,

Roehrs, Douglass, & Boutros, 2014; Bourdet & Goldenberg, 1994; Doane, Gress-Smith, Brientenstein, 2015; Spira, Stone, Beaudreau, Ancoli-Israel, & Yaffe, 2009). It is possible that these variables indirectly diminish emotion regulatory effectiveness by exacerbating other psychopathologies that are characterized by broad difficulties with emotion regulation such as major depressive disorder (Berking, Wirtz, Svaldi, & Hofmann, 2014). Alternatively, these variables may not influence emotion regulatory effectiveness per se, but may impair other components of emotion regulation such as emotion regulation strategy choice. Selecting adaptive, functional, and non-destructive emotion regulation strategies is a crucial component of healthy emotional functioning and one that requires a great deal of cognitive resources and flexibility (Aldao & Nolen-Hoeksema, 2012; Sheppes et al., 2011). Given that problems with SQ such as lower rated SQ impair at least some cognitive processes such as sustained attention (Gobin et al., 2015), they may also impair other cognitive processes such as decision-making that are required in these other emotion regulation domains (i.e., emotion regulation choice). As we did not examine the influence of these variables on emotion regulatory choice, this remains to be an open empirical question.

Sleep quality predicting emotion regulation effectiveness: Corrugator supercilii activity. There was one exception to the general pattern of statistically non-significant findings for the impact of SQ on the general effectiveness of mindful awareness and distraction; consistent with our hypotheses, higher week-long SE predicted improved emotion regulatory effectiveness as indexed by corrugator supercilii activity. This result suggests that resting levels of higher SE does in fact improve emotion in the behavioural/expressive domain of emotion regulation effectiveness. It is unclear why this finding was observed for this domain only; An overwhelming body of research shows that discrepancies in emotion indices are normative in BPD research (e.g., Baschnagel et al., 2013; Lang et al., 2012; Reitz et al., 2012; Schmahl et al., 2004; Scott et al., 2013; Welch, Linehan, Sylvers, Chittams, & Rizvi, 2008) because these domains reflect different, independent, emotional processes, rather than ones that mirror each other (Gross & Thompson, 2007). Given that emotional expression

occurs later in emotion generative cycle (Gross, 1998), it is possible that the threshold for emotional responding on the behavioural/expressive domain is higher than in other domains, such that high behavioural/expressive reactivity is indicative of particularly intense emotional response processes; one that has “travelled” through all other stages of emotional responding and remained intense at the final, behavioural/expressive stage. Accordingly, it could be that downregulating behavioural/expressive emotional responses is particularly challenging when there has been substantial change in those responses. Perhaps this system is simply slower to adapt, or more resistant, to emotion regulation strategies after it has been provoked. In this instance, downregulating emotion in this domain would require more of the cognitive and emotional resources that are afforded by high levels of SE. Modulating emotional expression arguably also requires more behavioural inhibition than altering other emotional response components. Indeed, prior work demonstrates the deleterious impact of sleep deprivation on behavioural inhibition (Anderson & Platten, 2011). Although SE and sleep deprivation are distinct constructs, low SE may similarly be a form of SQ that diminishes behavioural inhibition and thus, higher SE might therefore exert a particularly notable impact on behavioural/expressive indices of emotion regulation.

Sleep quality predicting the differential effectiveness of emotion regulation strategies. While the majority of our findings suggested that SQ does not *uniformly* influence emotion regulatory effectiveness, they did indicate that they may *specifically* influence particular emotion regulation strategies but not others. Results indicated that higher week-long SE and rated SQ both predicted improved effectiveness of distraction but not mindful awareness as indexed by SCR, and greater improvements in distraction than mindful awareness as indexed by corrugator supercilii activity. Interestingly, the post-hoc analyses involving recent (night-before) SE did not mirror these findings, indicating that the week-long, typical levels of SE may be particularly important to differential emotion regulation effectiveness, rather than night-before levels per se. However, analyses involving recent (night-before) rated SQ did largely mirror the week-long rated SQ findings, suggesting that,

across groups, higher rated SQ either did not improve mindful awareness and improved distraction, or impaired mindful awareness and did not influence distraction, across rating dial, RSA, and SCR indices.

Evidence for the differential impact of SQ on different emotion regulation strategies might explain why there were so few statistically significant findings of their impact on general emotion regulatory effectiveness; the influence of SQ is likely specific to the emotion regulation strategy used. There is a general theme across these findings that lower levels of SQ facilitate the effectiveness of distraction, but either do not alter or diminish the effectiveness of mindful awareness. This finding is surprising given that the only work to examine the impact of rated SQ on emotion regulation effectiveness suggested that higher rated SQ resulted in improved effectiveness of cognitive reappraisal, an engagement strategy (Mauss et al., 2013). This study would suggest that higher rated SQ might facilitate the effectiveness of other engagement strategies as well, such as mindful awareness, but our findings did not support this.

Both lower SE and rated SQ are evident in populations characterized by attentional problems, namely attention-deficit and hyperactivity disorder, compared to healthy groups (Boonstra, Kooij, Oosterlaan, Sergeant, Buitelaar et al., 2007; Sobanski, Schredl, Kettler, & Alm, 2008; Yoon, Jain, & Shapiro, 2013). Both mindful awareness and distraction involve shifting attention. However, one quintessential difference is that, while mindful awareness involves re-directing attention back *towards* emotional stimuli, distraction involves shifting attention *away* from emotional stimuli towards neutral content. An experimental study showed that lower rated SQ is associated with difficulties sustaining attention towards *non-emotional stimuli*, and increased memory for negatively emotional stimuli (Gobin, Banks, Fin, & Tartar, 2015). It is therefore possible that the reason that SE and rated SQ facilitate the effectiveness of distraction but not mindful awareness is because higher levels of these variables improve individual's capacity to shift attention *away* from emotional stimuli, towards neutral content. Perhaps these processes are particularly impaired for those with

lower SE and rated SQ, inhibiting their ability to effectively use this strategy. Indeed, it is possible that individuals with low rated SQ and SE may be more suited towards mindful awareness if their lower SQ predisposes them towards attending to emotional content anyways. Improvements in attention that are associated with increased SE and rated SQ may thus be less likely to facilitate this strategy.

Another possible reason for the discrepancy between strategies involves their relative complexity. Distraction is arguably a much simpler strategy to grasp and master than mindful awareness, which is a nuanced and complex behaviour that may require more than a brief, 10-minute training period to master. If participants had a weak foundation in the application of mindful awareness, then the extent to which its effectiveness could be improved by high SE or rated SQ may be limited since it is not being effectively implemented in the first place. Related, our anecdotal clinical experiences teaching mindful awareness to individuals suggests that those new to these practices often experience distress upon its initial practice. Some research corroborates this; one study compared the relationship between mindful awareness practices and general distress between a group of experienced meditators and three groups of non-experienced meditators: students, individuals from the community, and a group that was demographically matched to the experienced meditators. For community members, there was no relationship between mindful awareness and general distress. However, for students, mindful awareness practices were associated with increased distress. Further, the reverse pattern was observed for experienced meditators (Baer et al., 2008). These findings suggest that mindful awareness practices affect groups in different ways and support the notion that they may, at least temporarily, provoke distress in those who are not experienced with them. Given this research, it is possible that those higher in SE and rated SQ actually put in greater effort to the implementation of mindful awareness and, accordingly, experienced greater frustration at its difficulty when learning this strategy. This effect would also produce an illusion of unimproved, or diminished, emotion regulatory effectiveness.

It is also possible that distraction and mindful awareness exhibit different temporal trajectories, wherein mindful awareness takes longer to become effective. The window in which emotion regulation strategy effectiveness was assessed was brief (i.e., 2.5 minutes). Perhaps such a short timeframe would allow for an assessment of a simple, fast-acting, strategy that shifts attention away from emotion (distraction). However, a strategy that involves engaging with emotion is likely to involve continued emotional responding, or even increases in emotional responding, for some time before the downregulating effects take place. Thus, perhaps the effects of mindful awareness take more time to unfold than that of distraction, and the brief assessment window in the present study did not capture these effects. As we did not examine the impact of mindful awareness over a longer time frame, this remains an open empirical question.

Discrepancies across indices of emotion regulation, and the influence of week-long versus recent sleep quality. It is notable that the differential impact of week-long SQ on mindful awareness and distraction effectiveness was evident with the sympathetic and behavioural/expressive domains of emotion, but not general physiological (e.g., HR), parasympathetic (e.g., RSA), or experiential domains (e.g., EMG). Interestingly, although the impact of recent (night before) rated SQ on differential emotion regulatory effectiveness largely mirrored the week-long rated SQ findings, the indices that it impacted were different: while both week-long and recent rated SQ showed a differential influence on emotion regulation strategies in the behavioural/expressive domain, week-long rated SQ demonstrated a differential influence in the sympathetic domain, whereas the differential influence of recent rated SQ was present in the experiential (rating dial) and parasympathetic (RSA) domains. These findings importantly suggest that rated SQ has the potential to impact disengagement strategies such as distraction across almost all domains of emotion. However, whereas week-long rated SQ influence sympathetic domains, recent rated SQ appear to influence experiential and parasympathetic ones. As the “fight or flight” system, sympathetic activity is often conceptualized as an index of current arousal (e.g., Dawson et al., 2007). Improved

week-long SE and rated SQ may potentiate the effectiveness of distraction by dampening such arousal, rather than increasing the emotion regulation effect of the parasympathetic nervous system per se. Conversely, recent rated SQ may potentiate the capacity of the parasympathetic system to become active during disengagement strategy implementation. It's possible that such increased parasympathetic activity may have a corresponding influence on experiential domains of emotion, facilitating effectiveness across the self-report index as well. Moreover, some research suggests that higher rated SQ is predictive of increased positive emotion more so than decreased negative emotion (Bower, Bylsma, Morris, & Rottenberg, 2010). Thus, it is possible that higher recent rated SQ potentiated experiential emotion regulation effectiveness by up-regulating experiences of positive emotion, something that may be more readily detectable on self-report rather than physiological indices. Regardless of their mechanisms, these findings suggest that both typical and recent rated SQ can potentiate disengagement strategies across several emotional domains.

The moderating effect of group on the relationship between sleep quality and emotion regulation. We did not find evidence that group status moderated the effect of week-long SQ on general and differential emotion regulatory effectiveness. The lack of statistical significance involving group as a moderator indicates that emotion regulation in individuals with BPD and HCs is largely equally (un)affected by SQ. There is one exception to the pattern of non-statistically significant findings involving group as a moderator; there was a statistically significant interaction of group, SE, and emotion regulatory effectiveness as indexed by the rating dial such that higher SE *improved* emotion regulation for HCs, but did not impact it for the BPD group. That the moderating effect of group on SQ and emotion regulation was evident only using the rating dial index indicates that SE specifically influences the *subjective* experience of emotion regulation in HCs more than those with BPD.

Week-long versus recent influence of SE in the HC group. As with the week-long rated SQ analyses, post-hoc examinations suggested that recent (night-before) rated SQ did not influence emotion regulation differentially between BPD and HC groups. However, two

indices suggested that recent (night before) SE influenced emotion regulation differentially across BPD versus HC groups, but in the opposite way as the week-long finding. In the behavioural/expressive domain, higher recent SE impaired emotion regulation effectiveness for HCs, but did not impact it for the BPD group. Similarly, in the parasympathetic domain, higher SE did not differentially influence the effectiveness of emotion regulation strategies in the BPD group, but impaired mindful awareness more so than distraction for the HCs.

Although examinations of the impact of week-long and recent SE on BPD and HC groups indicated opposing patterns, they share one common theme: when groups are differentially impacted, it is because HCs are influenced by SE and the BPD group is not. HCs may simply have a more responsive subjective emotion regulatory system that is more readily impacted by behavioural variables such as week-long or recent SE. Moreover, the greater impact of week-long or recent SE, in either direction, on emotion regulation in HCs may also indicate a greater flexibility in their emotion regulation systems in general, which is a marker of emotion regulatory health (Aldao & Nolen-Hoeksema, 2012). Emotion regulation in individuals with BPD, on the other hand, may be generally more fixed and less amenable to improvement from antecedent-focused behavioural domains such as sleep. Relatedly, the lives of individuals with BPD are characterized by many antecedent-focused behavioural variables that may influence emotion regulation (e.g., co-morbidities, distressed and conflictual relationships, frequent crises, unstable home environments, substance use; Ball, Cobb-Richardson, Connolly, Bujosa, & O'Neill, 2005; Daley, Burge, & Hammen, 2000; Trull, Sher, Minks-Brown, Durbin, & Burr, 2000; Zanarini et al., 1998). Perhaps, for this group with highly chaotic and crisis-ridden lives, SQ is simply too minor relative to other behavioural concerns to substantially influence emotion regulation or its differential effectiveness. Conversely, given the relative stability in the lives of HCs, impaired SQ in this group may be particularly novel and influential.

It is unclear why week-long SE would facilitate emotion regulation in HCs while recent SE would impair it. However, it is important to note that low and high SE can be

equally problematic for different reasons. Whereas low SE may be indicative of higher insomnia-based problems (i.e., spending a great deal of time in bed but not sleeping), SE that is abnormally high demonstrates a particularly quick transition into sleep when the opportunity for it arises. This may be indicative of sleep deprivation, as typical and healthy sleep does involve some time in bed prior to falling asleep (e.g., Perlis et al., 2005). For this reason, “healthy” SE rates typically range from 85% to 90%, with values above or below indicating some form of sleep problem (e.g., Perlis et al., 2005). While 58% of HCs scored above 90% for week-long SE, 68% had recent (night before) SE levels above 90%. However, throughout the course of the week, some variability in SE might be expected, which are compensated for during subsequent sleep nights as part of sleep regulation and homeostatic processes (e.g., Saper, Scammell, & Lu, 2005). For this reason, optimal and stable estimates of SE require approximately two weeks of ongoing assessment (Wohlgemuth, Edinger, Fins, & Sullivan, 1999). It is therefore difficult to ascertain whether particularly high SE throughout the week is indicative of chronic sleep deprivation per se, or perhaps a week with a few outlier nights that inadvertently yielded a higher SE mean. That is, if one has a few nights of sleep deprivation throughout the week, their sleep processes the following nights may “correct” for this imbalance, resulting in normal levels of sleep deprivation, or lack thereof (e.g., Saper et al., 2005). However, having a few outlier nights of deprived sleep throughout the week may produce an average SE percentage that “looks like” deprivation, even though individuals are not currently experiencing chronic sleep deprivation per se.

Unlike week-long SE, as a singular index, night before estimates of SE *can* provide an acute index of sleep deprivation, one that may be corrected through variability later in the week but, in and of itself, acutely functions as sleep loss. Thus, in the HC group, it is possible that high SE the night before was indicative of acute sleep deprivation, whereas high SE throughout the week may have been a conflation of chronic sleep deprivation for some, and normal variability in sleep processes for others. There is some evidence that, at least in older adults, lower SE is associated with reduced cognitive functioning (Miyata et al., 2012).

“Healthily high” levels of week-long SE may therefore have improved cognitive functioning and, accordingly, emotion regulation in the HC group. However, unlike week-long SE, recent SE may have been more conflated with sleep deprivation, a factor reliably demonstrated to impair emotion regulation in healthy groups (e.g., Gruber & Cassoff, 2014; Yoo et al., 2007). Thus, very high recent SE may mark higher sleep deprivation in HCs, which impairs neural networks required for healthy emotion regulation (e.g., Gruber & Cassoff, 2014; Yoo et al., 2007). These findings therefore indicate that increased SE over time can facilitate emotion regulation to a point but, when too high, may be symptomatic of larger sleep loss, which interferes with emotion regulation capacity.

The influence of sleep quality in the BPD group. These differential effects between week-long versus recent SE were not observed in the BPD group. It is possible that the HC group put more effort into the application of the emotion regulation strategies than the BPD group, or found emotion regulation more challenging in general, therefore leaving more “room” for SE to exert an impact. Given the high intensity, very chaotic, and crisis-ridden lives of individuals with BPD, engaging in emotion regulation in response to laboratory stories may be relatively easy compared to the types of “emotion provocations” that they are used to, leaving less “room” to be influenced by SE. Conversely, for HCs, engaging in the emotion regulation strategies in the face of elicited emotion may have been more anomalous, and required greater focus, attention, or effort.

