Using Ambulatory Assessment to Unravel Specific Patterns of Emotion Dysregulation and Instability in the Daily Life of Patients with Borderline Personality Disorder

Zur Erlangung des akademischen Grades eines

DOKTORS DER PHILOSOPHIE (Dr. phil.)

von der KIT-Fakultät für Geistes- und Sozialwissenschaften des

Karlsruher Instituts für Technologie (KIT)

angenommene

DISSERTATION

von

Tobias D. Kockler

KIT-Dekan: Prof. Dr. Michael Schefczyk

1. Gutachter: Prof. Dr. Ulrich W. Ebner-Priemer

2. Gutachter: Prof. Dr. Martin Bohus

Tag der mündlichen Prüfung: 22. Februar 2021

SUMMARY

In the 11th revision of the International Classification of Diseases (ICD-11), all categorical personality disorders will be replaced by dimensional classifications, except for borderline personality disorder (BPD), which will be represented in the form of a borderline qualifier. While other mental disorders are defined by deficits or excesses, a peculiarity of BPD is its characterization as a pervasive pattern of instability. Ambulatory assessment (AA), i.e., the use of computer-based methodology like electronic diaries (e-diaries) to repeatedly assess self-reported symptoms, behaviors, or physiological processes in individuals' daily lives, has become the gold standard to capture the dynamic course of BPD symptomatology. However, recent AA studies have questioned the BPD specificity of the core feature of BPD, affective instability, which is commonly seen as a transdiagnostic mechanism by now. In this thesis, I took a look at emotion dysregulation and instability in the daily life of patients BPD from a novel perspective, analyzing understudied constructs like emotion sequences, the occurrence of specific emotions, and self-esteem instability. The BPD specificity of these constructs was investigated by comparing BPD samples to multiple clinical control groups and healthy controls (HCs).

In study 1, I examined dysregulated emotion sequences, i.e., patterns of emotion activation, persistence, and down-regulation as well as switches from one emotion to another, in 43 female patients with BPD, 28 patients with posttraumatic stress disorder (PTSD), 20 patients with bulimia nervosa (BN), and 28 HCs. Participants' momentary emotions were assessed in their daily lives, using high-frequency e-diary assessments every 15 minutes for 24 hours. Variance analytic strategies were applied to determine group differences in the relative frequencies of emotion sequences. The study results replicated five previously reported dysregulated emotion sequences in BPD: Compared to HCs, patients with BPD displayed a higher frequency of persisting anxiety

and sadness, more switches from anxiety to sadness, from sadness to anxiety, and from anxiety to anger. However, none of these dysregulated emotion sequences exhibited BPD specificity, i.e., none revealed higher frequencies than the PTSD group or the BN group.

In study 2, the same data set was used to investigate whether patients with BPD exhibit disorder-specific differences in the frequency and intensity of specific emotions as well as the distress associated with these specific emotions. Multilevel analyses revealed that patients with BPD experience all of the assessed negative emotions more frequently and nearly all of the negative emotions more intensely than HCs. Standing out from the otherwise largely transdiagnostic patterns without relevant differences between the clinical groups, patients with BPD experienced anger more frequently than any other study group, demonstrating specificity. No BPD-specific difference was found regarding the intensity of anger, but anger was the only specific emotion that contributed to distress above and beyond emotional intensity.

Study 3 addressed affective instability and the neglected criterion of self-esteem instability. In a large sample comprising 131 patients with BPD, 121 patients with anxiety disorders (ADs), and 134 HCs, momentary self-esteem and affective state were assessed 12 times daily for four consecutive days. Three established instability indices were analyzed in multilevel models to determine group differences in self-esteem instability and affective instability. Both in patients with BPD and with ADs, self-esteem instability and affective instability were higher than in HCs. Importantly, BPD patients' self-esteem instability was significantly higher than that of patients with ADs across all instability indices, while affective instability showed a transdiagnostic pattern, suggesting that self-esteem instability defines BPD more than affective instability.

Future AA studies should use samples covering a wide range of personality patterns to unravel BPD-specific daily life manifestations of personality disorders. Novel AA methods should be applied to capture the social context surrounding emotion dysregulation and instability in BPD.

ZUSAMMENFASSUNG

In der 11. Revision der Internationalen Klassifikation der Krankheiten (ICD-11) werden alle kategorialen Persönlichkeitsstörungen durch dimensionale Klassifikationen ersetzt, mit Ausnahme der Borderline-Persönlichkeitsstörung (BPS), welche auch künftig in Form eines Borderline-Qualifiers diagnostiziert werden kann. Andere psychische Störungen werden durch Defizite oder Exzesse definiert, wohingegen eine Besonderheit der BPS ihre Charakterisierung als tiefgreifendes Muster von Instabilität darstellt. Der Goldstandard um den dynamischen Verlauf der BPS-Symptomatik zu erfassen, ist die Methode des Ambulanten Assessments (AA), worunter man die Verwendung von computergestützten Methoden wie elektronischen Tagebüchern zur wiederholten Erfassung von selbstberichteten Symptomen, Verhaltensweisen oder physiologischen Prozessen im Alltag von Menschen versteht. Neuere AA-Studien haben die Spezifität der als Kernmerkmal für die BPS geltenden affektiven Instabilität in Frage gestellt, sodass diese inzwischen allgemein als transdiagnostischer Mechanismus angesehen wird. Das Ziel in dieser Dissertation war es, die emotionale Dysregulation und Instabilität im Alltag von Individuen mit BPS aus einer Perspektive zu betrachten, indem bislang wenig untersuchte Konstrukte wie Emotionssequenzen, das Auftreten spezifischer Emotionen und die Selbstwertinstabilität erforscht wurden. Die Spezifität dieser Konstrukte für die BPS wurde untersucht, indem Stichproben von Patientinnen mit BPS mit verschiedenen klinischen Kontrollgruppen und gesunden Kontrollgruppen verglichen wurden.