It is also possible that there are additional sleep difficulties in the BPD group that are more likely to impact emotion regulation than SE. For example, the BPD group reported higher levels of sleepiness and eveningness than HCs. Perhaps there are occult sleep problems are more influential for the BPD group. Namely, problems involving disordered-breathing during sleep such as sleep apnea involve excessive levels of daytime sleepiness given their association with chronic sleep fragmentation and deprivation (e.g., Kales, Vela-Bueno, & Kales, 1987; Kimoff, 1996; Lavie, 1983; Sackner, Landa, Forrest, & Greeneltch, 1975). Given that sleep apnea can result in significant sleep loss, and aforementioned works suggest

that sleep loss and deprivation can impair emotion regulation (e.g., Gruber & Cassoff, 2014), it is plausible that the BPD group may be particularly elevated in co-morbid sleep apnea which, through sleep deprivation, impacts emotion regulation processes. Relatedly, a recent meta-analysis demonstrated that individuals with BPD exhibit shorter total sleep times and rapid eye-movement sleep initiation latency relative to HCs (Winsper et al., 2017). This study also demonstrated that individuals with BPD are more likely to have delayed sleep phase syndrome, exhibit greater variability sleep on week-nights versus weekends, and greater variability in activity levels across days versus nights (Winsper et al., 2017). The latter findings are particularly important, as they suggest that sleep patterns for individuals with BPD are not necessarily solely characterized by chronic lower SE or rated SQ per se, but rather chronic *variability*.

For these reasons, we investigated the possibility of alternative SQ markers (excessive time in bed and variability in sleep times) influencing emotion regulation in BPD through our post-hoc analyses. While our findings indicated that excessive time in bed did not influence emotion regulation, they did suggest that the BPD group may be more influenced by variability in sleep times than HCs. Sympathetic indices indicated that both groups have impaired emotion regulation as a result of higher rise time variability, but the BPD group is particularly impaired. Thus, in accordance with Winsper and colleagues' (2017) findings demonstrating robust linkages between variability in sleep times and BPD, our findings suggest that it is this variability which may be particularly influential over emotion regulation in this group, rather than SE or rated SQ per se. This finding is in tandem with a long-established link between sleep variability and affect instability in other affective disorders, namely bipolar disorder (e.g., Harvey, 2008). Given that the lives of individuals with BPD are often highly chaotic and unstable, it is unsurprising that prior work suggests that their sleep schedules mirror this instability. Our findings also dovetail with these in suggesting that this instability does in fact influence emotion regulation generally in BPD, although it does not differentially influence strategy effectiveness in this group. Importantly, high rise time

variability can repeatedly produce effects akin to “jetlag”, wherein sleep times and schedules are constantly shifting and misaligned with biological sleep cues. This has a range of negative consequences such as depressive symptoms (Levandovski et al., 2010) and cognitive impairments (Cho, Ennaceur, Cole, & Kook Suh, 2000). Based on this research, it is possible that variability exerts a general deleterious effect on some of the already-vulnerable emotional and cognitive systems in BPD, one of which is emotion regulation. Greater investigations of variability in sleep processes as a predictor of emotion processes in BPD, rather than chronic SQ (i.e., SE, rated SQ), may be a fruitful line of inquiry for future research.

Emotion Regulation Factor #2: Antecedent-Focused Biology (basal vagal tone)

In addition to behavioural contexts, emotion processes are nested within broader biological contexts, which can also influence emotion regulation. We drew on Linehan’s (1993a) theory that BPD is characterized by a biological vulnerability to emotion dysregulation to identify a biological factor that may influence emotion regulation; basal vagal tone, as indexed by baseline RSA. Emerging research implicates basal vagal tone as a marker of biological vulnerability to emotion dysregulation (Beauchaine, 2001; Porges, 1995). Therefore, we hypothesized that, as an index of one’s capacity to emotionally engage with their environment (Beauchaine, 2001), higher basal vagal tone would predict improved emotion regulatory effectiveness. Consistent with our hypotheses, our findings showed that basal vagal tone (as indexed by baseline RSA) predicted emotion regulatory effectiveness as indexed by both the rating dial and RSA.

As previously discussed, baseline RSA is distinct from the other baseline indices collected in this study (e.g., SCR, rating dial); while the other baseline indices measure baseline negative emotional intensity, baseline RSA indexes resting engagement of the parasympathetic vagal system, and reflects an individual’s potential to be able to respond effectively and flexibly to the changing emotional demands presented to them (e.g., regulation; Beauchaine, 2001). Our finding that basal vagal tone (as indexed by baseline RSA) predicted improved emotion regulation effectiveness is consistent with this theory, and

suggests that an individual's baseline emotion regulation "capacity" influences the extent to which the parasympathetic system can become increasingly responsive when necessary, and effectively down-regulate negative emotion.

Discrepancies across indices of emotion regulation. It is important to note that basal vagal tone predicted improved emotion regulation effectiveness across parasympathetic and experiential domains, but not sympathetic or behavioural/expressive ones. The lack of findings with sympathetic outcomes is somewhat unsurprising given psychophysiological research demonstrating that the parasympathetic and sympathetic branches of the autonomic nervous system are independent processes. These works have highlighted that high parasympathetic activation does not necessarily mean low sympathetic activation, or vice versa, and parallel activation or non-activation of both domains is possible (e.g., Beauchaine, 2001; Berntson et al., 1994). Our findings therefore suggest that, as an index of resting emotion regulatory capacity, basal vagal tone has more influence on emotion regulation in the domain in which it itself is nested, the parasympathetic branch, than the sympathetic one, which is independent. However, despite the independence of the parasympathetic and sympathetic branches, theory suggests that both branches influence experiential and behavioural/expressive emotional domains, often in opposing ways (see Beauchaine, 2001, for review). Given this theorizing, it is unsurprising that basal vagal tone predicted emotion regulation in the experiential domain. However, while basal vagal tone did influence emotion regulation effectiveness in the experiential domain, it did not do so with behavioural/expressive (EMG) indices.

Our finding of an absence of a relationship between basal vagal tone and the behavioural/expressive indices of emotion is inconsistent with a body of literature showing linkages between the two (e.g., Demaree, Pu, Robinson, Schmeichel, & Everhart, 2006; Moore & Calkins, 2004; Stifter, Fox, & Porges, 1989; Quas, Hong, Alkin, & Boyce, 2000). However, it is notable that, with some exceptions (e.g., Demaree et al., 2006), many of the studies documenting a general relationship between basal vagal tone and

behavioural/expressive domains of emotion processes have been conducted with children and infants (e.g., Moore & Calkins, 2004; Stifter et al., 1989; Quas et al., 2000). It is possible that, in childhood, the influence of basal vagal tone on behavioural/expressive domains of emotional intensity is more pronounced and, as one develops into adulthood, an individual may begin to acquire more behaviours or skills that influence emotional expression, such as expressive suppression tendencies (i.e., inhibiting visual expressions of emotion; Gross & John, 2003). Specifically, adults may be more likely to mask or inhibit signs of emotion (i.e., expressive suppression), which would result in a lower apparent emotional response in the behavioural/expressive domain of emotion, despite the fact that other emotional domains may be exhibiting large responses. Consequently, it is possible that, in adulthood, the relationship between vagal tone and emotion as indicated by the behavioural/expressive domain is obfuscated, or attenuated by behaviours such as expressive suppression. Conversely, the relationship between the parasympathetic system and experiential emotion may remain intact.

Lack of differential impact of basal vagal tone on emotion regulation

effectiveness. In addition to examining the impact of antecedent-focused biology on general emotion regulation effectiveness, we also examined whether it predicted the *differential* effectiveness of mindful awareness and distraction across groups (BPD and HC). It was hypothesized that higher basal vagal tone would provide individuals with greater capacity to engage with emotion and effectively implement engagement mindful awareness than those with lower basal vagal tone. Thus, individuals with lower baseline RSA were hypothesized to exhibit greater differential effectiveness of mindful awareness and distraction, whereby distraction would be more effective for these individuals. This hypothesis was uniformly not supported, as basal vagal tone did not predict the differential effectiveness of the two strategies.

This finding is somewhat in contradiction with research showing that people with higher basal vagal tone tend to adopt engagement strategies (cognitive reappraisal) more and disengagement strategies (distraction) less than those with low basal vagal tone (Volkhov &

Demaree, 2010 and Aldao et al., 2016, respectively). However, while the aforementioned work examined the relationship between vagal tone and differential emotion regulation strategy *choice*, this study examined differential emotion regulation strategy *effectiveness*. Indeed, the present results indicate that, while those with lower vagal tone may *select* strategies differentially, they *experience* them similarly.

One additional important difference between the present study and Volokohov and Demaree's (2010) and Aldao and colleagues' (2016) works is that, while the disengagement strategy in the present study was the same one used in previous similar inquiries (distraction), the engagement strategy was not. Unlike these studies, which examined cognitive reappraisal as the engagement strategy (Aldao et al., 2016; Volokohov & Demaree, 2010), the present study examined mindful awareness. We elected to use mindful awareness because this engagement strategy is much more heavily utilized in evidence-based BPD treatments such as DBT (Linehan, 1993a; 1993b; 2015) than cognitive reappraisal. We have argued that mindful awareness is an engagement strategy because, like cognitive reappraisal, it involves engaging with emotional content and holding it in working memory. However, another way to distinguish engagement and disengagement strategies is on the basis of which stage of the emotion generative cycle they operate, wherein engagement strategies influence the appraisal stage, and disengagement strategies operate earlier in the cycle, at the attentional stage (Sheppes & Gross, 2011; Sheppes et al., 2011). Thus, a quintessential component of disengagement strategies is that they primarily utilize attention. Although mindful awareness involves engaging with emotion like an engagement strategy, it also does so by shifting *attention* towards emotional stimuli repeatedly. Thus, one key commonality between distraction and mindful awareness is that both strategies predominantly utilize attentional shift as the mechanism through which they operate (distraction shifts attention away, and mindful awareness shifts attention towards, emotion). Mindful awareness thus might bear more similarity to distraction than cognitive reappraisal, which predominately modulates appraisals rather than attention. As a strategy that involves attention deployment, perhaps mindful

awareness is thus better classified as a disengagement strategy than an engagement strategy, or some combination of both. If this is the case, then one might expect it to be affected by basal vagal tone in relatively equivalent ways. Perhaps if cognitive reappraisal were selected as the engagement strategy, as it was in past works examining the differential influence of basal vagal tone (Aldao et al., 2016; Volokohov & Demaree, 2010), then the hypothesized effect would have been observed. Indeed, this work highlights the importance of generating a more nuanced and comprehensive understanding of precisely *how* mindful awareness operates in relation to Gross' (1998) process model of emotion regulation. Further, it also points to potential gaps in the classification system of emotion regulation strategies, as mindful awareness may be one that “falls between” disengagement and engagement categorizations.

Antecedent-focused biology predicting effectiveness of strategies: Examining diagnostic group differences. It is also notable that there were no moderating effects of group status on the relationship between baseline RSA and the general or differential effectiveness of emotion regulation strategies. This finding indicates that biological vulnerability is influential on emotion regulation effectiveness regardless of diagnostic status. It is also consistent with emerging research that suggests that basal vagal tone is a transdiagnostic marker of emotion dysregulation, difficulties controlling behaviour, and emotion dysfunction (see Beauchaine & Thayer, 2015, for review). Indeed, basal vagal tone may be a “great equalizer” which allows treatment providers to identify potential difficulties with emotion regulation across diagnoses or lack thereof.

Emotion Regulation Factor #3: Antecedent-Focused Emotion (Baseline Emotional Intensity)

In addition to examining behavioural and biological processes that occur prior to the presentation of emotional stimuli, we also investigated whether emotion processes that occur before emotion evocation (baseline emotional intensity) influence emotion regulatory effectiveness. Baseline emotional intensity was a particularly compelling potential predictor of emotion regulation effectiveness given the robust body of literature showing that it is

elevated in BPD (Ebner-Priemer et al., 2007; Elices et al., 2012; Feliu-Soler et al., 2013; Gratz et al., 2010; Kuo & Linehan, 2009; Kuo et al., 2016; Scott et al., 2013). In investigating the impact of antecedent-focused emotion (baseline emotional intensity) on emotion regulation, we hypothesized that higher baseline emotional intensity would predict diminished emotion regulatory effectiveness across emotion regulation strategies (mindful awareness and distraction) and groups (BPD and HCs). Interestingly, our hypotheses were not supported. Our results indicated that baseline emotional intensity did not influence emotion regulatory effectiveness across the indices of emotion collected. In addition, baseline emotional intensity did not differentially influence emotion regulation effectiveness across strategies or diagnostic groups.

This lack of statistically significant findings is contrary to our hypothesis that higher baseline emotional intensity would inhibit emotion regulatory effectiveness. Indeed, it appears that baseline emotional intensity has no effect on emotion regulation, whether mindful awareness or distraction strategies are being utilized, in both individuals with BPD and HCs. These findings indicate that where an individual “starts off” (i.e., baseline emotional intensity) prior to emotion evocation may not be relevant to the extent to which they can decrease the emotion that is provoked. Importantly, the emotion regulation strategies examined in the present study were focused on reducing acute increases in emotion (i.e., provoked emotion immediately following an emotion induction). It is possible that chronic, trait-like indices such as baseline emotional intensity may not influence the *acute* or immediate effectiveness of emotion regulation strategies. However, it may affect more chronic, trait-like aspects of emotion regulation, such as habitual tendencies to engage in some specific emotion regulation strategies over others. This is supported by research demonstrating linkages between trait negative affect and the habitual use of maladaptive emotion regulation strategies such as expressive suppression (Gross & John, 2003), as well as general difficulties with emotion regulation such as limited access to emotion regulation strategies, difficulties engaging in goal-directed behaviour, higher impulsivity, and low

emotional clarity and acceptance (Veilleux, Skinner, Reese, & Shaver, 2014). Baseline emotional intensity may thus very well influence emotion regulation, but it may do so by impacting other trait-like components of it such as habitual strategy selection.

Relatedly, it is notable that emotion regulation effectiveness was quantified as the rate at which emotional intensity decreased over the 2.5-minute emotion regulation strategy implementation period (i.e., the slope of emotional intensity over time). It is possible that baseline emotional intensity may influence emotion regulation effectiveness as quantified in other ways. For example, perhaps another way to study emotion regulation effectiveness is not evaluating the rate of change over time, but rather examining the fixed level of emotional intensity that participants experience following emotion regulation strategy implementation (i.e., their “end point”). Variables such as baseline emotional intensity may constrain the level of emotional intensity that can be reached following emotion regulation strategy use. Indeed, perhaps the level that emotion can be downregulated to is akin to the fixed “set points” of individual’s body weights: The set point theory of weight loss suggests that individuals have their own, idiographic “set points” of body weight that their bodies naturally gravitate towards. Thus, regardless of weight loss or gain efforts, individual’s weight is theorized to tend to return to their original “set points” through changes in various processes such as metabolism (Mrosovsky & Powley, 1977). Emotional intensity may similarly have a resting “set point”. It is therefore possible that, once an emotional response is provoked, using emotion regulation strategies to downregulate emotion back to the “set point”, or baseline emotion intensity, is feasible. However, perhaps regulating emotion below or above that point is relatively challenging. In this instance, while baseline emotional intensity may not influence the *rate* with which emotional intensity decreases throughout the emotion regulation period, it could be predictive of individual’s “end points”, or their level of emotional intensity following strategy implementation. There is no research to our knowledge directly testing this assertion. However, research within the personality literature has demonstrated that resting levels of negative emotional intensity vary between individuals and are stable over time (e.g., Watson

& Walker, 1996), suggesting that individuals might indeed have fixed emotional “set points”. However, whether such a set point informs their ability to engage in emotion regulation is unclear, and as this method of quantifying emotion regulation effectiveness was not used in this study, this theorizing remains conjecture.

Lack of differential impact of baseline emotional intensity on emotion regulation effectiveness. It was also hypothesized that higher baseline emotional intensity would predict greater differential effectiveness of mindful awareness versus distraction, such that distraction would become more effective as baseline emotional intensity increased. As with the investigation of baseline RSA predicting the differential effectiveness of the two emotion regulation strategies, this hypothesis was not supported. Baseline emotional intensity did not differentially predict emotion regulation strategy effectiveness.