In Studie 1 untersuchte ich in einer Stichprobe von 43 Patientinnen mit BPS, 28 Patientinnen mit posttraumatischer Belastungsstörung (PTBS), 20 Patientinnen mit Bulimia nervosa (BN) und 28 gesunden Kontrollprobandinnen dysregulierte Emotionssequenzen, d.h. Muster emotionaler Aktivierung, Persistenz und Herunterregulierung sowie Wechsel von einer

Emotion zur anderen. Die momentanen Emotionen im Alltag der Teilnehmerinnen wurden in einem hochfrequenten Studiendesign alle 15 Minuten in einem Zeitraum von 24 Stunden mittels elektronischer Tagebücher erfasst. Gruppenunterschiede in den relativen Häufigkeiten der Emotionssequenzen wurden in Varianzanalysen verglichen. Die Studienergebnisse replizierten Befunde einer früheren Studie zu fünf dysregulierten Emotionssequenzen bei der BPS: Im Vergleich zu gesunden Kontrollpatientinnen zeigten Patientinnen mit BPS ein häufigeres Auftreten von persistierender Angst sowie von Traurigkeit, mehr Wechsel von Angst zu Traurigkeit, von Traurigkeit zu Angst und von Angst zu Ärger. Keine dieser dysregulierten Emotionssequenzen wies jedoch eine BPS-Spezifität auf, d.h. keine trat häufiger auf als in der PTBS-Gruppe oder der BN-Gruppe.

In Studie 2 wurde mit dem gleichen Datensatz untersucht, ob Patientinnen mit BPS störungsspezifische Unterschiede in der Häufigkeit und Intensität spezifischer Emotionen sowie in der mit diesen spezifischen Emotionen verbundenen Anspannung aufweisen. Die Ergebnisse der Mehrebenenanalysen zeigten, dass Patientinnen mit BPS alle erfassten negativen Emotionen häufiger und fast alle negativen Emotionen intensiver erleben als gesunde Kontrollpatientinnen. Patientinnen mit BPS erlebten im Alltag häufiger Ärger als jede andere Studiengruppe. Dieser Befund sticht aus den sonst weitgehend transdiagnostischen Mustern ohne bedeutsame Unterschiede zwischen den klinischen Gruppen hervor und deutet auf eine BPS-Spezifität in der Häufigkeit von Ärger hin. Hinsichtlich der Intensität von Ärger wurden keine für die BPS spezifischen Unterschiede gefunden; allerdings war Ärger war die einzige Emotion, die über die emotionale Intensität hinaus zu einer zusätzlichen Anspannung führte.

Studie 3 befasste sich mit der affektiven Instabilität und dem bislang wenig beachteten Diagnosekriterium der Selbstwertinstabilität. Das momentane Selbstwertgefühl und die Stimmung von Probandinnen wurden in einer Stichprobe von 131 Patientinnen mit BPS, 121 Patientinnen mit

Angststörungen und 134 gesunden Kontrollprobandinnen zwölf Mal pro Tag an vier aufeinander folgenden Tagen abgefragt. Drei etablierte Instabilitätsindizes wurden in Mehrebenenmodellen analysiert, um Gruppenunterschiede in der Selbstwertinstabilität und der affektiven Instabilität zu bestimmen. Sowohl bei Patientinnen mit BPS als auch bei Patientinnen mit Angststörungen waren die Selbstwertinstabilität und die affektive Instabilität höher ausgeprägt als bei den gesunden Kontrollpatientinnen. Das bedeutendste Ergebnis war, dass Patientinnen mit BPS über alle Instabilitätsindizes hinweg eine signifikant höhere Selbstwertinstabilität aufwiesen als Patientinnen mit Angststörungen. Dagegen zeigte sich bei der affektiven Instabilität ein transdiagnostisches Muster, was darauf hindeutet, dass die Instabilität des Selbstwertgefühls die BPS stärker definiert als die affektive Instabilität.

Zukünftige AA-Studien sollten Stichproben verwenden, die ein breites Spektrum von dimensionalen Persönlichkeitsmerkmalen abdecken, um für die BPS spezifische Merkmale von Persönlichkeitsstörungen im Alltag zu entschlüsseln. Neue AA-Methoden könnten zusätzliche Erkenntnisse zum sozialen Kontext liefern, in welchem sich die emotionale Dysregulation und Instabilität bei Menschen mit BPS zeigt.

PREFACE

Chapter 2 (study 1) is based on a manuscript that has been published as Kockler, T. D., Tschacher, W., Santangelo, P. S., Limberger, M. F., & Ebner-Priemer, U. W. (2017). Specificity of emotion sequences in borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls: An e-diary study. *Borderline Personality Disorder and Emotion Dysregulation*, *4.* https://doi.org/10.1186/s40479-017-0077-1

Chapter 3 (study 2) is based on a manuscript that has been published as Kockler, T. D., Santangelo, P. S., Limberger, M. F., Bohus, M., & Ebner-Priemer, U. W. (2020). Specific or transdiagnostic? The occurrence of emotions and their association with distress in the daily life of patients with borderline personality disorder compared to clinical and healthy controls. *Psychiatry Research*, *284*, 112692. https://doi.org/10.1016/j.psychres.2019.112692

Chapter 4 (comment) is based on a letter to the editor that has been published as Kockler, T. D., Santangelo, P. S., & Ebner-Priemer, U. W. (2018). Investigating Binge Eating Using Ecological Momentary Assessment: The Importance of an Appropriate Sampling Frequency. *Nutrients*, *10*(1). https://doi.org/10.3390/nu10010105

Chapter 5 (study 3) is based on a manuscript that has been submitted to the Journal of Abnormal Psychology as Kockler, T. D., Santangelo, P. S., Eid, M., Kuehner, C., Bohus, M., Schmaedeke, S., & Ebner-Priemer, U. W. (under review). Self-Esteem Instability Defines Borderline Personality Disorder More Than Affective Instability: Findings from an E-Diary Study with Clinical and Healthy Controls.

Therefore, it may be possible to read chapters 2 to 5 independently from each other. For better readability, each chapter ends with its own references section. However, this inevitably entails some redundancies in the references.

ACKNOWLEDGMENTS

During my time as a PhD student at the Karlsruhe Institute of Technology, I received a lot of support. In particular, I want to thank my supervisor Ulrich Ebner-Priemer. I could count on his support and rely on his judgment at any time. Throughout the entire dissertation phase, he gave me valuable recommendations and constructive feedback to improve my research. Working with him on our joint research projects was always inspiring and motivating. Not only is his office door usually open, but he always had an open ear for questions. I could not have wished for a better supervisor.

Moreover, I owe thanks to Martin Bohus, my second examiner, and I am grateful for the time and effort he invested in reviewing my dissertation thesis and enriching our common papers with his scientific and clinical expertise. I am also grateful to all co-authors for their valuable contribution to our joint work, particularly to Philip Santangelo, from whom I could learn so much. Many thanks also to my colleagues at the Mental mHealth Lab, who made the time that I worked on my thesis really great.

Finally, I would like to take the opportunity to thank Katja Dlouhy, my family, and my friends with all my heart for their constant support and encouragement over the past years. Without you, this thesis would certainly not have been possible.

TABLE OF CONTENTS

Table of Contents

GENERAL INTRODUCTION

Borderline Personality Disorder

In the Diagnostic and Statistical Manual of Mental Disorders (5th Edition, DSM-5, American Psychiatric Association, 2013), borderline personality disorder (BPD) is described as a pervasive pattern of instability in interpersonal relationships, self-image, and emotion, as well as marked impulsivity beginning by early adulthood and present in a variety of contexts. Among other mental disorders, BPD is standing out in a special way for several reasons. First, the DSM-5 diagnostic criteria for BPD are exceptional. Most other disorders are defined by criteria that describe individuals' deficits, such as diminished interest or pleasure in major depressive disorder, or excesses, such as time-consuming obsessions or compulsions in obsessive-compulsive disorder. In contrast, four of the nine BPD criteria refer to persistent instability, i.e., unstable relationships, unstable self-image or sense of self, affective instability, and impulsivity (American Psychiatric Association, 2013), which suggests that BPD is mainly characterized by its fluctuating symptomatology.

Second, there is a broad theoretical framework for BPD, covering different schools of psychotherapy (e.g., Fonagy et al., 2000; Judd & McGlashan, 2008; Kernberg, 1967; Linehan, 1993). One of those etiological models, Linehan's biosocial theory (1993), suggests that emotion dysregulation is central to BPD. According to Linehan's theory, individuals with BPD exhibit heightened emotional sensitivity, are unable to regulate intense emotional responses, and slowly return to emotional baseline. Moreover, the assumption of BPD as a disorder of emotion regulation is underpinned by a body of research on neurobiological mechanisms mediating emotion

dysregulation, for example, about the role of the prefrontal-limbic circuit (for a review, see Herpertz et al., 2018).

Third, there has been a very high research interest in BPD in the last decades, with BPD being the most studied personality disorder (PD) with regard to etiology and treatment (Herpertz et al., 2017). Regarding treatment, several schools of psychotherapy specifically developed treatment programs for BPD. Among those are cognitive-behavioral programs like dialectical behavior therapy (DBT; Linehan, 1993) and psychodynamic treatments like mentalization-based therapy (Bateman & Fonagy, 2010) or transference-focused psychotherapy (Clarkin et al., 1999), all of which are approved and similarly effective for BPD symptomatology (for a review, see Cristea et al., 2017). Surprisingly for a severe PD, long-term follow-up studies indicate that most patients with BPD experience a remission of the disorder, and many have a recovery (Temes & Zanarini, 2018).

Fourth, according to a recent review, the prevalence of BPD in general populations is about 1.6 percent, but BPD individuals' share in psychiatric outpatient clinics ranges between 15 and 28 percent (Gunderson et al., 2018). Moreover, individuals diagnosed with BPD are highly prevalent in general practitioner-based treatment settings (Torgersen, 2012) and account for disproportionately high treatment costs in the health care systems (Bender et al., 2001), indicating a distinct treatment-seeking behavior.

Despite these peculiarities of the disorder, the continued existence of the BPD diagnosis has been questioned in the last years. In their attempts to develop the classification of PDs, the two internationally acknowledged classification systems are in transition from categorical to dimensional descriptions. This applies both to the DSM-5 (American Psychiatric Association, 2013) and, in a more radical way, the International Classification of Diseases, 11th Revision (ICD-

11, World Health Organization, 2020). While dimensional PD classifications are merely represented as an alternative model of PD diagnosis in the DSM-5, individual PD categories have been entirely removed in the ICD-11. Instead of different PD diagnoses, the ICD-11 will only include a single core diagnosis of PD, which can be specified as mild, moderate, or severe. To further describe an individual's pattern of personality dysfunction, the ICD-11 proposes five trait domains for clinical diagnosis, that is, negative affectivity, detachment, dissociality, disinhibition, and anankastia. However, while all other former PD categories will merely be recognized by the specification of these traits, one acquainted category will remain almost unchanged: The borderline pattern qualifier basically lists the nine DSM-5 symptoms of BPD (Bach & First, 2018). Additionally, it also lists the following three attributions: 1) A view of the self as inadequate, bad, guilty, disgusting, and contemptible; 2) an experience of the self as profoundly different and isolated from other people; a painful sense of alienation and pervasive loneliness; and 3) proneness to rejection hypersensitivity; problems in establishing and maintaining consistent and appropriate levels of trust in interpersonal relationships; frequent misinterpretation of social signals (Bach & First, 2018).