This finding is inconsistent with a growing basic emotion literature suggesting that engagement (mindful awareness) and disengagement (distraction) emotion regulation strategies, while not differentially effective under low to moderate emotional intensity conditions, exhibit differential effectiveness under high emotional intensity situations. Specifically, theory and research support the notion that disengagement distraction becomes increasingly more effective than engagement mindful awareness as emotional intensity increases (Shafir, Schwartz, Blechert, & Sheppes, 2015; Sheppes et al., 2011; 2014b).

It is notable that a majority of basic emotion research that has studied these phenomena has measured emotional intensity through the intensity rating of emotional stimuli (i.e., normed intensity scores of standardized images; Shafir et al., 2015; Sheppes et al., 2014a; Sheppes et al., 2014b). No published studies to date have examined *experienced* emotional intensity as a predictor of differential emotion regulation strategy effectiveness. It is possible that the intensity of an emotional situation/stimulus influences the differential effectiveness of engagement and disengagement emotion regulation strategies, while experienced emotional intensity does not.

Alternatively, the majority of studies examining this phenomenon to date also utilized *perceived effectiveness* (i.e., asking participants “how effective was that strategy in regulating your emotions?”) as their metric of emotion regulatory effectiveness, rather than directly assessing changes in emotion as in the present study. Perhaps antecedent-focused emotion would similarly influence the *perception* of differential effectiveness of emotion regulation strategies without altering more “objective” indicators of effectiveness. Furthermore, much of the research on the emotional intensity differentially influencing strategies is not on emotion regulatory effectiveness, but emotion regulation strategy choice; several studies show that individuals are more likely to *choose* disengagement strategies in response to high emotional stimulus intensities than engagement strategies, but this effect is not observed in response to low to moderate stimulus intensities (Sheppes & Gross, 2011; Sheppes et al., 2011). If emotional intensity influences the *perceived* effectiveness of emotion regulation strategies differentially, then it would be logical that individuals would choose strategies in accordance with these perceptions, or that their perceptions would be altered to support their choice. Such perceptions may not be reflective of actual differential effectiveness of these strategies, however, and our findings indicate that they are not.

In addition to this theorizing, it is notable that all of the aforementioned studies showing differential effectiveness or choice as a function of emotional intensity have also used cognitive reappraisal as the engagement strategy, rather than mindful awareness (e.g., Sauer et al., 2016; Shafir et al., 2015; Sheppes et al., 2011). As previously mentioned, mindful awareness may bear more resemblance to distraction and disengagement strategies than cognitive reappraisal. It is therefore possible that, while mindful awareness and distraction may be similarly affected by baseline emotional intensity, cognitive reappraisal and distraction may not be. As noted before, more work is required to more precisely categorize mindful awareness as an engagement or disengagement strategy in order to clarify its relationships to other strategies.

The Impact of Response-Focus Predictors on Emotion Regulation

Emotion Regulation Factor #4: Response-Focused Emotion (Emotional Reactivity)

Finally, in addition to examining emotion processes that occur prior to emotional stimulus presentation, this study also investigated the impact of response-focused emotion (emotional reactivity) on general and differential emotion regulation strategy effectiveness. It was hypothesized that higher emotional reactivity would predict diminished emotion regulatory effectiveness across emotion regulation strategies (mindful awareness and distraction) and groups (BPD and HCs). Interestingly, the opposite of our hypothesized pattern was observed; we found that higher emotional reactivity influenced emotion regulatory effectiveness as indexed by the rating dial and HR such that higher emotional reactivity predicted *improved*, rather than diminished, emotion regulation effectiveness.

These results directly contradict the assertion that the more intense an emotional response is, the “harder” it is to regulate. Perhaps the reason for these findings is that the “higher an emotion goes”, the “farther it has to fall”; Indeed, it is possible that larger emotional responses produce more emotion to “work with” during emotion regulation, which facilitates the emotion regulation process. If this is the case, then a logical question to follow would be: is higher emotional reactivity always “better”, or is there an optimal range of emotional reactivity that yields optimal emotion regulation? Higher levels of emotional reactivity observed in a laboratory setting using a standardized emotion induction may not approximate the high levels of emotional reactivity that can be experienced in an idiographic, evocative, real-life situation. Perhaps the extent of emotional reactivity which can be elicited by a standardized emotion induction within a laboratory context cannot reach the level of intensity that would actually impair emotion regulation effectiveness, as would be possible in the real world. Indeed, it is possible that the higher emotional reactivity ranges elicited in the laboratory fall into an “optimal range” for emotion regulation strategy effectiveness. Conversely, emotional reactivity that is higher than these values, perhaps high emotional reactivity elicited in real-world scenarios, might inhibit emotion regulatory effectiveness.

Related, it may also be that higher emotional reactivity does not improve emotion regulation effectiveness per se, but lower emotional reactivity inhibits it. Given the importance of flexibility both in emotional reactivity and regulation to emotional health (e.g., Aldao, Sheppes, & Gross, 2015; Hollenstein, Lichtwarck-Aschoff, & Potworowski, 2013; Kashdan & Rottenberg, 2010), perhaps individuals with lower emotional reactivity possessed blunted emotional response systems that are less responsive to both emotional provocation and modulation. Indeed, emotional reactivity in response to a stimulus designed to elicit emotion is not necessarily a marker of emotional dysfunction and may in fact indicate a responsive, sensitive, and fluid emotional system. These findings are evident in the developmental literature, which demonstrates that infants who have high basal vagal tone (i.e., low biological vulnerability) show increased negative and positive emotional reactions to negative and positive stimuli, respectively, thereby exhibiting increased general capacity to engage fluidly with their environment (See Beauchaine, 2001, for review). Such infants are also more sociable and approach-oriented in later infancy (Fox, 1989), corroborating the notion that flexible emotional reactivity may contribute to developing emotion and socialization systems.

The adult literature similarly demonstrates that lower emotional reactivity is indicative of lower emotional functioning. For example, there is evidence that when adults are presented with multiple changing emotional events, their flexibility in emotional responding (e.g., the extent to which their emotional response changes from positive to negative depending on the emotional stimuli) is associated with higher general emotional resilience (Waugh, Thompson, & Gotlib, 2011). Studies among individuals with major depressive disorder similarly suggest that individuals with this disorder are, in fact, characterized by reduced emotional reactivity (Bylsma, Morris, & Rottenberg, 2008), and that such reduced reactivity predicts higher depression severity (Peeters, Berkhof, Rottenberg, & Nicolson, 2010). It is therefore possible that higher emotional reactivity in this study marked a general increase in emotional

responsivity and fluidity, which in turn also facilitated a greater ease with which emotion could be reduced by emotion regulation strategies.

Discrepancies across indices of emotional reactivity. It is notable that the influence of emotional reactivity on emotion regulation effectiveness was evident within our experiential (rating dial) and general physiological (HR) indices of emotion, but not our behavioural/expressive index or the more “pure” measures of sympathetic (SCR) and parasympathetic (RSA) activity. As discussed, discrepancies in emotion indices are common in BPD research (e.g., Baschnagel et al., 2013; Lang et al., 2012; Reitz et al., 2012; Schmahl et al., 2004; Scott et al., 2013; Welch et al., 2008). However, that the influence of emotional reactivity on emotion regulation was evident within experiential and general physiological domains but not behavioural/expressive or specific sympathetic or parasympathetic indices also provides important information.

These findings suggest that *experienced* emotional reactivity may have more impact on emotion regulation abilities than “objective” emotional reactivity. Subjective awareness of emotional responses thus appears to be a crucial factor that affects the extent to which individuals can implement emotion regulation strategies. Alternatively, it is possible that the impact of emotional reactivity on emotion regulation effectiveness was observed specifically in the experiential domain because this index is more confounded by expectations or bias than the other, more “objective” indices of emotional responding. Specifically, it is possible that individual’s reports of their emotional intensity was informed not only by their own emotional experiences, but also by their expectations for the effects of the emotion inductions and emotion regulation strategies (i.e., demand characteristics; Orne, 1962). Participants may thus be more likely to report both increased emotional reactivity in response to the emotion induction, and then decreased emotional intensity following emotion regulation strategy implementation, simply because they expected, or thought that they were supposed to exhibit, those changes. However, if this explanation were the case, then one would expect not to find a relationship between emotional reactivity and emotion regulation across any of the more

“objective” indices of emotion in the present study. That emotional reactivity also influenced emotion regulation as indexed by HR suggests that the findings observed in the experiential domain may not be entirely due to demand characteristics and confirmation bias.

There may also be additional confounding factors in the domains in which this relationship was not observed that prevented these findings from being detected. As discussed, behavioural/expressive markers of emotion (EMG) in particular, can be confounded by additional expressive tendencies. For example, it is possible that individuals with higher experiential emotional reactivity are also more likely to engage in expression-based emotion regulation behaviours such as expressive suppression (Gross & John, 2003). In this instance, emotional reactivity in the behavioural/expressive domain may be confounded with expressive suppression-based behaviours that mask its detection. Thus, while these individuals appear to not be exhibiting emotional reactivity, they may actually have moderate to high experiential emotional reactivity but be actively masking its presence in the behavioural/expressive domain through suppression. As we did not examine behavioural tendencies such as expressive suppression, this possibility remains an open empirical question. However, that such discrepancies across the emotion indices in this study were observed further underscores the importance of comprehensively studying these processes across multiple domains.

Lack of differential impact of emotional reactivity on emotion regulation effectiveness. In addition to influencing the general effectiveness of emotion regulation, it was also hypothesized that higher emotional reactivity would predict higher differential effectiveness of engagement and disengagement strategies. This hypothesis was based on aforementioned works suggesting that high emotional intensity increases the differential effectiveness of these two strategy types, wherein distraction becomes more effective (Sheppes et al., 2011; Sheppes & Gross, 2011). However, as with similar investigations with the baseline RSA and baseline emotional intensity variables, this hypothesis was not supported. Similar to the parallel findings with baseline emotional intensity, this result could

be due to previously discussed methodological discrepancies between related past works examining differential effectiveness as a function of emotional intensity (e.g., Sauer et al., 2016; Shafir et al., 2015; Sheppes et al., 2011) and this one. These findings may also be due to previously discussed similarities between mindful awareness and distraction, compared to the clearer distinctions between cognitive reappraisal and distraction, which are the strategies used in similar works (Sauer et al., 2016; Shafir et al., 2015; Sheppes et al., 2011). Last, as previously discussed, it is possible that the standardized emotion induction paradigms in the laboratory do not elicit a sufficient level emotional reactivity required to influence emotion regulation strategy effectiveness differentially. The emotion induced within the present study may not have elicited beyond the “low to moderate” range of emotional intensity and, if this were the case, one would expect equivalent effectiveness of mindful awareness and distraction in relation to emotional reactivity. Perhaps if individuals were facing their “real life stressors” in the “real world”, sufficiently high emotional reactivity could be provoked to produce differential effectiveness of the two strategy types. Work examining the differential effectiveness of these strategies in individual’s real lives facing their own, more authentic stressors, would be required to investigate this.

Response-focused emotion predicting effectiveness of strategies- examining diagnostic group differences. We also investigated whether the impact of reactivity on emotion regulation was moderated by group status (i.e., BPD or HC) and, further, whether group status moderated the *differential* impact of emotional reactivity on emotion regulation strategies. For the most part, we did not find evidence of this. Indeed, our results indicate that emotion regulation in individuals with BPD and HCs is largely equally affected by response-focused emotion. As some research demonstrates comparable emotional reactivity and emotion regulation across BPD and HC groups (Feliu-Soler et al., 2013; Jacob et al., 2009; Kuo & Linehan, 2009; Scott et al., 2013; Staebler et al., 2009), our lack of statistically significant findings indicate that, in addition to being of similar magnitudes across groups, the *relationship* between these variables is also similar.

The moderating effect of group on the relationship between emotional reactivity and emotion regulation: Corrugator supercilii activity. There was one exception to the lack of statistically significant findings involving group status and emotional reactivity: group status had a moderating effect on the relationship between emotional reactivity and emotion regulation effectiveness as indicated by corrugator supercilii activity. Specifically, higher emotional reactivity in the HC group diminished emotion regulation effectiveness but, for the BPD group, did not impact it. That HCs experienced diminished emotion regulatory effectiveness as a result of heightened reactivity is inconsistent with our aforementioned findings that higher emotional reactivity facilitates emotion regulation effectiveness. It seems that, when it comes to behavioural/expressive domains of emotional responding, for HCs at least, this is not the case.

This finding is in conflict with other results, which suggested that high emotional reactivity facilitates emotion regulation effectiveness. As discussed, it is possible that there is an optimal range of emotional reactivity for emotion regulation such that levels that are “too high” or “too low” diminish emotion regulation effectiveness. Perhaps the high emotional reactivity values within the HC group exceeded this range, resulting in an inhibition of emotion regulation processes, rather than the facilitation observed in other domains. As previously discussed, heightened emotional reactivity as evident in the behavioural/expressive domain may be particularly intense as emotional expression occurs late in the emotion generative cycle (Gross, 1998). Thus, an intense emotional response in this domain may have needed to be sufficiently pronounced enough to “travel through” the other stages of emotional responding and remained sufficiently intense. In this case, it could be that HCs who experienced this heightened level of emotional reactivity experienced it to a sufficiently high level that it no longer facilitated emotion regulation, as was the case in the experiential and HR domains, but began to inhibit it.

Importantly, the impact of emotional reactivity on emotion regulatory effectiveness as indexed by corrugator supercilii activity was not observed within the BPD group. One

explanation for this finding may involve differences between BPD and HC groups in behavioural/expressive tendencies. BPD feature severity is associated with greater use of expressive suppression to regulate emotions (Salsman & Linehan, 2012). It is possible that, unlike the HCs, the individuals with BPD who had heightened experiential emotional reactivity utilized expressive suppression to regulate their emotions during the emotion regulation period. This behaviour would have resulted in the appearance of emotion regulation effectiveness in the behavioural/expressive domain, because it would result in a reduction in expressive responding. It is therefore possible that habitual expressive tendencies in the BPD group confounded the relationship between emotional reactivity and regulation in this group, but not for HCs, who are less likely to engage in this behaviour.

Chapter VIII: Clinical Implications, Limitations, and Future Directions

Clinical Implications

This dissertation was ultimately devised with two clinically focused goals: (1) to identify factors that, when targeted alongside emotion regulation-based BPD treatments, can optimize these treatments (“working better”); (2) to identify factors that clinicians and clients can use to guide emotion regulation strategy selection, by indicating which strategies are the most likely to be optimally effective for that particular individual at a given point in time (“working smarter”). Study results provide important information towards both of these ends. As discussed, the present study’s findings suggest that SQ is a key factor that influence emotion regulation effectiveness, and may have a differential impact depending on what emotion regulation strategy is being used (i.e., wherein improved SQ tends to improve distraction effectiveness, but do not effect or exacerbate mindful awareness effectiveness). The present study’s findings also suggest that one’s baseline biological vulnerability and state emotional reactivity are key factors that likely influence emotion regulation effectiveness, regardless of which emotion regulation strategy is being used.

Using sleep quality to improve emotion regulation and select the optimal emotion regulation strategy. Our findings indicate that higher SE and rated SQ could improve the emotion regulation effectiveness of distraction specifically, but not necessarily mindful awareness. There are several important implications that can be derived from this finding. First, for clients with high SE and rated SQ, disengagement strategies are likely to be particularly effective for them. However, for clients with lower SE and rated SQ, engagement and disengagement strategies may be more equivalent in effectiveness. Given that theory highlights greater benefits to engagement strategy than disengagement strategy use (Gross & John, 2003; Sheppes et al., 2011), clinicians are advised to encourage the latter strategies for low SE and rated SQ clients. This finding also suggests that, if clinicians and clients are in a situation where it is imperative that the emotion regulation strategy work (i.e., a suicidal crisis), and clients have high SE or rated SQ, disengagement strategies (distraction) are the

optimal ones to utilize. Second, given the high emotional intensity that characterizes individuals with BPD, improving the effectiveness of any emotion regulation strategy is a positive outcome for those with BPD. Given that higher SE and rated SQ improved the effectiveness of distraction in *both* individuals with BPD and HCs, targeting SQ may facilitate at least disengagement emotion regulation in this group.