The decision to maintain BPD as a specific qualifier has given rise to some controversy (e.g., Herpertz et al., 2017; Hopwood et al., 2019; Tyrer et al., 2019). On the one hand, researchers supporting the special role of BPD argued that BPD is the most studied PD, with a body of research covering decades (Reed, 2018). Furthermore, it was argued that BPD symptomatology would not be sufficiently covered by the five trait domains and, importantly, that there are well-established and effective treatment programs for BPD (Herpertz et al., 2017).

On the other hand, the main criticism concerned the large overlap of BPD symptoms with other PD symptoms and the strong association of BPD with general PD severity (Sharp et al.,

2015; Watters et al., 2019). Using factor analytic approaches, those studies found that when including all BPD criteria and a general factor, the BPD criteria almost entirely loaded on the general PD factor (e.g., Sharp et al., 2015). That is, they failed to find BPD-specific factors and conclude that the borderline pattern qualifies for having a moderate or severe PD.

However, although these studies used elaborate factor analytic approaches, their underlying data is based on (semi-)structured interviews and self-report questionnaires, which has two major limitations when investigating dynamic personality features. First and inherently incorporated in the study design, those studies applied trait level methods to capture BPD symptomatology, which is, in contrary, characterized by dynamic state fluctuations. Second, retrospective assessment strategies rely on patients' memory recall of behavioral, emotional, or cognitive symptoms, making them prone to retrospective bias and distortion (Stone & Shiffman, 2002). Retrospective bias is especially pronounced in the assessment of dynamic features like unstable and rapidly changing symptoms, as shown in studies that found a limited congruence between retrospective assessments of unstable symptoms and the actual ups and downs of the symptoms (Solhan et al., 2009). Therefore, studies relying on retrospective self-report may not cover the unique quality of emotion dysregulation and instability, which is widely associated with BPD.

Ambulatory Assessment in Borderline Personality Disorder Research

In the last decade, the methodology of ambulatory assessment (AA; Fahrenberg, 1996; Fahrenberg et al., 2007) - also known as experience sampling method (Larson & Csikszentmihalyi, 1983), ecological momentary assessment (Stone & Shiffman, 1994), or real-time data capture (Stone et al., 2007) - has become the gold standard to assess dynamic features such as instability

(Carpenter et al., 2016). Using computer-based methodology such as electronic diaries (e-diaries) to assess self-reported symptoms, behaviors, or physiological processes repeatedly, AA allows for capturing people's emotional states in real time and in the real world and for modeling unstable symptomatology and dynamic within-person processes with high ecological validity (Trull & Ebner-Priemer, 2013). New possibilities opened up by mobile assessment devices and evolving statistical methods nowadays allow for sophisticated statistical modeling of temporal dynamics (Ebner-Priemer et al., 2009; Jahng et al., 2008). Thus, AA is ideally suited to investigate the dynamic course of BPD symptoms in individuals' everyday lives, and there is already a body of research that used AA to study BPD (for a review, see Santangelo, Bohus, & Ebner-Priemer, 2014).

Most AA studies aiming to find unique BPD features focused on affective instability, which is considered the core pathology in patients with BPD (Linehan, 1993). Those studies consistently confirmed the assumption of heightened affective instability in BPD patients' daily lives compared to healthy controls (HCs). However, addressing the question of specificity, even AA studies mostly failed to show the particular prominence of affective instability in BPD compared to other mental disorders: Differences between BPD and clinical control groups did not occur regarding the instability of general negative affect (Trull et al., 2008), global affective instability (Santangelo, Reinhard, et al., 2014), subcomponents of affective instability (Santangelo et al., 2016), or emotional switching (Houben et al., 2016). Even though BPD patients' affective instability was found to be heightened compared to those with avoidant PD (Snir et al., 2017), differences in global affective instability between BPD and clinical groups do not seem to be readily apparent. Taken together, from a perspective of general affect, studies investigating the specificity of affective instability rather give a transdiagnostic picture.

5

Research Questions

In an attempt to unravel unique patterns specifically characterizing BPD, I approached the constructs of emotion dysregulation and instability in BPD from different perspectives. In studies 1 and 2, I investigated whether patients with BPD exhibit particularly dysregulated specific emotions in their daily lives, and in study 3, I focused on the neglected criterion of self-esteem instability.

In study 1, I investigated altered emotion sequences, i.e., patterns of two consecutive specific emotions. Participants' current perceived emotions were assessed, using high-frequency sampling with e-diary assessments every 15 minutes over a 24-hour period. Conducting nonparamentric analyses of variance, I aimed to replicate previously found differences in BPD patients' emotion activation, emotion persistence, and switches from one emotion to another compared to HCs (Reisch et al., 2008). Moreover, as the specificity of altered emotion sequences is unclear, I examined whether some emotion sequences are particularly frequent in BPD patients' daily lives compared to clinical control patients with posttraumatic stress disorder and those with bulimia nervosa.