Third, our post-hoc analyses suggest that targeting variability in sleep times is particularly important to improving emotion regulation specifically in BPD. Indeed, rise time variability seemed to be both particularly characteristic of, and problematic for, individuals with BPD attempting to regulate their emotions. This is a particularly important finding given the exorbitant rates of impaired SQ such as lower rated SQ and SE, and higher rise time variability, in BPD (Winsper et al., 2017). Indeed, in our sample, 80% of individuals with BPD had at least a lifetime diagnosis of insomnia. Unlike BPD treatment, insomnia-based sleep treatments that can improve SE and rated SQ, and increase the stability in rise times, can be implemented very quickly (i.e., between one and four sessions; Edinger, Wohlgemuth, Radtke, Coffman, & Carney, 2007) and are thus very low in labour and resource demands. The costs of incorporating insomnia interventions into emotion regulation based treatments is thus very low, and such an incorporation promises potentially high gains in improving the effectiveness of at least some (disengagement) emotion regulation strategies in BPD. Given the prevalence of insomnia in this population, and the relationship between these variables and emotion regulation, BPD clinicians are advised to seek training in the treatment of insomnia to augment their existing interventions.

Identifying ways to improve basal vagal tone. That antecedent-focused biology (basal vagal tone) also predicted improved emotion regulation effectiveness across emotion regulation strategy conditions and groups also bears important clinical implications. This finding suggests that one way that emotion regulation effectiveness can be improved among individuals with BPD is to identify ways to improve basal vagal tone.

There is a small but burgeoning body of literature in this area. For example, there is evidence that yoga practitioners have higher resting vagal tone than non-yoga practitioners and those with a metabolic syndrome (Tyagi et al., 2016), suggesting that regular mindfulness practices such as yoga may have the capacity to increase vagal tone over time. Another study demonstrated that basal vagal tone can be increased through positive emotions (elicited through loving-kindness meditation), and that this relationship is mediated by positive perceived social connection (Kok et al., 2013). Basal vagal tone, accordingly, is purported to increase one's proclivity for positive emotion. These researchers thus reasoned that the increase in positive emotion, perceived social connection, and vagal tone interact in an "upward spiral" that continually reinforce each other over time (Kok et al., 2013). Although there are a few skills that emphasize positive emotion in DBT (i.e., accumulating positive experiences; Linehan, 2015), the vast majority of emotion regulation skills are focused understandably on the downregulation of negative affect. It is possible that adjunct interventions that draw on positive psychology, or seek to upregulate positive affect, may have a potentiating effect on emotion regulation strategies above and beyond the downregulation of negative affect (i.e., a primary aim of most interventions) because they increase resting vagal tone over time.

Moreover, Kok and colleagues' (2012) work importantly highlights that positive social connections are critical to increasing vagal tone over time. This is particularly relevant to BPD as this disorder is characterized by intense interpersonal conflict and distress (Bouchard, Sabourin, Lussier, & Villeneuve, 2009; Clifton, Pilkonis, & McCarty, 2007; Hill et al., 2008; Hill et al., 2011). Interpersonal conflict is also a particularly stable feature of BPD, as research shows that, while other features of BPD improve over the course of six years, interpersonal dysfunction and distress does not (Zanarini, Frankenburg, Hennen, Reich, & Silk, 2005). Directly improving interpersonal functioning and relationships in the lives of individuals with BPD may thus be one method of improving resting vagal tone, and

accordingly emotion regulation effectiveness. It may thus be advisable for clinicians to focus on improving the quality of individuals with BPD's relationships as a key treatment target.

Emotional reactivity isn't necessarily a “bad thing”. Our finding that higher levels of emotional reactivity actually *facilitate* emotion regulation effectiveness across both emotion regulation strategies, while surprising, is also particularly noteworthy. Current rhetoric in emotion regulation treatments often indicate that disengagement strategies such as distraction need to be used in situations in which emotional reactivity is high. Conversely, engagement strategies such as mindful awareness are purported to be optimally effective in moderate to low emotional intensity situations (Linehan, 2015). Although possibly due to methodological limitations, in our study, this was not the case. Given the compelling theory and research that suggests that engagement strategies are crucial to long-term emotional well-being (Gross & John, 2003; Sheppes et al., 2011), “protecting” clients from engagement strategies when they have a large emotional reaction may be counter-productive. In fact, high emotional reactivity may actually facilitate the use of these strategies. Based on our findings, paired with theory on the purported benefits of using engagement strategies in the long term (Sheppes et al., 2011; Sheppes & Gross, 2011), clinicians are advised to be discerning in their use of disengagement strategies based on emotional reactivity levels. Indeed, treatment outcomes might be enhanced if clinicians resist the urge to immediately offer a disengagement strategy simply because an emotional reaction is large, as engagement strategies may be equally effective but with more beneficial long-term gains. However, as discussed, perhaps there is a range of “optimal emotional intensity” that facilitates emotion regulation, such that anything above or below that range obstructs it. This remains an open empirical question, and it is possible that there are magnitudes of emotional reactions that are so large, that a disengagement strategy is required to regulate them. This study may not have elicited such magnitudes, and the use of disengagement strategies under such emotional circumstances may still be warranted.

The emotional reactivity findings also provide one additional important psychoeducational component for individuals with BPD; emotional reactivity is not necessarily a “bad thing”. In fact, it might be helpful. Our anecdotal clinical experience suggests that many individuals with BPD exhibit high levels of shame and self-loathing in relation to the fact that their emotional reactions are so much larger than others. Such shame is unjustified in the context of the present study findings and the broader developmental literature which suggests that higher emotional reactivity is associated with a higher generally capacity to flexibly respond to the emotional environment (e.g., Beauchaine, 2001). These findings may be used to dispel myths and their associated shame that emotional reactions are inherently problematic.

Improving understanding of BPD and its relationship to emotion regulation.

Finally, the lack of statistically significant findings involving group (BPD versus HC) as a moderator bear important diagnostic and treatment implications. Although there are a few exceptions, most of the findings in the present study suggest that SQ, basal vagal tone, baseline emotional intensity, and emotional reactivity all influence emotion regulation in the same way (or not), regardless of diagnostic status. These findings suggest that, for the most part, the relationships between factors that influence emotion regulation effectiveness and emotion regulation are largely uniform across diagnostic status. Rather, these factors influence emotion regulation regardless of diagnostic status, and individuals with BPD may exhibit difficulties with emotion regulation simply because they are more likely to possess some of these factors, such as lower SQ and low vagal tone (e.g., Kuo & Linehan, 2009; Selby, 2013). Of note, although Linehan’s (1993a) theory defines emotion dysregulation in BPD as dysfunction in emotional intensity variables (e.g., baseline emotional intensity, emotional reactivity) and difficulties with regulation, it does not specify the relationship between these variables. Our findings further the literature by suggesting that there is no “dysfunction” in the relationship between these variables in BPD.

Moreover, the rare findings suggesting that the relationships between SQ and emotional reactivity with emotion regulation were distinct between groups indicate that this was because these relationships were evident in HCs and not within the BPD group. Thus, it is possible that if there is something distinct about emotion regulation processes in BPD, it is that their emotion regulation systems are more *rigid* and less responsive to external or internal influence. This may be in keeping with research suggesting that BPD is characterized by lower basal vagal tone (Kuo et al., 2009; 2015; Weinberg et al., 2009), indicating a potentially less responsive emotion system in general. Indeed, although BPD has traditionally been understood as a disorder of “hyper emotionality” our data suggest that it might be better characterized as a disorder of emotional rigidity. As there is a growing trend in emotion regulation research that emphasizes that flexibility and responsivity in emotion processes as crucial to optimal functioning (Aldao et al., 2015), examining rigidity in emotion regulation processes in BPD may be the key to understanding the emotion-related “dysfunctions” in this group.

Limitations and Future Directions

Limitations in the assessment of study outcomes and future directions for emotion regulation research. Despite these important clinical implications, this study is also limited in numerous ways, and these limitations highlight key directives for future research. First, the present work specifically focused on emotion regulation effectiveness in the context of a laboratory setting. However, there are many ways in which emotion regulation can be disrupted; Gross and Jazaieri (2014), for example, highlight that emotion regulation can be deficient because of low levels of emotional awareness, problematic emotion regulation goals (i.e., problematic prioritization of short-term emotion regulatory goals over important long-term ones, such as the use of substances or self-harm to temporarily reduce negative emotional intensity despite long-term destructive consequences), or problematic emotion regulation strategies (i.e., the selection of inappropriate emotion regulation strategies). Moreover, there is a burgeoning body of literature which suggests that emotion regulation

health is indexed not by the extent to which individuals can use one particular strategy or another, but by their flexibility in being able to apply a range of strategies appropriately to many different situations (Aldao & Nolen-Hoeksema, 2012). This study thus only investigated one way that emotion regulation might be disrupted (i.e., emotion regulation effectiveness), although there are many other forms of emotion regulation deficiency that might be impacted by the variables studied in this work. Future research should examine the impact of both antecedent and response-focused factors on these other emotion regulation domains in BPD.

Related, it is possible that the way emotion regulation effectiveness was quantified in this study did not allow for a thorough assessment of the effectiveness of engagement mindful awareness. Given that engagement strategies involve engaging with emotional content in the interest of long-term learning, it is plausible that these strategies necessarily involve brief escalations in, or at least a temporarily prolonging of, negative emotional intensity. However, such short-term escalations may not necessarily indicate ineffectiveness of these strategies, as they were interpreted in this study. In fact, the benefit of engagement strategies may be qualitatively different from that of disengagement ones and such escalation or prolonging of emotion may indicate that the strategy is being properly implemented. Whereas the benefit of disengagement strategies may be the reductions in short term emotional intensity examined in this study, engagement strategies may not consistently produce such reductions, but may instead offer reduced emotional reactivity in future situations or general improvements in emotion regulation over time. If this is the case, comparing the differential influence of the factors examined in this study on engagement versus disengagement strategies' ability to reduce emotional intensity in a 2.5 minute window may not produce an accurate comparison of the ways in which these strategies can impact emotion. Comparing these strategies in both the short-term and long-term would yield a much more comprehensive understanding of what they can offer to individuals, how they offer it, and whether their potential gains are modulated by various factors.

Moreover, research suggests that abnormalities in some emotion processes in BPD might be specific to the emotion elicited (Koenigsberg et al., 2002). It is similarly possible that emotion regulation strategies are optimally effective in regulating some specific emotions, but not others. All of the indices of emotion regulation effectiveness in this study were general ones that indexed negative emotional intensity broadly, without indicating which specific emotions are or are not being regulated. It is entirely possible that the strategies examined in this study were differentially effective as a function of the factors examined, but only as indexed by specific emotions. Future investigations of emotion regulation processes in BPD would be substantially more comprehensive and informative if they involved assessments of specific emotions.

In addition, this study examined the general and differential effectiveness of engagement versus disengagement strategies between only two emotion regulation strategies, distraction and mindful awareness. Findings may not generalize beyond these specific emotion regulation strategies to the broader classes of engagement and disengagement. This limitation is also particularly important in light of previously discussed (re)conceptualization that mindful awareness may not be fully classifiable as an engagement strategy because, like disengagement strategies, it involves attention manipulation. This possibility particularly limits the impact with which findings pertaining to mindful awareness can be generalized to other emotion regulation strategies. Future examinations of factors that generally and differentially impact emotion regulation in BPD would be substantially stronger if they examined a wide range of emotion regulation strategies. Indeed, it is possible that differential effectiveness may not even fall along an engagement versus disengagement strategy axis, but rather another form of classifying and distinguishing between emotion regulation strategies would be particularly useful for this group.

One final limitation of the assessment of emotion regulation involves the use of EMG data. As an index of emotional intensity, EMG data is typically utilized in methodologies that examine very brief changes in emotion to discrete stimuli (e.g., brief changes in response to a

distressing image presented for between six to ten seconds; Baschnagel et al., 2013; Deveney & Pizzagalli, 2008; Larsen, Norris, & Cacioppo, 2003; Lee et al., 2009). This is because the changes in facial expression that EMG is theorized to index are typically of very brief duration (i.e., seconds), rather than ones that change over minutes (Tassinary, Cacioppo, & Vanman, 2007). Though there is a precedent for studies examining changes in EMG over longer durations (i.e., minutes; Gomez, Zimmermann, Guttormsen-Schar, & Danuser, 2005; Rushby et al., 2013), it is not entirely clear whether alterations in EMG activity over these durations purely reflect reductions in emotional intensity per se, or alternative confounding variables such as increases in task difficulty or effort (de Morree & Marcora, 2010). The EMG emotion regulation indices are thus somewhat confounded, which limits the extent to which conclusions can be drawn from them. A more optimal use of EMG to study emotion regulation would involve examining changes in EMG after a very brief implementation of an emotion regulation strategy.

Limitations and future directions for the study of antecedent-focused predictors.

One strength of the study was its assessment of both antecedent-focused and response-focused predictors, which informed multiple potential points of intervention to improve emotion regulation. Indeed, clients may work on improving chronic antecedent-factors such as SQ and basal vagal tone in therapy, while utilizing specific skills to respond to varying levels of response-focused factors (i.e., emotional reactivity) in the moments in which an emotional response is provoked. However, there are many other potential antecedent- and response-focused factors that could be important to examine and were not studied in this work. For example, other antecedent factors that could be relevant to emotion regulation is, as discussed, perceived social support or interpersonal functioning (Bouchard et al., 2009; Clifton et al., 2007; Hill et al., 2008; Hill et al., 2011) and potentially destructive behaviours that often co-occur with BPD such as substance use (e.g., Trull, Sher, Minks-Brown, Durbin, & Burr, 2000). Similarly response-focused predictors such as the *type* of emotional stimulus (i.e., interpersonal rejection versus non-interpersonal; Limberg et al., 2011), the specific emotion

elicited (Koenigsberg et al., 2002), and whether urges to engage in specific BPD-relevant behaviours (e.g., suicidal behaviour; Soloff, Lynch, & Kelley, 2002) arise may also be relevant to both the general and differential effectiveness of emotion regulation strategies.

In addition to its assessment of emotion and emotion regulation, this study is also limited by its narrow assessment of SQ. As mentioned, there is evidence that various domains of sleep might be disrupted in BPD and may impact emotion regulation processes, such as abnormalities in sleep phases and circadian disruptions (Winsper et al., 2017). It is plausible that the reason that there were not more statistically significant findings indicating that SQ impacts emotion regulation in BPD was because the wrong markers of SQ were studied. A particularly important direction for future research is to study the impact of other sleep disruptions on general and differential emotion regulation effectiveness, such as circadian rhythms, sleep architecture, general fatigue, and sleepiness. Another potential limitation involves the use of one one-week, instead of two-weeks, of SQ, and particularly SE, assessment using the CSD. While research indicates that the greatest variability in sleep parameters as measured by sleep diaries diminishes within the first seven nights (Wohlgemuth et al., 1999), it also indicates that approximately 12 days of CSD recording is optimal to provide strong stability of SE in people with insomnia from home (Wohlgemuth et al., 1999). Therefore, some indices of SQ, particularly SE, may not have achieved adequate stability, and may be somewhat confounded.

Moreover, several theories highlight that lower SQ impairs not only emotion regulation processes in BPD, but emotions more generally by increasing negative emotional intensity (see Baglioni et al., 2010 and Kahn et al., 2013, for review). It is possible that SQ influences emotion regulation *because* they exacerbate baseline intensity and/or emotional reactivity. This study, however, did not study the linkages between the identified predictors of emotion regulation (i.e., SQ and baseline intensity or reactivity). A mediational model examining whether lower SQ influences emotion regulation indirectly through an influence on baseline emotional intensity and emotional reactivity may be particularly illuminating and

aligned with theory and research on the impact of sleep on the broader emotion system (Baglioni et al., 2010; Kahn et al., 2013). Relatedly, research and theory also suggests that the relationship between lower SQ and emotion processes is a bidirectional one, such that, while SQ influences emotion processes, they also exacerbate SQ (Kahn et al., 2013). This work did not investigate the potential influence of emotion processes on SQ, which would have yielded a much more holistic and nuanced understanding of the relationship between these variables. Future works should investigate the bidirectional relationships between sleep and emotion/emotion regulation in BPD.