In study 2, the same data set was used to investigate the frequency and intensity of specific emotions and the distress associated with specific emotions. Previous research revealed heightened frequencies and intensities of negative emotions and lowered frequencies of positive emotions in BPD patients' daily lives compared to HCs (Ebner-Priemer et al., 2007). To examine whether these findings withstand the comparison with clinical controls, that is, whether they demonstrate specificity, I used multilevel modeling to analyze group differences in the frequency and intensity of specific emotions between patients with BPD, those with posttraumatic stress disorder, and those with bulimia nervosa. In detail, it was hypothesized that the two specific emotions anger and

shame, which have been highlighted in previous BPD research (for example, Scott et al., 2015), would be particularly frequent and intense in patients with BPD. Moreover, the distressing quality of specific emotions was investigated, analyzing the additional effect of a specific emotion on distress beyond the pure influence of emotional intensity.

In study 3, I slightly shifted my research focus towards the instability of self-esteem, a diagnostic criterion of BPD that has been neglected so far. The few existing studies on self-esteem instability in BPD provided evidence that self-esteem instability is higher in patients with BPD than in HCs and closely intertwined with affective instability (Santangelo et al., 2017). Study 3 is the first study to compare BPD patients' self-esteem instability to a clinical control group of patients with anxiety disorders and HCs. It aimed to investigate the BPD specificity of self-esteem instability and replicate previous findings that affective instability is a transdiagnostic feature (Santangelo, Reinhard, et al., 2014). Momentary affective state and current self-esteem was repeatedly assessed 12 times daily for four consecutive days. To determine group differences in instability, multilevel models were conducted to determine group differences in three established instability indices, i.e., squared successive difference (SSD), probability of acute change (PAC), and aggregated point-by-point change (APPC). Thus, I intended to shed light on the role of the understudied construct of self-esteem.

Additionally, in a comment that was published as a letter to the editor, idiographic data was used to demonstrate the importance of an appropriate sampling frequency in AA studies. I precisely describe short time sections of two patients with bulimia nervosa who experience uncontrolled eating behavior while participating in an AA study with high-frequency sampling.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. Washington, DC: American Psychiatric Publishing.

Bach, B., & First, M. B. (2018). Application of the ICD-11 classification of personality disorders. *BMC Psychiatry*, *18*(1), 351. https://doi.org/10.1186/s12888-018-1908-3

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

Bender, D. S., Dolan, R. T., Skodol, A. E., Sanislow, C. A., Dyck, I. R., McGlashan, T. H., Shea, M. T., Zanarini, M. C., Oldham, J. M., & Gunderson, J. G. (2001). Treatment Utilization by Patients With Personality Disorders. *The American Journal of Psychiatry*, *158*(2), 295–302. https://doi.org/10.1176/appi.ajp.158.2.295

Carpenter, R. W., Wycoff, A. M., & Trull, T. J. (2016). Ambulatory Assessment. *Assessment*, *23*(4), 414–424. https://doi.org/10.1177/1073191116632341

Clarkin, J. F., Yeomans, F. E., & Kernberg, O. F. (1999). *Psychotherapy for borderline personality*. Wiley.

Cristea, I. A., Gentili, C., Cotet, C. D., Palomba, D., Barbui, C., & Cuijpers, P. (2017). Efficacy of Psychotherapies for Borderline Personality Disorder: A Systematic Review and Meta-analysis. *JAMA Psychiatry*, *74*(4), 319–328. https://doi.org/10.1001/jamapsychiatry.2016.4287

Ebner-Priemer, U. W., Eid, M., Kleindienst, N., Stabenow, S., & Trull, T. J. (2009). Analytic strategies for understanding affective (in)stability and other dynamic processes in psychopathology. *Journal of Abnormal Psychology*, *118*(1), 195–202. https://doi.org/10.1037/a0014868

Ebner-Priemer, U. W., Welch, S. S., Grossman, P., Reisch, T., Linehan, M. M., & Bohus, M. (2007). Psychophysiological ambulatory assessment of affective dysregulation in borderline personality disorder. *Psychiatry Research*, *150*(3), 265–275. https://doi.org/10.1016/j.psychres.2006.04.014

Fahrenberg, J. (Ed.). (1996). *Ambulatory assessment: Computer-assisted ; psychological and psychophysiological methods in monitoring and field studies*. Hogrefe und Huber.

Fahrenberg, J., Myrtek, M., Pawlik, K., & Perrez, M. (2007). Ambulatory Assessment - Monitoring Behavior in Daily Life Settings. *European Journal of Psychological Assessment*, *23*(4), 206–213. https://doi.org/10.1027/1015-5759.23.4.206

Fonagy, P., Target, M., & Gergely, G. (2000). Attachment and borderline personality disorder. A theory and some evidence. *Psychiatric Clinics of North America*, *23*(1), 103–122. https://doi.org/10.1016/s0193-953x(05)70146-5

Gunderson, J. G., Herpertz, S. C., Skodol, A. E., Torgersen, S., & Zanarini, M. C. (2018). Borderline personality disorder. *Nature Reviews. Disease Primers*, *4*, 18029. https://doi.org/10.1038/nrdp.2018.29

Herpertz, S. C., Huprich, S. K., Bohus, M., Chanen, A., Goodman, M., Mehlum, L., Moran, P., Newton-Howes, G., Scott, L. N., & Sharp, C. (2017). The Challenge of Transforming the Diagnostic System of Personality Disorders. *Journal of Personality Disorders*, *31*(5), 577–589. https://doi.org/10.1521/pedi_2017_31_338

Herpertz, S. C., Schneider, I., Schmahl, C., & Bertsch, K. (2018). Neurobiological Mechanisms Mediating Emotion Dysregulation as Targets of Change in Borderline Personality Disorder. *Psychopathology*, *51*(2), 96–104. https://doi.org/10.1159/000488357