Furthermore, studying emotion regulation effectiveness in a laboratory context allowed for greater precision in isolating factors that influence emotion regulation, and generally, enhancing internal validity. However, as previously discussed, it is possible that the kind of response-focused emotion elicited by standardized laboratory paradigms is notably distinct from that elicited from the real world stressors in individuals with BPD's lives. Furthermore, perhaps emotion regulation strategies are relatively easy for individuals with BPD to implement when they are in a controlled and isolated laboratory environment, but this is not the case in the real world. The external validity of these findings is thus somewhat unclear. Future works would extend these findings substantially by examining whether they can generalize to emotion and emotion regulation processes as they are occurring in the real world through experience sampling or ambulatory monitoring methodologies.

Concluding Remarks

Regardless of these limitations, this study makes several substantial contributions to the literature. This study is one of the first to attempt to identify both antecedent- and response-focused factors that influence emotion regulation and indicate which type of emotion regulation strategies are optimally effective given these factors. It is also one of the first studies to comprehensively examine both antecedent-focused and response-focused predictors in relation to emotion regulation in BPD. The emphasis of identifying which strategies are optimally effective at a specific point in time fits within a broader trend in the

literature to understand healthy emotion regulation strategy use as dependent on a range of contextual factors (Aldao, 2013; Aldao & Nolen-Hoeksema, 2012; Aldao et al., 2015; Bonanno & Burton, 2013). Our findings suggest that antecedent-focused biology (i.e., baseline RSA) and response-focused emotion (i.e., emotional reactivity) influence emotion regulation effectiveness, and that antecedent-focused behaviour (i.e., SQ) differentially influence the effectiveness of disengagement strategies versus engagement ones. It is our hope that this study is amongst the first to begin to understand the broader emotional, biological, and behavioural contexts in which emotion regulation is nested, and use the increasingly nuanced understanding of emotion regulation to improve the lives of those with BPD.

Appendices
APPENDIX A
Self-Report Measures in the Present Study

Demographics Form

1. **What is your age:** _____
2. **What is your date of birth (dd/mm/yy):** _____ / _____ / _____
3. **What is your sex:** ☐ male ☐ female
4. **Were you born in Canada?** ☐ yes ☐ no
 - a. **If not:** In what country were you born? _____
 - b. At what age did you move here? _____
5. **What is your ethnic background?**
 - ☐ White/Caucasian/European Origin
 - ☐ Aboriginal Canadian/First Nations/Métis/Inuit
 - ☐ Black-Canadian/Black/Caribbean Origin
 - ☐ Chinese or Chinese Canadian
 - ☐ Japanese or Japanese Canadian
 - ☐ Korean or Korean Canadian
 - ☐ Other Asian or other Asian Canadian
 - ☐ Mexican or Mexican Canadian
 - ☐ Puerto Rican
 - ☐ Other Hispanic/Latino
 - ☐ East Indian
 - ☐ Middle Eastern
 - ☐ Bi-racial/Multi-racial
 - ☐ Other (please specify): _____
6. **What religion do you practice or identify with?**
 - ☐ Protestantism
 - ☐ Catholicism
 - ☐ Judaism
 - ☐ Islam
 - ☐ Hindu
 - ☐ Buddhism
 - ☐ Agnosticism or Atheism
 - ☐ Other (Please specify): _____
7. **What is the highest grade of formal education that you completed?**
 - ☐ grade eight or less
 - ☐ some high school
 - ☐ GED
 - ☐ high school graduate
 - ☐ some college/university
 - ☐ college diploma
 - ☐ undergraduate degree
 - ☐ masters degree
 - ☐ doctoral degree
8. **Please estimate your gross annual income (before taxes) for the last year:**
 - ☐ less than \$20,000
 - ☐ \$20,000-35,000
 - ☐ \$35,001-70,000

- ☐ \$70,001-92,000
- ☐ \$92,001-114,000
- ☐ \$114,001-150,000
- ☐ \$150,001-200,000
- ☐ greater than \$200,000

9. What is your relationship status?

- ☐ single, never married
- ☐ dating, never married
- ☐ separated
- ☐ divorced
- ☐ married/common law partner/life partner
- ☐ other (please specify): _____

10. What is your profession/occupation?

11. Do you consider yourself to be:

- ☐ Heterosexual/straight
- ☐ Gay/Lesbian
- ☐ Bisexual
- ☐ Other (please specify): _____

12. People are different in their sexual attraction to other people. Which best describes your feelings? Are you:

- ☐ Only sexually attracted to women?
- ☐ Mostly sexually attracted to women?
- ☐ Equally sexually attracted to women and men?
- ☐ Mostly sexually attracted to men?
- ☐ Only sexually attracted to men?
- ☐ Not sure?

13. Please list the current medications that you are taking:

14. Do you have any current serious medical conditions? If so, please list:

Have any of your closest relationships been troubled by a lot of arguments or repeated breakups?	YES	NO
Have you deliberately hurt yourself physically (e.g., punched yourself, cut yourself, burned yourself)? How about made a suicide attempt?	YES	NO
Have you had at least two other problems with impulsivity (e.g., eating binges and spending sprees, drinking too much and verbal outbursts)?	YES	NO
Have you been extremely moody?	YES	NO
Have you felt very angry a lot of the time? How about often acted in an angry or sarcastic manner?	YES	NO
Have you often been distrustful of other people?	YES	NO
Have you frequently felt unreal or as if things around you were unreal?	YES	NO
Have you chronically felt empty?	YES	NO
Have you often felt that you had no idea of who you are or that you have no identity?	YES	NO
Have you made desperate efforts to avoid feeling abandoned or being abandoned (e.g., repeatedly called someone to reassure yourself that he or she still cared, begged them not to leave you, clung to them physically)?	YES	NO

Difficulties with Emotion Regulation Scale (DERS; Gratz & Roemer, 2004)

Please indicate how often the following statements apply to you by writing the appropriate number from the scale below on the line beside each item:

1-----	2-----	3-----	4-----	5-----
almost never	sometimes	about half the time	most of the time	almost always
(0-10%)	(11-35%)	(36-65%)	(66-90%)	(91-100%)

- 1) I am clear about my feelings. _____
- 2) I pay attention to how I feel. _____
- 3) I experience my emotions as overwhelming and out of control. _____
- 4) I have no idea how I am feeling. _____
- 5) I have difficulty making sense out of my feelings. _____
- 6) I am attentive to my feelings. _____
- 7) I know exactly how I am feeling. _____
- 8) I care about what I am feeling. _____
- 9) I am confused about how I feel. _____
- 10) When I'm upset, I acknowledge my emotions. _____
- 11) When I'm upset, I become angry with myself for feeling that way. _____
- 12) When I'm upset, I become embarrassed for feeling that way. _____
- 13) When I'm upset, I have difficulty getting work done. _____
- 14) When I'm upset, I become out of control. _____
- 15) When I'm upset, I believe that I will remain that way for a long time. _____
- 16) When I'm upset, I believe that I'll end up feeling very depressed. _____
- 17) When I'm upset, I believe that my feelings are valid and important. _____
- 18) When I'm upset, I have difficulty focusing on other things. _____
- 19) When I'm upset, I feel out of control. _____
- 20) When I'm upset, I can still get things done. _____
- 21) When I'm upset, I feel ashamed with myself for feeling that way. _____
- 22) When I'm upset, I know that I can find a way to eventually feel better. _____
- 23) When I'm upset, I feel like I am weak. _____
- 24) When I'm upset, I feel like I can remain in control of my behaviors. _____
- 25) When I'm upset, I feel guilty for feeling that way. _____
- 26) When I'm upset, I have difficulty concentrating. _____
- 27) When I'm upset, I have difficulty controlling my behaviors. _____
- 28) When I'm upset, I believe that there is nothing I can do to make myself feel better. _____
- 29) When I'm upset, I become irritated with myself for feeling that way. _____
- 30) When I'm upset, I start to feel very bad about myself. _____
- 31) When I'm upset, I believe that wallowing in it is all I can do. _____
- 32) When I'm upset, I lose control over my behaviors. _____
- 33) When I'm upset, I have difficulty thinking about anything else. _____
- 34) When I'm upset, I take time to figure out what I'm really feeling. _____
- 35) When I'm upset, it takes me a long time to feel better. _____
- 36) When I'm upset, my emotions feel overwhelming. _____
- 37) I feel that if I started crying I would never stop. _____
- 38) If I had to think about the sad and tragic things in my life, I would never recover. _____
- 39) I have to keep tight control over my emotions or else I will be engulfed by sadness. _____

Please read each statement and circle a number 0, 1, 2 or 3 which indicates how much the statement applied to you *over the past week*. There are no right or wrong answers. Do not spend too much time on any statement.

The rating scale is as follows:

- 0 Did not apply to me at all
- 1 Applied to me to some degree, or some of the time
- 2 Applied to me to a considerable degree, or a good part of time
- 3 Applied to me very much, or most of the time

1	I found myself getting upset by quite trivial things	0	1	2	3
2	I was aware of dryness of my mouth	0	1	2	3
3	I couldn't seem to experience any positive feeling at all	0	1	2	3
4	I experienced breathing difficulty (eg, excessively rapid breathing, breathlessness in the absence of physical exertion)	0	1	2	3
5	I just couldn't seem to get going	0	1	2	3
6	I tended to over-react to situations	0	1	2	3
7	I had a feeling of shakiness (eg, legs going to give way)	0	1	2	3
8	I found it difficult to relax	0	1	2	3
9	I found myself in situations that made me so anxious I was most relieved when they ended	0	1	2	3
10	I felt that I had nothing to look forward to	0	1	2	3
11	I found myself getting upset rather easily	0	1	2	3
12	I felt that I was using a lot of nervous energy	0	1	2	3
13	I felt sad and depressed	0	1	2	3
14	I found myself getting impatient when I was delayed in any way (eg, lifts, traffic lights, being kept waiting)	0	1	2	3
15	I had a feeling of faintness	0	1	2	3
16	I felt that I had lost interest in just about everything	0	1	2	3
17	I felt I wasn't worth much as a person	0	1	2	3
18	I felt that I was rather touchy	0	1	2	3
19	I perspired noticeably (eg, hands sweaty) in the absence of high temperatures or physical exertion	0	1	2	3
20	I felt scared without any good reason	0	1	2	3
21	I felt that life wasn't worthwhile	0	1	2	3
22	I found it hard to wind down	0	1	2	3
23	I had difficulty in swallowing	0	1	2	3

24	I couldn't seem to get any enjoyment out of the things I did	0	1	2	3
25	I was aware of the action of my heart in the absence of physical exertion (eg, sense of heart rate increase, heart missing a beat)	0	1	2	3
26	I felt down-hearted and blue	0	1	2	3
27	I found that I was very irritable	0	1	2	3
28	I felt I was close to panic	0	1	2	3
29	I found it hard to calm down after something upset me	0	1	2	3
30	I feared that I would be "thrown" by some trivial but unfamiliar task	0	1	2	3
31	I was unable to become enthusiastic about anything	0	1	2	3
32	I found it difficult to tolerate interruptions to what I was doing	0	1	2	3
33	I was in a state of nervous tension	0	1	2	3
34	I felt I was pretty worthless	0	1	2	3
35	I was intolerant of anything that kept me from getting on with what I was doing	0	1	2	3
36	I felt terrified	0	1	2	3
37	I could see nothing in the future to be hopeful about	0	1	2	3
38	I felt that life was meaningless	0	1	2	3
39	I found myself getting agitated	0	1	2	3
40	I was worried about situations in which I might panic and make a fool of myself	0	1	2	3
41	I experienced trembling (eg, in the hands)	0	1	2	3
42	I found it difficult to work up the initiative to do things	0	1	2	3

The questionnaire presents some statements concerning perceptions people experience sometimes. Please tick off the momentary level of your perception. If you don't experience this perception, you tick off 0. If you tick off 9, your sensation is very strong.

If the perception changes while answering the questions, please rate the perception prior to the change.

Just now ...

1. I cannot feel my body or a part of it.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

2. I have problems with seeing.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

3. I remember an event so vividly that I feel as if I am reliving that event.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

4. I have the impression my body does not belong to me.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

1. I have problems with listening, for example, I hear sounds from nearby as if they come from far away.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

6. I have difficulties in controlling and coordinating my movements.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

7. I was staring off into space and was not aware of the passage of time.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

8. I feel like a robot while doing all my activities.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

9. I cannot speak; I can only whisper or feel like my voice is failing.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

10. I experience burning, a sort of itching, or numbness in parts of my body.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

11. I feel as though I am standing next to or am watching myself do something. actually see myself as if I were looking at another person.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

12. I feel paralyzed, rigid.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

13. I have the impression that other people, objects, and the world around me are not real.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

14. I have the impression that my body or a part of it is insensitive to pain.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

15. I am so absorbed by something that I am not aware of other events happening around me.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

16. I have the impression that I have done something that I cannot remember.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

17. I feel as if I am looking at the world through a fog so that people and objects appear far away or unclear.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

18. I have the impression that I can not have any human feelings.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

19. I am going through a rare sensual experience, like there is lightning or geometrical figures right before my eyes, or strange noises or smells.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

20. I am remaining without any motion.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

21. I am experiencing an alteration of my breathing.

0	1	2	3	4	5	6	7	8	9
---	---	---	---	---	---	---	---	---	---

Visual Analogue Scales (VAS)

How do you feel right now, at the present moment? Rate your response from 0 to 100 on the following items.

Relaxed	Tense
0	100
<div></div>	
Relaxed	Anxious
0	100
<div></div>	
Calm	Angry
0	100
<div></div>	
Unafraid	Afraid
0	100
<div></div>	
Happy	Sad
0	100
<div></div>	
Normal	Unreal
0	100
<div></div>	
Relieved	Uptight
0	100
<div></div>	
Content	Ashamed
0	100
<div></div>	
Non-suicidal	Suicidal
0	100
<div></div>	
No Urges to Harm	Feel like Harming Myself
0	100
<div></div>	
Connected to Others	Lonely or Alone
0	100
<div></div>	
Pleased or satisfied with myself	Disgusted with myself
0	100
<div></div>	
Accepted	Rejected
0	100
<div></div>	

The Insomnia Severity Index (ISI; Bastien, Vallieres, & Morin, 2001)

1. Please rate the current (i.e., last 2 weeks) SEVERITY of your insomnia problem(s):

	None	Mild	Moderate	Severe	Very Severe
Difficulty falling asleep	0	1	2	3	4
Difficulty staying asleep	0	1	2	3	4
Problem waking up too early	0	1	2	3	4

2. How SATISFIED/dissatisfied are you with your CURRENT sleep pattern?

Very Satisfied		Moderately Satisfied		Very Dissatisfied
0	1	2	3	4

3. To what extent do you consider your sleep problem to INTERFERE with your daily functioning (e.g., daytime fatigue, ability to function at work/daily chores, concentration, memory, mood, etc.)?

Not at all interfering	A little	Somewhat	Much	Very much interfering
0	1	2	3	4

4. How NOTICEABLE to others do you think your sleeping problem is in terms of impairing the quality of your life?

Not at all noticeable	A little	Somewhat	Much	Very much noticeable
0	1	2	3	4

5. How WORRIED/distressed are you about your current sleep problem?

Not at all	A little	Somewhat	Much	Very Much
0	1	2	3	4

After a poor night's sleep, which of the following problems do you experience the next day?
Circle all those that apply.

- Daytime fatigue: tired, exhausted, washed out, sleepy.
- Difficulty functioning: performance impairment at work/daily chores, difficulty concentrating, memory problems.
- Mood problems: irritable, tense, nervous, groggy, depressed, anxious, grouchy, hostile, angry, confused.
- Physical symptoms: muscle aches/pain, light-headed, headache, nausea, heartburn, muscle tension.
- None.

General Instructions

What is a Sleep Diary? A sleep diary is designed to gather information about your daily sleep pattern.
How often and when do I fill out the sleep diary? It is necessary for you to complete your sleep diary every day. If possible, the sleep diary should be completed within one hour of getting out of bed in the morning.

What should I do if I miss a day? If you forget to fill in the diary or are unable to finish it, leave the diary blank for that day.

What if something unusual affects my sleep or how I feel in the daytime? If you sleep or daytime functioning is affected by some unusual event (such as an illness, or an emergency) you may make brief notes on your diary.

What do the words “bed” and “day” mean on the diary? This diary can be used for people who are awake or asleep at unusual times. In the sleep diary, the word “day” is the time when you choose or are required to be awake. The term “bed” means the place where you usually sleep.

Will answering these questions about my sleep keep me awake? This is not usually a problem. You should not worry about giving exact times, and you should not watch the clock. Just give your best estimate.

Item Instruction

Use the guide below to clarify what is being asked for each item of the Sleep Diary.

Date: Write the date of the morning you are filling out the diary.

1. *What time did you get into bed?* Write the time that you got into bed. This may not be the times that you began “trying” to fall asleep.
2. *What time did you try to go to sleep?* Record the time you began “trying” to fall asleep.
3. *How long did it take you to fall asleep?* Beginning at the time you wrote in question 2, how long did it take you to fall asleep.
4. *How many times did you wake up, not counting your final awakening?* How many times did you wake up between the time you first fell asleep and your final awakening?
5. *In total, how long did these awakenings last?* What was the total time you were awake between the time you first fell asleep and your final awakening. For example if you woke 3 times for 20 minutes, 35 minutes, and 15 minutes, add them all up ($20+35+15 = 70$ min or 1 hr and 10 min).
6. *What time was your final awakening?* Record the last time you woke up in the morning.
7. *What time did you get out of bed for the day?* What time did you get out of bed with no further attempt at sleeping? This may be different from your final awakening time (e.g. you may have woken up at 6:35 a.m. but did not get out of bed to start your day until 7:20 a.m.)
8. *How would you rate the quality of your sleep?* “Sleep Quality” if your sense of whether your sleep was good or poor.
9. *Comments* If you have anything that you would like to say that is relevant to your sleep feel free to write it here

WEEK 1
Consensus Sleep Diary – Core
Sample

Today's Date	4/5/11							
1. What time did you get into bed?	10:15 p.m							
2. What time did you try to go to sleep?	11:30 p.m							
3. How long did it take you to fall asleep?	55 min.							
4. How many times did you wake up, not counting your final awakening?	3 times							
5. In total, how long did these awakenings last?	1 h 10 min.							
6. What time was your final awakening?	6:35 a.m							
7. What time did you get out of bed for the day?	7:20 a.m							
8. How would you rate the quality of your sleep?	☐ Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good	☐ Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good	☐ Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good	☐ Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good	☐ Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good	☐ Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good	☐ Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good	☐ Very Poor ☐ Poor ☐ Fair ☐ Good ☐ Very Good
9. Comments (if applicable)	I have a cold							

THE EPWORTH SLEEPINESS SCALE (Johns, 1991)

How likely are you to doze off or fall asleep in the following situations, in contrast to feeling just tired? This refers to your usual way of life in recent times. Even if you have not done some of these things recently try to work out how they would have affected you.

Use the following scale to choose the *most appropriate number* for each situation.

0 = would *never* done

1 = *slight* chance of dozing

2 = *moderate* chance of dozing

3 = *high* change of dozing

Situation

Sitting and reading

Watching TV

Sitting, inactive in a public place (e.g., a theater or a meeting)

As a passenger in a care for an hour without a break

Lying down to rest in the afternoon when circumstances permit

Sitting and talking to someone

Sitting quietly after a lunch without alcohol

In a car, while stopped for a few minutes in the traffic

Chance of dozing

Morningness-Eveningness Questionnaire (Horne & Ostberg, 1976)

- Please read each question very carefully before answering.
- Answer ALL questions.
- Answer the questions in numerical order.
- Each question should be answered independently of others. Do NOT go back and check your answers.
- All questions have a selection of answers. For each question place a cross alongside ONE answer only. Some questions have a scale instead of a selection of answers. Place a cross at the appropriate point along the scale.
- Please answer each question as honestly as possible. Both your answers and the results will be kept in strict confidence.

1. Considering only your own “feeling best” rhythm, at what time would you get up if you were entirely free to plan your day?

5:00 – 6:30 AM	5
6:30 – 7:45 AM	4
7:45 – 9:45 AM	3
9:45 – 11:00 AM	2
11:00 AM – 12 NOON	1

2. Considering only your own “feeling best” rhythm, at what time would you go to bed if you were entirely free to plan your evening?

8:00 – 9:00 PM	5
9:00 – 10:15 PM	4
10:15 PM – 12:30 AM	3
12:30 – 1:45 AM	2
1:45 – 3:00 AM	1

3. If there is a specific time at which you have to get up in the morning, to what extent are you dependent on being woken up by an alarm clock?

Not at all dependent	4
Slightly dependent	3
Fairly dependent	2
Very dependent	1

4. Assuming adequate environmental conditions, how easy do you find getting up in the mornings?

Not at all easy	1
Not very easy	2
Fairly easy	3
Very easy	4

5. How alert do you feel during the first half hour after having woken in the mornings?

Not at all alert	1
Slightly alert	2
Fairly alert	3
Very alert	4

6. How is your appetite during the first half-hour after having woken in the mornings?

Very poor	1
Fairly poor	2
Fairly good	3
Very good	4

7. During the first half-hour after having woken in the morning, how tired do you feel?
Very tired	1
Fairly tired	2
Fairly refreshed	3
Very refreshed	4
8. When you have no commitments the next day, at what time do you go to bed compared to your usual bedtime?
Seldom or never later	4
Less than one hour later	3
1-2 hours later	2
More than two hours later	1
9. You have decided to engage in some physical exercises. A friend suggests that you do this for one hour, twice a week, and the best time for him is being 7:00 – 8:00 AM. Bearing in mind nothing else but your own “feeling best” rhythm, how do you think you would perform?
Would be in good form	4
Would be in reasonable form	3
Would find it difficult	2
Would find it very difficult	1
10. At what time in the evening do you feel tired and, as a result, in need of sleep?
8:00 – 9:00 PM	5
9:00 – 10:15 PM	4
10:15 PM – 12:45 AM	3
12:45 – 2:00 AM	2
2:00 – 3:00 AM	1
11. You wish to be at your peak performance for a test, which you know is going to be mentally exhausting and lasting for two hours. You are entirely free to plan your day and considering only your own “feeling best” rhythm, which ONE of the four testing times would you choose?
8:00 – 10:00 AM	6
11:00 AM – 1:00 PM	4
3:00 – 5:00 PM	2
7:00 – 9:00 PM	0
12. If you went to bed at 11:00 PM, at what level of tiredness would you be?
Not at all tired	0
A little tired	2
Fairly tired	3
Very tired	5
13. For some reason you have gone to bed several hours later than usual, but there is no need to get up at any particular time the next morning. Which ONE of the following events are you most likely to experience?
Will wake up at usual time and will NOT fall asleep	4
Will wake up at usual time and will doze thereafter	3
Will wake up at usual time but will fall asleep again	2
Will NOT wake up until later than usual	1
14. One night you have to remain awake between 4:00 – 6:00 AM in order to carry out a night watch. You have no commitments the next day. Which ONE of the following alternatives will suit you best?
Would NOT go to bed until watch was over	1

Would take a nap before and sleep after	2
Would take a good sleep before and nap after	3
Would take ALL sleep before watch	4

15. You have to do two hours of hard physical work. You are entirely free to plan your day and considering only your own “feeling best” rhythm, which ONE of the following times would you choose?

8:00 – 10:00 AM	4
11:00 AM – 1:00 PM	3
3:00 – 5:00 PM	2
7:00 – 9:00 PM	1

16. You have decided to engage in hard physical exercise. A friend suggests that you do this for one hour twice a week and the best time for him is between 10:00 – 11:00 PM. Bearing in mind nothing else but your own “feeling best” rhythm, how well do you think you would perform?

Would be in good form	1
Would be in reasonable form	2
Would find it difficult	3
Would find it very difficult	4

17. Suppose that you can choose your own work hours. Assume that you worked a FIVE-hour day (including breaks) and that your job was interesting and pay by results. Which FIVE CONSECUTIVE HOURS would you select?

5 hours starting between 4:00 AM and 8:00 AM	5
5 hours starting between 8:00 AM and 9:00 AM	4
5 hours starting between 9:00 AM and 2:00 PM	3
5 hours starting between 2:00 PM and 5:00 PM	2
5 hours starting between 5:00 PM and 4:00 AM	1

18. At what time of day do you think that you reach your “feeling best” peak?

5:00 – 8:00 AM	5
8:00 – 10:00 AM	4
10:00 AM – 5:00 PM	3
5:00 – 10:00 PM	2
10:00 PM – 5:00 AM	1

19. One hears about “morning” and “evening” types of people. Which ONE of these types do you consider yourself to be?

Definitely a “morning” type	6
Rather more a “morning” than an “evening” type	4
Rather more an “evening” than a “morning” type	2
Definitely an “evening” type	0

APPENDIX B

Instructions for Training Individuals in Emotion Regulation Strategies

Mindful Awareness Instructions

Derived from and modified based on Erisman and Roemer (2010) and Kuo and colleagues (2016)

For the next several minutes, I'm going to ask you to think about, and try, a particular kind of awareness, called mindfulness. Mindfulness is paying attention in the present moment, with openness and curiosity, and without judgment. We often focus on things other than what is happening in the moment—worrying about the future, thinking about the past, focusing on what is coming next, rather than what is right in front of us. And it is useful that we can do a number of things without paying attention to them. However, sometimes it is helpful to bring our attention, particularly a curious and kind attention, to what we are doing in the moment.

One of the hardest times to be mindful is when we are experiencing a strong emotion, like fear, or sadness, or joy. In those moments, we often want to either hold on to the emotion or get rid of it, rather than allowing it to rise and fall naturally. And sometimes it feels like we can make emotions stay or make them leave, but other times we may find that trying to make an emotion stay makes it leave even faster, while trying to get rid of it keeps it hanging around. Also, emotions can give us important information about our lives, a particular situation, or the way someone we care about is responding to us. So it can be useful for us to notice the emotions we are having as they happen, rather than judging them or trying to change them. We such a nonjudgmental and accepting awareness to any emotional experience, noticing what we feel in our bodies, what thoughts we have, and just letting that experience happen without getting caught up in it. Our feelings will change on their own when we let them be, rather than seeing them as bad or good or something to be changed. This is what we will be asking you to do today.

For example, you might notice that you feel sad [EMOTION], the thought “this is terrible” [THOUGHT] and notice that your heart is beating faster [PHYSIOLOGICAL], and that you feel like crying [URGE]. Don't try to decrease or increase your emotional response, don't try to hold onto it or fight it, but just notice your experience and your emotional response as it comes and goes, without judgment.

Very soon, we are going to play an audio clip that may or may not elicit some distressing thoughts, images, feelings, or emotions. *After you have listened* to the audio clip, rather than attempting to modify these experiences, we would like you to be mindful of what happens in your mind and body. Specifically, after you listen to the clip, you will see a prompt that will say “Please engage in **mindful awareness**.” *Only after you have seen this prompt* we want you to notice how your emotions unfold as you experience them. Do not don't try to control or change your emotion in any way or do anything to avoid it. Rather, just notice and be aware of the entire emotional experience without judgment- notice any emotions that arise, thoughts you might have, any physiological reactions, or any urges you might have. Don't try to change your experience in any way.

In order to examine your understanding of the concept, could you take a moment and notice what's going on in your mind right now? Notice what thoughts are floating through your mind, emotions are occurring, or physiological sensations are happening within your body. I'll give you a minute to notice those things nonjudgmentally, and then describe to me what you've noticed.

[corrects participants if necessary]

Distraction Instructions

Derived from and modified based on Kohl, Rief, and Glombiewski (2013), Kuo and colleagues (under review), and Sheppes, Scheibe, Suri, and Gross (2011)

For the next several minutes, I'm going to describe to you a particular kind of strategy, called distraction. Our attention works like a spotlight. Depending on which thoughts and feelings come into focus, other thoughts and feelings are blanked out. Thus we are able to shift our attention to other aspects to avoid unpleasant thoughts and feelings. It is possible to distract yourself internally, for example by thinking very hard about something completely unrelated to what is upsetting you that is totally emotionally neutral, like the colour of a friend's car or the shiny surface of a trumpet. This is what the strategy "distraction" is.

Experiencing a strong emotion like fear or sadness can be really difficult. In those moments, it can be useful for us to distract ourselves from challenging emotional experiences in order to help us feel less negative. Thus, rather than feeling the negative emotion so intensely, it is useful to focus and shift our attention towards neutral objects, experiences, and things and away from negative thoughts or feelings in order to reduce the negative emotional intensity. This is what we will be asking you to do today.

For example, imagine one of your last visits to the dentist. Maybe at one of those visits you had to experience pain. To endure this pain, you possibly concentrated on something else in your mind like a painting. Perhaps you even tried to think very hard about the detail in that painting. And maybe in your thoughts you planned the rest of the day and were thinking about the things you can do after your visit at the dentist. By means of the distraction you were able to cope with the treatment.

Very soon, we are going to play a tape that may or may not elicit some distressing thoughts, images, feelings, or emotions. *After you have listened* to the audio clip, you will be prompted with a cue that says, "Please engage in distraction." *Only after you have seen this prompt* we would like you to use distraction and thus try your best to feel less negative about what you're hearing by thinking of something that is emotionally neutral and completely unrelated to the story. There are a few ways you can do this. First, you could imagine your neighborhood or other familiar streets. For instance, you could think of biking around campus and the different buildings around you. Second, you could imagine yourself doing everyday tasks, such as taking a shower or making coffee in the morning. You could use any one of these ways (or any other ways that work for you) to distract yourself and help you feel less negative. You don't have to use the same way to distract the whole time but may choose to if you like. Also, when distracting, it's important that you not focus on something that is highly emotional. Try to think of something neutral. For example, we don't want you to think about anything that brings you sadness, fear, anger, or extreme happiness. Does this make sense?

What kinds of things can you think about that are emotionally neutral?

[check participant's examples to ensure that they are able to think of neutral events, correct if necessary]

APPENDIX C

Emotion Induction Scripts

Script 1: Rejection from mother

Context (read before induction): You are a university or college student. You really want to be self-sufficient, but because of the expenses of school, you've moved back in with your mother to help make ends meet. You just found out that you did not pass an exam, but are trying to keep this fact hidden from your mother.

Induction: You walk into the kitchen to say good morning to your mother, but the second her eyes fall upon you they narrow. Her lips purse and face contorts as if she ate something sour when she looks you over. You wonder if you've done something wrong. A jittery feeling of nervousness pulses through your body, and your mother quickly spits out "that's what you're wearing out in public today?". There is a deep, sinking feeling in your chest. Her words are already so upsetting. You can't figure out why it is that you're seem to be repulsive to her, but it makes you feel like some kind of annoying stone in her shoe. It seems like just being in the room is offensive to her. You look down at your clothes, mad at yourself for actually thinking that you looked okay today. Your eyes land on the kitchen table. A rush of heat overcomes your body and you start to sweat as you see that it's the results of your exam – open and clearly read. You're paralyzed with terror. Your mother knows you failed. Noticing where your eyes went she says, "You're such a disappointment. After all my hard work raising you right, how could you have let this happen?!" These words send powerful surges of grief throughout your whole body as your eyes well up. You feel like you're going to be sick. You fall down and beg her to forgive you. You think about how all you want is for her to be proud of you, and you've worked so hard for her approval. Your mind races trying to figure out what you can do to make her happy. Your mother goes on to describe her embarrassment by you- saying that her friend's have children who are successful doctors and lawyers, asking you why you can't be more like them. You can't breathe. Everything around you starts to feel unreal and you're overwhelmingly dizzy. After a minute of examining you, her eyes narrow, and she says in a low and clear voice "sometimes you just make everything so much harder. I can't even look at you right now" Her words pierce you like icy daggers. You fall to your knees in complete and utter misery. In this moment, you realize that your mother doesn't want anything to do with you and has completely rejected you.

Script 2: Rejection from peers¹

Context (read before induction): You are planning a birthday party for yourself and have invited your five closest friends. You've been planning it for some time now, and have invited the people who care about you the most in the whole world.

Induction: Your party is in two hours and you're starting to feel tense about how it is going to go. Your phone rings. It's your friend; [SHE/HE] is calling to let you know that [SHE/HE] won't make it to your birthday party tonight. You think for a second that you hear someone giggle in the background. [SHE/HE] quickly spits out some excuse and then says [SHE/HE] needs to go. There is a tight, clenching knot in your stomach. You wonder; why doesn't [SHE/HE] care about you enough to show up on your birthday? Your phone beeps; it's a text from another friend. [SHE/HE] also won't be making it tonight. You text [HIM/HER] back and ask her why [SHE/HE] can't come and get no response. You try calling [HIM/HER], and [SHE/HE] doesn't answer. You think- why doesn't [SHE/HE] care either? It seems like nobody wants to even be near you on your birthday. Fifteen minutes into the party starting, nobody has arrived. You panic- what if nobody comes?