Hopwood, C. J., Krueger, R. F., Watson, D., Widiger, T. A., Althoff, R. R., Ansell, E. B., Bach, B., Bagby, R. M., Blais, M. A., Bornovalova, M. A., Chmielewski, M., Cicero, D. C., Conway, C., Clerq, B. de, Fruyt, F. de, Docherty, A. R., Eaton, N. R., Edens, J. F., Forbes, M. K., . . . Zimmermann, J. (2019). Commentary on "The Challenge of Transforming the Diagnostic System of Personality Disorders". *Journal of Personality Disorders*, 1–4. https://doi.org/10.1521/pedi_2019_33_00

Houben, M., Bohus, M., Santangelo, P. S., Ebner-Priemer, U. W., Trull, T. J., & Kuppens, P. (2016). The specificity of emotional switching in borderline personality disorder in comparison to other clinical groups. *Personality Disorders*, *7*(2), 198–204. https://doi.org/10.1037/per0000172

Jahng, S., Wood, P. K., & Trull, T. J. (2008). Analysis of affective instability in ecological momentary assessment: Indices using successive difference and group comparison via multilevel modeling. *Psychological Methods*, *13*(4), 354–375. https://doi.org/10.1037/a0014173

Judd, P. H., & McGlashan, T. H. (2008). *A Developmental Model of Borderline Personality Disorder: Understanding Variations in Course and Outcome* (1st ed.). American Psychiatric Publishing.

Kernberg, O. F. (1967). Borderline personality organization. *Journal of the American Psychoanalytic Association*, *15*(3), 641–685. https://doi.org/10.1177/000306516701500309

Larson, R., & Csikszentmihalyi, M. (1983). The Experience Sampling Method. *New Directions for Methodology of Social & Behavioral Science*(15), 41–56.

Linehan, M. M. (1993). *Cognitive-behavioral treatment of borderline personality disorder*. *Diagnosis and Treatment of Mental Disorders*. Guilford Press.

Reed, G. M. (2018). Progress in developing a classification of personality disorders for ICD-11. *World Psychiatry : Official Journal of the World Psychiatric Association (WPA)*, *17*(2), 227–229. https://doi.org/10.1002/wps.20533

Reisch, T., Ebner-Priemer, U. W., Tschacher, W., Bohus, M., & Linehan, M. M. (2008). Sequences of emotions in patients with borderline personality disorder. *Acta Psychiatrica Scandinavica*, *118*(1), 42–48. https://doi.org/10.1111/j.1600-0447.2008.01222.x

Santangelo, P. S., Bohus, M., & Ebner-Priemer, U. W. (2014). Ecological momentary assessment in borderline personality disorder: A review of recent findings and methodological challenges. *Journal of Personality Disorders*, *28*(4), 555–576. https://doi.org/10.1521/pedi_2012_26_067

Santangelo, P. S., Limberger, M. F., Stiglmayr, C., Houben, M., Coosemans, J., Verleysen, G., Kuppens, P., Tuerlinckx, F., Vanpaemel, W., & Ebner-Priemer, U. W. (2016). Analyzing subcomponents of affective dysregulation in borderline personality disorder in comparison to other clinical groups using multiple e-diary datasets. *Borderline Personality Disorder and Emotion Dysregulation*, *3*, 5. https://doi.org/10.1186/s40479-016-0039-z

Santangelo, P. S., Reinhard, I., Koudela-Hamila, S., Bohus, M., Holtmann, J., Eid, M., & Ebner-Priemer, U. W. (2017). The temporal interplay of self-esteem instability and affective instability in borderline personality disorder patients' everyday lives. *Journal of Abnormal Psychology*, *126*(8), 1057–1065. https://doi.org/10.1037/abn0000288

Santangelo, P. S., Reinhard, I., Mussgay, L., Steil, R., Sawitzki, G., Klein, C., Trull, T. J., Bohus, M., & Ebner-Priemer, U. W. (2014). Specificity of affective instability in patients with borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls. *Journal of Abnormal Psychology*, *123*(1), 258–272. https://doi.org/10.1037/a0035619

Scott, L. N., Stepp, S. D., Hallquist, M. N., Whalen, D. J., Wright, A. G. C., & Pilkonis, P. A. (2015). Daily shame and hostile irritability in adolescent girls with borderline personality disorder symptoms. *Personality Disorders*, *6*(1), 53–63. https://doi.org/10.1037/per0000107

Sharp, C., Wright, A. G. C., Fowler, J. C., Frueh, B. C., Allen, J. G., Oldham, J. M., & Clark, L. A. (2015). The structure of personality pathology: Both general ('g') and specific ('s') factors? *Journal of Abnormal Psychology*, *124*(2), 387–398. https://doi.org/10.1037/abn0000033

Snir, A., Bar-Kalifa, E., Berenson, K. R., Downey, G., & Rafaeli, E. (2017). Affective instability as a clinical feature of avoidant personality disorder. *Personality Disorders*, *8*(4), 389–395. https://doi.org/10.1037/per0000202

Solhan, M. B., Trull, T. J., Jahng, S., & Wood, P. K. (2009). Clinical assessment of affective instability: Comparing EMA indices, questionnaire reports, and retrospective recall. *Psychological Assessment*, *21*(3), 425–436. https://doi.org/10.1037/a0016869

Stone, A. A., & Shiffman, S. (1994). Ecological momentary assessment (EMA) in behavioral medicine. *Annals of Behavioral Medicine : A Publication of the Society of Behavioral Medicine*, *16*(3), 199–202. https://doi.org/10.1093/abm/16.3.199

Stone, A. A., & Shiffman, S. (2002). Capturing momentary, self-report data: A proposal for reporting guidelines. *Annals of Behavioral Medicine : A Publication of the Society of Behavioral Medicine*, *24*(3), 236–243. https://doi.org/10.1207/S15324796ABM2403_09

Stone, A. A., Shiffman, S., Atienza, A., & Nebeling, L. (2007). *The science of real-time data capture: Self-reports in health research*. Oxford University Press.