Your body starts to shake. Thirty minutes after the party was supposed to start, still no one has arrived. No one is coming. Nobody cares. You're all alone. Hot tears stream down your face. You can't control or stop your crying.

To feel better, you go for a walk. You're several blocks from your house when you notice five [WOMEN/MEN] walking on the other side of the street. Your skin is hot and your heart pounds faster as you see that its the five friends you invited to your party. The rejection is so angering. You check your phone, hoping someone, anyone bothered to text you a happy birthday, or maybe that they invited you out, scared of the notion that you mean so little to everyone in the world. Nothing. You turn your phone off and on again. Your whole body feels frozen. Still, no new messages. You feel like a total failure. Nobody cares about you enough to even leave a message, and they all lied just to avoid spending one night with you. You think to yourself- how could you be so loathsome, so repulsive that people would go to such great lengths to avoid you? You've never felt so utterly and completely rejected.

Script 3: Rejection from romantic partner⁶

Context (read before induction): If you currently have a partner, picture them. If you don't, picture a perfect partner who you want to spend the rest of your life with. You have been with your partner for a few years now. You are in love with them and you plan on having a nice life together.

Induction: You arrive home one night after work and you walk into the dimly lit kitchen to see your partner sitting at the table. You are anxious as [SHE/HE] has an expression on [HIS/HER] face that indicates that [SHE/HE] has something serious to say. Before [SHE/HE] begins to speak, you notice that [SHE/HE] seems different. Colder. [SHE/HE] barely even looks at you. For some reason your heart is pounding. You reach out and try to touch [HIS/HER] arm for comfort, but [SHE/HE] pulls [HIS/HER] arm away. "I don't love you," [SHE/HE] says. These are the most painful words you've ever heard. You want to say something, but [HIS/HER] words have paralyzed you. You are disoriented as you lose touch with where you are at the moment. You are stuck inside your own head and your mind is racing as it jumps from thought to thought: why doesn't [SHE/HE] love me? What's so wrong with me? The thought that [SHE/HE] might prefer to be with someone else makes you nauseous and fills you with rage. You beg [HIM/HER] to explain why, as you did everything you could to make it work out. [SHE/HE] seems cold, disinterested, and shrugs "It doesn't matter. I just don't love you anymore. I don't want you.", [SHE/HE] says. You stop breathing. Hearing that is agonizing and you start to shake. You think about the way [SHE/HE] must see you as just a waste of space and all you can feel is pain. You feel totally unlovable. You collapse onto the floor, overcome with sadness. [HIS/HER] words just keep replaying over and over in your head, "I don't love you, I don't want you", as you lie on the floor unable to compose yourself feeling utterly rejected.

⁶ Two versions of script 2 and 3 exist: one in which the friends (script 2) or romantic partner (script 3) are female ("she"), and one in which the friends/romantic partner are male ("he"). The gender of the majority of participant's friends (script 2) and sexual orientation (script 3) was assessed for prior to the inductions, and the scripts that were in accordance with the main gender of participant's friends (script 2) and prospective romantic partners (script 3) were played.

Appendix D

Post-Hoc Generalized Estimating Equations Analyses involving Recent (Night Before) Sleep Efficiency and Quality

Table 37.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Rating Dial

	B (SE)	χ^2	df	p-value
Intercept	2.69 (.26)	129.79	1	.000***
Time	.21 (.05)	32.54	1	.000***
Emotion regulation strategy	-.07 (.22)	.10	1	.76
Dissociation	-.01 (.01)	.85	1	.36
Depression	-.02 (.02)	1.00	1	.32
Recovery	.19 (.17)	1.25	1	.26
Sleep efficiency (night before)	-2.86 (1.91)	1.33	1	.25
Emotion regulation strategy $\times$ Time	.04 (.05)	.88	1	.35
Time $\times$ Sleep efficiency (night before)	.14 (.19)	.01	1	.91
Emotion regulation strategy $\times$ Sleep efficiency (night before)	2.45 (1.88)	1.70	1	.19
Emotion regulation strategy $\times$ Sleep efficiency (night before) $\times$ Time	-.24 (.19)	1.57	1	.21

Note. Dissociation, recovery, and sleep efficiency variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 38.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Rating Dial

	B (SE)	χ^2	df	p-value
Intercept	2.60 (.26)	118.06	1	.000***
Time	.23 (.05)	35.33	1	.000***
Emotion regulation strategy	.03 (.21)	.01	1	.91
Dissociation	-.01 (.02)	.49	1	.48
Depression	-.02 (.03)	.49	1	.48
Recovery	.19 (.14)	1.79	1	.18
Rated sleep quality (night before)	-.14 (.33)	.23	1	.63
Emotion regulation strategy $\times$ Time	.02 (.05)	.13	1	.72
Time $\times$ Rated sleep quality (night before)	-.04 (.05)	.03	1	.86
Emotion regulation strategy $\times$ Rated sleep quality (night before)	.01 (.30)	.001	1	.98
Emotion regulation strategy $\times$ Rated sleep quality (night before) $\times$ Time	.09 (.04)	5.19	1	.02*

Note. Dissociation, recovery, and rated sleep quality variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 39.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Heart Rate

	B (SE)	χ^2	df	p-value
Intercept	73.87 (1.29)	3582.96	1	.000***
Time	-.12 (.17)	.10	1	.75
Emotion regulation strategy	-.39 (.65)	.37	1	.55
Dissociation	-.04 (.05)	.63	1	.43
Depression	.24 (.15)	2.57	1	.11
Recovery	-.27 (.26)	1.09	1	.30
Sleep efficiency (night before)	4.43 (8.51)	.10	1	.75
Emotion regulation strategy $\times$ Time	.15 (.20)	.55	1	.46
Time $\times$ Sleep efficiency (night before)	-.80 (.99)	1.02	1	.31
Emotion regulation strategy $\times$ Sleep efficiency (night before)	-3.52 (2.55)	1.91	1	.17
Emotion regulation strategy $\times$ Sleep efficiency (night before) $\times$ Time	-.37 (.85)	.19	1	.66

Note. Dissociation, recovery, and sleep efficiency variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 40.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Heart Rate

	B (SE)	χ^2	df	p-value
Intercept	73.53 (1.34)	3289.4	1	.000***
Time	-.11 (.17)	.09	1	.76
Emotion regulation strategy	-.22 (.67)	.11	1	.74
Dissociation	-.04 (.06)	.42	1	.52
Depression	.19 (.16)	1.36	1	.24
Recovery	-.22 (.28)	.62	1	.43
Rated sleep quality (night before)	.29 (1.50)	.02	1	.90
Emotion regulation strategy $\times$ Time	.13 (.20)	.39	1	.53
Time $\times$ Rated sleep quality (night before)	-.13 (.20)	.69	1	.41
Emotion regulation strategy $\times$ Rated sleep quality (night before)	-.23 (.73)	.10	1	.75
Emotion regulation strategy $\times$ Rated sleep quality (night before) $\times$ Time	.02 (.19)	.01	1	.93

Note. Dissociation, recovery, and rated sleep quality variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 41.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Respiratory Sinus Arrhythmia

	B (SE)	χ^2	df	p-value
Intercept	6.66 (.15)	2633.15	1	.000***
Time	-.05 (.04)	2.24	1	.13
Emotion regulation strategy	-.07 (.16)	.20	1	.66
Dissociation	.01 (.01)	1.58	1	.21
Depression	-.01 (.02)	.15	1	.70
Recovery	.01 (.12)	.004	1	.95
Sleep efficiency (night before)	.58 (.89)	.47	1	.49
Emotion regulation strategy $\times$ Time	.03 (.05)	.46	1	.50
Time $\times$ Sleep efficiency (night before)	.05 (.14)	1.12	1	.29
Emotion regulation strategy $\times$ Sleep efficiency (night before)	-.03 (.70)	.002	1	.97
Emotion regulation strategy $\times$ Sleep efficiency (night before) $\times$ Time	.19 (.18)	1.04	1	.31

Note. Dissociation, recovery, and sleep efficiency variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 42.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Respiratory Sinus Arrhythmia

	B (SE)	χ^2	df	p-value
Intercept	6.65 (.14)	2751.11	1	.000***
Time	-.05 (.04)	2.12	1	.15
Emotion regulation strategy	-.10 (.15)	.46	1	.50
Dissociation	.003 (.01)	.28	1	.60
Depression	.01 (.02)	.12	1	.73
Recovery	-.03 (.12)	.07	1	.80
Rated sleep quality (night before)	.56 (.16)	6.60	1	.01*
Emotion regulation strategy $\times$ Time	.02 (.05)	.19	1	.67
Time $\times$ Rated sleep quality (night before)	-.10 (.04)	1.62	1	.20
Emotion regulation strategy $\times$ Rated sleep quality (night before)	-.27 (.15)	3.17	1	.08
Emotion regulation strategy $\times$ Rated sleep quality (night before) $\times$ Time	.12 (.05)	6.63	1	.01*

Note. Dissociation, recovery, and rated sleep quality variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 43.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Skin Conductance Responses

	B (SE)	χ^2	df	p-value
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Intercept	.41 (.15)	18.47	1	.000***
Time	-.05 (.04)	2.84	1	.09
Emotion regulation strategy	.22 (.19)	1.35	1	.25
Dissociation	.004 (.004)	.90	1	.34
Depression	.01 (.01)	.92	1	.34
Recovery	-.02 (.04)	.44	1	.51
Sleep efficiency (night before)	1.66 (.97)	7.61	1	.01*
Emotion regulation strategy × Time	-.02 (.06)	.11	1	.75
Time × Sleep efficiency (night before)	-.08 (.43)	3.23	1	.07
Emotion regulation strategy × Sleep efficiency (night before)	-.19 (1.90)	.01	1	.92
Emotion regulation strategy × Sleep efficiency (night before) × Time	-.43 (.63)	.47	1	.49

Note. Dissociation, recovery, and sleep efficiency variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 44.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Skin Conductance Responses

	B (SE)	χ^2	df	p-value
Intercept	.52 (.15)	21.9	1	.000***
Time	-.10 (.04)	5.15	1	.02*
Emotion regulation strategy	.21 (.14)	2.37	1	.12
Dissociation	-.01 (.004)	4.14	1	.04*
Depression	.02 (.01)	4.99	1	.03*
Recovery	-.04 (.04)	.94	1	.33
Rated sleep quality (night before)	.17 (.15)	2.97	1	.09
Emotion regulation strategy × Time	-.02 (.06)	.16	1	.69
Time × Rated sleep quality (night before)	.04 (.04)	.000	1	.99
Emotion regulation strategy × Rated sleep quality (night before)	.09 (.13)	.5	1	.48
Emotion regulation strategy × Rated sleep quality (night before) × Time	-.08 (.05)	2.65	1	.10

Note. Dissociation, recovery, and rated sleep quality variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 45.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Corrugator Supercilii Activity

	B (SE)	χ^2	df	p-value
Intercept	.08 (.14)	.05	1	.82
Time	.01 (.01)	.94	1	.33
Emotion regulation strategy	-.10 (.05)	3.66	1	.06
Dissociation	-.001 (.004)	.07	1	.80

Depression	.02 (.004)	1.42	1	.23
Recovery	.42 (3.03)	.02	1	.89
Sleep efficiency (night before)	-.35 (.88)	.000	1	.99
Emotion regulation strategy × Time	.01 (.02)	2.28	1	.13
Time × Sleep efficiency (night before)	.01 (.02)	.04	1	.84
Emotion regulation strategy × Sleep efficiency (night before)	.71 (.72)	1.00	1	.32
Emotion regulation strategy × Sleep efficiency (night before) × Time	-.03 (.02)	1.79	1	.18

Note. Electromyography predictors and outcomes were z-scores. Dissociation, recovery, and sleep efficiency variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 46.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Corrugator Supercilii Activity

	B (SE)	χ^2	df	p-value
Intercept	.09 (.14)	.09	1	.77
Time	.01 (.01)	.84	1	.36
Emotion regulation strategy	-.10 (.05)	3.66	1	.06
Dissociation	.00 (.01)	.00	1	.99
Depression	.02 (.02)	1.56	1	.21
Recovery	.60 (2.79)	.05	1	.83
Rated sleep quality (night before)	.13 (.23)	.87	1	.35
Emotion regulation strategy × Time	-.01 (.01)	2.53	1	.11
Time × Rated sleep quality (night before)	.01 (.01)	.21	1	.65
Emotion regulation strategy × Rated sleep quality (night before)	.12 (.11)	1.08	1	.30
Emotion regulation strategy × Rated sleep quality (night before) × Time	-.01 (.01)	3.71	1	.05*

Note. Electromyography predictors and outcomes were z-scores. Dissociation, recovery, and sleep quality variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 47.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Sleep Efficiency Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Zygomaticus Major

	B (SE)	χ^2	df	p-value
Intercept	-.22 (.060)	19.67	1	.000***
Time	-.003 (.01)	.19	1	.66
Emotion regulation strategy	-.04 (.05)	.68	1	.41
Dissociation	-.002 (.003)	.37	1	.54
Depression	.01 (.01)	.48	1	.49
Recovery	-1.93 (.22)	78.88	1	.000***

Sleep efficiency (night before)	.32 (.24)	.002	1	.97
Emotion regulation strategy × Time	.01 (.01)	.98	1	.32
Time × Sleep efficiency (night before)	.01 (.02)	1.08	1	.30
Emotion regulation strategy × Sleep efficiency (night before)	-.68 (.51)	1.78	1	.18
Emotion regulation strategy × Sleep efficiency (night before) × Time	-.08 (.06)	2.29	1	.13

Note. Electromyography predictors and outcomes were z-scores. Dissociation, recovery, and sleep efficiency variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 48.

Generalized Estimating Equations Analyses Examining whether Recent (Night Before) Rated Sleep Quality Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Zygomaticus Major

	B (SE)	χ^2	df	p-value
Intercept	-.21 (.07)	18.66	1	.000***
Time	-.004 (.01)	.09	1	.76
Emotion regulation strategy	-.05 (.06)	.72	1	.40
Dissociation	-.003 (.003)	.99	1	.32
Depression	.004 (.01)	.28	1	.60
Recovery	-1.87 (.22)	72.91	1	.000***
Rated sleep quality (night before)	.01 (.08)	.38	1	.54
Emotion regulation strategy × Time	.01 (.01)	.90	1	.34
Time × Rated sleep quality (night before)	-.001 (.01)	.30	1	.58
Emotion regulation strategy × Rated sleep quality (night before)	-.12 (.09)	1.71	1	.19
Emotion regulation strategy × Rated sleep quality (night before) × Time	-.003 (.01)	.09	1	.76

Note. Electromyography predictors and outcomes were z-scores. Dissociation, recovery, and rated sleep quality variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 49.

Generalized Estimating Equations Group Analyses Examining whether Group Status (BPD versus HC) Moderates the Influence of Recent (Night Before) Sleep Efficiency Across All Indices

	χ^2	df	p-value
Rating dial			
Group × time × Sleep efficiency (night before)	.01	1	.94
Group × time × Sleep efficiency (night before) × emotion regulation strategy	.04	1	.83
Heart rate			
Group × time × Sleep efficiency (night before)	1.69	1	.19
Group × time × Sleep efficiency (night before)	1.69	1	.19
Respiratory sinus arrhythmia			
Group × time × Sleep efficiency (night before)	.29	1	.59
Group × time × Sleep efficiency (night before) × emotion regulation strategy	6.75	1	.04*

Skin conductance responses			
Group × time × Sleep efficiency (night before)	.46	1	.50
Group × time × Sleep efficiency (night before) × emotion regulation strategy	.95	1	.33
Corrugator supercilii activity			
Group × time × Sleep efficiency (night before)	4.73	1	.15
Group × time × Sleep efficiency (night before) × emotion regulation strategy	2.63	1	.11
Zygomaticus major activity			
Group × time × Sleep efficiency (night before)	.02	1	.89
Group × time × Sleep efficiency (night before) × emotion regulation strategy	2.69	1	.10

Sleep efficiency variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 50.