Temes, C. M., & Zanarini, M. C. (2018). The Longitudinal Course of Borderline Personality Disorder. *The Psychiatric Clinics of North America*, *41*(4), 685–694. https://doi.org/10.1016/j.psc.2018.07.002

Torgersen, S. (2012). Epidemiology. In T. A. Widiger (Ed.), *Oxford library of psychology. The Oxford handbook of personality disorders* (pp. 185–205). Oxford University Press. https://doi.org/10.1093/oxfordhb/9780199735013.013.0009

Trull, T. J., & Ebner-Priemer, U. W. (2013). Ambulatory assessment. *Annual Review of Clinical Psychology*, *9*, 151–176. https://doi.org/10.1146/annurev-clinpsy-050212-185510

Trull, T. J., Solhan, M. B., Tragesser, S. L., Jahng, S., Wood, P. K., Piasecki, T. M., & Watson, D. (2008). Affective instability: Measuring a core feature of borderline personality disorder with ecological momentary assessment. *Journal of Abnormal Psychology*, *117*(3), 647–661. https://doi.org/10.1037/a0012532

Tyrer, P., Mulder, R., Kim, Y.-R., & Crawford, M. J. (2019). The Development of the ICD-11 Classification of Personality Disorders: An Amalgam of Science, Pragmatism, and Politics. *Annual Review of Clinical Psychology*, *15*, 481–502. https://doi.org/10.1146/annurev-clinpsy-050718-095736

Watters, C. A., Bagby, R. M., & Sellbom, M. (2019). Meta-analysis to derive an empirically based set of personality facet criteria for the alternative DSM-5 model for personality disorders. *Personality Disorders*, *10*(2), 97–104. https://doi.org/10.1037/per0000307

World Health Organization. (2020). *International statistical classification of diseases and related health problems (11th ed.).* World Health Organization. https://icd.who.int/

STUDY 1: SPECIFICITY OF EMOTION SEQUENCES IN BORDERLINE PERSONALITY DISORDER

Chapter 2

Abstract

Patients with borderline personality disorder (BPD) exhibit dysregulated emotion sequences in daily life compared to healthy controls (HCs). Empirical evidence regarding the specificity of these findings is currently lacking.

To replicate dysregulated emotion sequences in patients with BPD and to investigate the specificity of the sequences, we used e-diaries of 43 female patients with BPD, 28 patients with posttraumatic stress disorder (PTSD), 20 patients with bulimia nervosa (BN), and 28 HCs. To capture the rapid dynamics of emotions, we prompted participants every 15 minutes over a 24-hour period to assess their current perceived emotions. We analyzed group differences in terms of activation, persistence, switches, and down-regulation of emotion sequences.

By comparing patients with BPD to HCs, we replicated five of the seven previously reported dysregulated emotion sequences, as well as 111 out of 113 unaltered sequences. However, none of the previously reported dysregulated emotion sequences exhibited specificity, i.e., none revealed higher frequencies compared to the PTSD group or the BN group. Beyond these findings, we revealed a specific finding for patients with BN, as they most frequently switched from anger to disgust.

Replicating previously found dysregulated and unaltered emotional sequences strengthens the significance of emotion sequences. However, the lack of specificity points to emotion sequences as transdiagnostic features.

Introduction

Affective dysregulation is of central importance in borderline personality disorder (BPD) as it is assumed to drive other BPD symptoms (Linehan, 1993; Siever et al., 2002; Tragesser et al., 2007). Much progress has been made in recent years regarding the understanding of affective dysregulation (Santangelo, Bohus, & Ebner-Priemer, 2014; Trull et al., 2015). Multiple studies have investigated processes such as affective instability (Ebner-Priemer et al., 2015; Santangelo et al., 2016; Santangelo, Reinhard, et al., 2014), emotional switching (Houben et al., 2016), and emotion sequences (Reisch et al., 2008) in the most important context possible, the everyday lives of patients (Trull & Ebner-Priemer, 2014). However, there is surprisingly little evidence of specificity, namely, whether BPD patients exhibit temporal patterns of affective dysregulation distinct from other psychiatric disorders such as posttraumatic stress disorder (PTSD), bulimia nervosa (BN), major depressive disorder, and dysthymic disorder (Houben et al., 2016; Kohling et al., 2016; Santangelo et al., 2016; Santangelo, Reinhard, et al., 2014). This is especially notable given that BPD is defined as an emotionally unstable personality disorder in the ICD-10 (World Health Organisation, 1992).

A possible explanation is suggested by Santangelo, Reinhard, et al. (2014), who state that when examining valence, the quality of the affective states within the temporal pattern is obscured. Concretely, the emergence of anger after an affective state of shame is subsumed as a constant negative affect when considering only global valence. Empirical support for this premise is derived from the study of Trull et al. (2008), who investigated the instability of certain emotions and found

15

that patients with BPD exhibited higher instability with respect to hostility, fear, and sadness compared to patients with major depressive disorders, whereas, according to their 2008 paper, there was no significant difference regarding instability associated with negative affect. Extreme changes in hostility scores were more likely to occur in the BPD group. However, even the exploration of the course of a specific emotion lacks the information necessary to discover the quality of emotion sequences, such as the emergence of anger after an affective state of shame.

Unraveling such multi emotional patterns is only possible by investigating the activation, persistence, switch, and down-regulation of certain emotions as determined by Reisch et al. (2008), who differentiated four types of emotion sequences: the activation of an emotion, the persistence of an emotion across multiple prompts, the switch from one emotion to another, and the down-regulation of an emotion. In their e-diary study, the research group identified 80 different emotion sequences resulting from eight basic emotions. The emotions of a sample of 50 patients with BPD and a sample of 50 healthy controls (HCs) were assessed every 15 minutes over a 24-hour period. Of the 80 comparisons, seven revealed significant group differences. Specifically, compared with the HCs, the persistence of anxiety, the persistence of sadness, switches from sadness to anxiety, switches from anxiety to anger, and switches from anxiety to sadness were more pronounced among those in the BPD group. Conversely, the activation of joy and activation of interest occurred more frequently in the HC group.