Generalized Estimating Equations Group Analyses Examining whether Group Status (BPD versus HC) Moderates the Influence of Recent (Night Before) Rated Sleep Quality Across All Indices

	χ^2	df	p-value
Rating dial			
Group × time × Rated sleep quality (night before)	.96	1	.33
Group × time × Rated sleep quality (night before) × emotion regulation strategy	2.74	1	.10
Heart rate			
Group × time × Rated sleep quality (night before)	2.11	1	.15
Group × time × Rated sleep quality (night before) × emotion regulation strategy	.93	1	.34
Respiratory sinus arrhythmia			
Group × time × Rated sleep quality (night before)	.99	1	.32
Group × time × Rated sleep quality (night before) × emotion regulation strategy	.07	1	.79
Skin conductance responses			
Group × time × Rated sleep quality (night before)	.76	1	.38
Group × time × Rated sleep quality (night before) × emotion regulation strategy	.07	1	.79
Corrugator supercilii activity			
Group × time × Rated sleep quality (night before)	2.03	1	.03*
Group × time × Rated sleep quality (night before) × emotion regulation strategy	.02	1	.89
Zygomaticus major activity			
Group × time × Rated sleep quality (night before)	.38	1	.54
Group × time × Rated sleep quality (night before) × emotion regulation strategy	2.37	1	.12

Rated sleep quality variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Appendix E

Post-Hoc Generalized Estimating Equations Analyses involving Time in Bed

Table 51.

Generalized Estimating Equations Analyses Examining whether Time in Bed Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Rating Dial

	B (SE)	χ^2	df	p-value
Intercept	2.61 (.25)	160.21	1	.000***
Time	.26 (.05)	40.37	1	.000***
Emotion regulation strategy	.14 (.23)	.38	1	.54
Dissociation	-.01 (.01)	.91	1	.34
Depression	-.02 (.02)	.89	1	.35
Recovery	.21(.14)	2.47	1	.12
Time in bed	.01 (.17)	.33	1	.57
Emotion regulation strategy $\times$ Time	-.03 (.05)	.26	1	.61
Time $\times$ Time in bed	-.01 (.04)	1.20	1	.27
Emotion regulation strategy $\times$ Time in bed	.10 (.28)	.14	1	.71
Emotion regulation strategy $\times$ Time in bed $\times$ Time	-.03 (.05)	.40	1	.53

Note. Dissociation, recovery, and time in bed variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 52.

Generalized Estimating Equations Analyses Examining whether Time in Bed Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Heart Rate

	B (SE)	χ^2	df	p-value
Intercept	73.46 (1.17)	4351.98	1	.000***
Time	-.14 (.14)	.06	1	.81
Emotion regulation strategy	-.61 (.59)	1.08	1	.30
Dissociation	-.04 (.04)	1.02	1	.31
Depression	.15 (.15)	1.01	1	.32
Recovery	-.18 (.25)	.53	1	.47
Time in bed	.86 (.76)	2.65	1	.10
Emotion regulation strategy $\times$ Time	.22 (.18)	1.56	1	.21
Time $\times$ Time in bed	.10 (.09)	.46	1	.50
Emotion regulation strategy $\times$ Time in bed	.68 (.35)	3.88	1	.05*
Emotion regulation strategy $\times$ Time in bed $\times$ Time	-.09 (.12)	.62	1	.43

Note. Dissociation, recovery, and time in bed variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 53.

Generalized Estimating Equations Analyses Examining whether Time in Bed Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Respiratory Sinus Arrhythmia

	B (SE)	χ^2	df	p-value
Intercept	6.67 (.15)	3099.16	1	.000***
Time	-.04 (.03)	2.37	1	.12

Emotion regulation strategy	-.16 (.14)	1.27	1	.26
Dissociation	-.01 (.01)	1.15	1	.29
Depression	.01 (.11)	0.13	1	.72
Recovery	.02 (.04)	.00	1	.96
Time in bed	-.01 (.11)	.50	1	.48
Emotion regulation strategy $\times$ Time	.02 (.04)	.33	1	.56
Time $\times$ Time in bed	-.02 (.02)	.69	1	.41
Emotion regulation strategy $\times$ Time in bed	-.10 (.09)	1.34	1	.25
Emotion regulation strategy $\times$ Time in bed $\times$ Time	.02 (.03)	.64	1	.43

Note. Dissociation, recovery, and time in bed variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 54.

Generalized Estimating Equations Analyses Examining whether Time in Bed Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Skin Conductance Responses

	B (SE)	χ^2	df	p-value
Intercept	.62 (.13)	32.65	1	.000***
Time	-.09 (.04)	4.75	1	.03*
Emotion regulation strategy	.08 (.13)	.37	1	.55
Dissociation	.00 (.00)	.01	1	.93
Depression	.01 (.01)	.95	1	.33
Recovery	-.03 (.03)	.65	1	.42
Time in bed	-.001 (.07)	.003	1	.95
Emotion regulation strategy $\times$ Time	.03 (.05)	.35	1	.56
Time $\times$ Time in bed	.01 (.03)	.65	1	.42
Emotion regulation strategy $\times$ Time in bed	-.01 (.09)	.01	1	.93
Emotion regulation strategy $\times$ Time in bed $\times$ Time	.01 (.03)	.05	1	.83

Note. Dissociation, recovery, and time in bed variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 55.

Generalized Estimating Equations Analyses Examining whether Time in Bed Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Corrugator Supercilii Activity

	B (SE)	χ^2	df	p-value
Intercept	.03 (.12)	.02	1	.88
Time	.01 (.01)	.77	1	.38
Emotion regulation strategy	-.08 (.04)	4.23	1	.04
Dissociation	.00 (.003)	.001	1	.97
Depression	.02 (.01)	1.61	1	.20
Recovery	.22 (3.05)	.01	1	.94
Time in bed	-.01 (.09)	.57	1	.45
Emotion regulation strategy $\times$ Time	-.01 (.004)	1.32	1	.25
Time $\times$ Time in bed	-.09 (.06)	.21	1	.65
Emotion regulation strategy $\times$ Time in bed	.000 (.002)	2.36	1	.13
Emotion regulation strategy $\times$ Time in bed $\times$ Time	-.09 (.06)	.03	1	.85

Note. Dissociation, recovery, and time in bed variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 56.

Generalized Estimating Equations Analyses Examining whether Time in Bed Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Zygomaticus Major Activity

	B (SE)	χ^2	df	p-value
Intercept	-.19 (.06)	16.49	1	.000***
Time	-.004 (.004)	.19	1	.66
Emotion regulation strategy	-.06 (.05)	1.68	1	.20
Dissociation	-.003 (.002)	1.43	1	.23
Depression	.004 (.01)	.55	1	.46
Recovery	-1.89 (.21)	83.16	1	.000***
Time in bed	-.03 (.04)	.004	1	.95
Emotion regulation strategy $\times$ Time	.01 (.01)	1.49	1	.22
Time $\times$ Time in bed	-.001 (.003)	.36	1	.55
Emotion regulation strategy $\times$ Time in bed	.07 (.05)	1.96	1	.16
Emotion regulation strategy $\times$ Time in bed $\times$ Time	-.003 (.01)	.17	1	.68

Note. Dissociation, recovery, and time in bed variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 57.

Generalized Estimating Equations Group Analyses Examining whether Group Status (BPD versus HC) Moderates the Influence of Time in Bed Across All Indices

	χ^2	df	p-value
Rating dial			
Group $\times$ time $\times$ Time in bed	.24	1	.62
Group $\times$ time $\times$ Time in bed $\times$ emotion regulation strategy	2.84	1	.09
Heart rate			
Group $\times$ time $\times$ Time in bed	1.20	1	.27
Group $\times$ time $\times$ Time in bed	.007	1	.93
Respiratory sinus arrhythmia			
Group $\times$ time $\times$ Time in bed	1.52		.22
Group $\times$ time $\times$ Time in bed $\times$ emotion regulation strategy	.28		.60
Skin conductance responses			
Group $\times$ time $\times$ Time in bed	.22	1	.64
Group $\times$ time $\times$ Time in bed $\times$ emotion regulation strategy	1.23	1	.27
Corrugator supercilii activity			
Group $\times$ time $\times$ Time in bed	1.26	1	.26
Group $\times$ time $\times$ Time in bed $\times$ emotion regulation strategy	.33	1	.57
Zygomaticus major activity			
Group $\times$ time $\times$ Time in bed	1.10	1	.29
Group $\times$ time $\times$ Time in bed $\times$ emotion regulation strategy	.10	1	.75

Time in bed variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Appendix F

Post-Hoc Generalized Estimating Equations Analyses involving Rise Time Variability

Table 58.

Generalized Estimating Equations Analyses Examining whether Rise Time Variability Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Rating Dial

	B (SE)	χ^2	df	p-value
Intercept	2.61 (.25)	162.96	1	.000***
Time	.26 (.05)	41.06	1	.000***
Emotion regulation strategy	.15 (.23)	0.40	1	.528
Dissociation	-.01 (.01)	1.04	1	.308
Depression	-.02 (.02)	1.12	1	.291
Recovery	.20 (.14)	2.14	1	.143
Rise time variability	.06 (.16)	0.67	1	.415
Emotion regulation strategy $\times$ Time	-.03 (.05)	0.28	1	.60
Time $\times$ Rise time variability	.02 (.03)	0.11	1	.743
Emotion regulation strategy $\times$ Rise time variability	.10 (.13)	0.60	1	.437
Emotion regulation strategy $\times$ Rise time variability $\times$ Time	-.03 (.03)	0.92	1	.337

Note. Dissociation, recovery, and rise time variability variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 59.

Generalized Estimating Equations Analyses Examining whether Rise Time Variability Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Heart Rate

	B (SE)	χ^2	df	p-value
Intercept	70.50 (1.17)	4262.46	1	.000***
Time	-.14 (.14)	.05	1	.83
Emotion regulation strategy	-.59 (.60)	.95	1	.33
Dissociation	-.04 (.05)	.79	1	.37
Depression	.20 (.14)	1.97	1	.16
Recovery	-.19 (.26)	.55	1	.46
Rise time variability	-.55 (.91)	.21	1	.65
Emotion regulation strategy $\times$ Time	.22 (.18)	1.55	1	.21
Time $\times$ Rise time variability	.09 (.08)	1.05	1	.31
Emotion regulation strategy $\times$ Rise time variability	.32 (.41)	.62	1	.43
Emotion regulation strategy $\times$ Rise time variability $\times$ Time	-.02 (.12)	.04	1	.85

Note. Dissociation, recovery, and rise time variability variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 60.

Generalized Estimating Equations Analyses Examining whether Rise Time Variability Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Respiratory Sinus Arrhythmia

	B (SE)	χ^2	df	p-value
Intercept	6.68 (.15)	3068.01	1	.000***
Time	-.05 (.03)	2.32	1	.13
Emotion regulation strategy	-.17 (.14)	1.53	1	.22
Dissociation	.01 (.01)	1.45	1	.23
Depression	-.01 (.01)	0.32	1	.57
Recovery	-.02 (.12)	0.03	1	.87
Rise time variability	.06 (.09)	0.37	1	.54
Emotion regulation strategy $\times$ Time	.03 (.04)	0.36	1	.55
Time $\times$ Rise time variability	-.01 (.02)	.00	1	1.00
Emotion regulation strategy $\times$ Rise time variability	-.20 (.08)	6.29	1	.01
Emotion regulation strategy $\times$ Rise time variability $\times$ Time	.03 (.03)	1.08	1	.30

Note. Dissociation, recovery, and rise time variability variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 61. Generalized Estimating Equations Analyses Examining whether Rise Time Variability Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Skin Conductance Responses

	B (SE)	χ^2	df	p-value
Intercept	.52 (.12)	23.39	1	.000***
Time	-.05 (.04)	2.58	1	.11
Emotion regulation strategy	.09 (.15)	.38	1	.53
Dissociation	.001 (.004)	.15	1	.70
Depression	.01 (.01)	1.05	1	.31
Recovery	-.02 (.04)	.22	1	.64
Rise time variability	-.15 (.08)	1.34	1	.25
Emotion regulation strategy $\times$ Time	.01 (.05)	.02	1	.90
Time $\times$ Rise time variability	.06 (.02)	1.94	1	.16
Emotion regulation strategy $\times$ Rise time variability	.14 (.09)	2.51	1	.11
Emotion regulation strategy $\times$ Rise time variability $\times$ Time	-.07 (.03)	4.58	1	.03*

Note. Dissociation, recovery, and rise time variability variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 62.

Generalized Estimating Equations Analyses Examining whether Rise Time Variability Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Corrugator Supercilii Activity

	B (SE)	χ^2	df	p-value
Intercept	.04 (.12)	.01	1	.91
Time	.01 (.01)	.56	1	.45
Emotion regulation strategy	-.10 (.05)	3.66	1	.06
Dissociation	.001 (.004)	.05	1	.83
Depression	.01 (.01)	1.16	1	.28

Recovery	.53 (3.00)	.03	1	.86
Rise time variability	.03 (.09)	.04	1	.85
Emotion regulation strategy × Time	-.01 (.01)	2.75	1	.10
Time × Rise time variability	.004 (.01)	.29	1	.59
Emotion regulation strategy × Rise time variability	-.03 (.03)	1.02	1	.31
Emotion regulation strategy × Rise time variability × Time	-.003 (.003)	.75	1	.39

Note. Dissociation, recovery, and rise time variability variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 63.

Generalized Estimating Equations Analyses Examining whether Rise Time Variability Predicts General and Differential Emotion Regulatory Effectiveness as Indexed via Zygomaticus Major Activity

	B (SE)	χ^2	df	p-value
Intercept	-.19 (.06)	18.72	1	.000***
Time	-.004 (.004)	.15	1	.70
Emotion regulation strategy	-.06 (.05)	1.39	1	.24
Dissociation	-.003 (.003)	1.21	1	.27
Depression	.003 (.007)	.28	1	.60
Recovery	-1.91 (.22)	74.33	1	.000***
Rise time variability	.08 (.05)	2.68	1	.10
Emotion regulation strategy × Time	.01 (.01)	1.58	1	.21
Time × Rise time variability	-.01 (.003)	1.35	1	.25
Emotion regulation strategy × Rise time variability	-.03 (.04)	.57	1	.45
Emotion regulation strategy × Rise time variability × Time	.000 (.01)	.002	1	.96

Note. Dissociation, recovery, and rise time variability variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Table 64.

Generalized Estimating Equations Group Analyses Examining whether Group Status (BPD versus HC) Moderates the Influence of Rise Time Variability Across All Indices

	χ^2	df	p-value
Rating dial			
Group × time × Rise time variability	2.53	1	.11
Group × time × Rise time variability × emotion regulation strategy	5.47	1	.02*
Heart rate			
Group × time × Rise time variability	3.31	1	.07
Group × time × Rise time variability	9.51	1	.002**
Respiratory sinus arrhythmia			
Group × time × Rise time variability	.21	1	.62
Group × time × Rise time variability × emotion regulation strategy	.08	1	.78
Skin conductance responses			
Group × time × Rise time variability	3.75	1	.05*
Group × time × Rise time variability × emotion regulation strategy	.000	1	1.00

Corrugator supercilii activity			
Group × time × Rise time variability	2.18	1	.14
Group × time × Rise time variability × emotion regulation strategy	.49	1	.49
Zygomaticus major activity			
Group × time × Rise time variability	2.27	1	.13
Group × time × Rise time variability × emotion regulation strategy	1.69	1	.19

Rise time variability variables were mean centered.

* $p < .05$; ** $p < .01$; *** $p < .001$

Appendix G

List of Abbreviations

BPD	Borderline Personality Disorder
CSD	Consensus Sleep Diary
DASS	Depression, Anxiety, and Stress Scales
DERS	Difficulties with Emotion Regulation Scale
DSS	Dissociative State Scale
DSISD	Duke Structured Interview for Sleep Disorders
EMG	Electromyography
ESS	Epworth Sleepiness Scale
GEE	Generalized Estimating Equations
HC	Healthy controls
HR	Heart rate
IPDE-BPD	International Personality Disorders Examination- borderline personality disorder module
MEQ	Morningness-Eveningness Questionnaire
RSA	Respiratory Sinus Arrhythmia
SCID-IV-TR	Structured Clinical Interview for Diagnostic and Statistical Manual of Mental Disorders-IV- Text Revised Edition
SCR	Skin conductance responses
SE	Sleep efficiency
SQ	Sleep quality
SCR	Skin conductance responses

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