However, as Reisch et al. (2008) did not use clinical controls as comparison groups, it remains open whether these identified emotion sequences also occur with other mental disorders, i.e., whether they show specificity. For this purpose, we chose PTSD and BN as clinical control groups because both disorders exhibited affective dysregulation in previous studies (Anestis et al., 2010; Kashdan et al., 2006; Selby et al., 2012; Vansteelandt et al., 2013). To our knowledge, the study of Reisch et al. (2008) is the only study that investigated such emotion sequences, which is

remarkable given the importance of basic emotions in Linehan's biosocial theory (Linehan, 1993) as well as in psychotherapy in general.

Aims of the Study

First, we aimed at replicating the findings of Reisch et al. (2008), who identified seven dysregulated emotion sequences in BPD compared to HCs. Accordingly, we hypothesized that patients with BPD experience the activation of joy and interest less often than HCs, exhibit an increased persistence of anxiety and sadness, and have more frequent emotional switches from sadness to anxiety, from anxiety to anger, and from anxiety to sadness than HCs (hypothesis 1). Second, we hypothesized that these emotion sequences are specific for BPD (hypothesis 2). For this purpose, we compared these emotion sequences in patients with BPD to patients with PTSD and BN. In a final, purely explorative step, we screened all possible variants of emotion sequences for disorder-specific differences.

Methods

Subjects

All patients met the DSM-IV criteria for their specific disorder. Trained postgraduate psychologists diagnosed the disorders using the German versions of the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; Wittchen et al., 1997) and for DSM-IV Axis II Disorders (SCID-II; Fydrich et al., 1997). The inter-rater reliability of these interviews was found to be very good (κ=0.71 for SCID-I; κ=0.84 for SCID-II; Lobbestael et al., 2011). Additionally, we used the BPD section of the German version of the International Personality Disorder Examination (IPDE; Mombour et al., 1996). With respect to the patient groups, a history of schizophrenia, bipolar disorder, or current substance abuse constituted exclusion criteria.

Furthermore, we excluded patients from the clinical control groups who met the criteria for BPD. All other comorbidities were allowed in the clinical control groups. Lifetime or current psychiatric disorder diagnoses, psychotherapeutic treatments, and use of psychotropic medications were exclusion criteria for participation in the HC group.

Data collection of the all-female sample occurred at the Central Institute of Mental Health Mannheim and at the Psychosomatic Clinic St. Franziska Stift Bad Kreuznach in Germany. We recruited outpatients and inpatients from their outpatient clinics or wards or via advertisements in local newspapers and on the Internet. HCs were selected randomly from the national resident register of the City of Mannheim or recruited via advertisement. All participants provided written informed consent prior to participation in the study, which had received prior approval from the local ethics committee.

Assessment and Data Acquisition

To enable the replication of the findings of Reisch et al. (2008), we used the same set of items and a similar time-based design. In previously published studies, this set of items and the chosen time-based design resulted in satisfactory methodological quality, i.e., low reactivity, high compliance, minimal patient burden, etc. (for details, see Ebner-Priemer, Kuo, et al., 2007; Ebner-Priemer & Sawitzki, 2007; Ebner-Priemer, Welch, et al., 2007). Participants obtained palmtop computers (Tungsten E, Palm Inc., U.S.A.) that we programmed with the DialogPad e-diary-software (Gerhard Mutz, Cologne University, Germany). After being carefully instructed in its use, participants carried the e-diary with them for a 24-hour period. Every 15 min (±1 min) during their waking time, the e-diary prompted the participants, via a beep, to report their current perceived emotions. The question, "Do you feel any of the following emotions right now?" could be answered on a list composed of the following: happy, anxious, angry, shame, disgust, sad, guilt, interest,

envy/jealousy, emotion but cannot name it, and no emotion. In contrast to Reisch et al. (2008), we added two further emotions, guilt and jealousy, to broaden the range of emotions. If the participants selected the option "emotion but cannot name it", they were then asked whether the current emotion was pleasant or unpleasant. In addition, participants responded to three further questions that are not reported in this manuscript. After completing the assessment period, participants handed back the devices, and the e-diary data were downloaded.

Emotion Sequences

The classification of emotion sequences is based on the procedure established by Reisch et al. (2008) and was realized as follows. One emotion sequence is composed of the perceived basic emotions of two successive prompts: an emotion $E1$ at assessment point t followed by emotion $E2$ at assessment point t + 1 add up to one emotion sequence ($E1 \rightarrow E2$). All possible variants of two consecutive emotions amount to 120 different emotion sequences. We categorized these emotion sequences into four types:

Activation (of an emotion): the perception of no emotion at prompt t ($E1$) is followed by the perception of any emotion at prompt t + 1 ($E2$).

Persistence (of an emotion): the perception of the same emotion in two consecutive prompts.

Switch (a change from one emotion to another): the perception of any emotion is followed by the perception of a different emotion at the subsequent prompt.

Down-regulation (of an emotion): the perception of any emotion is followed by the perception of no emotion at the subsequent prompt.

Adjusted Relative Frequency

We followed the logic of Reisch et al. (2008) to calculate the adjusted relative frequencies. However, Reisch et al. (2008) used a shorter calculation method and adjusted the frequencies in relation to the group level, which was possible given that their sample sizes were identical between groups. With respect to the current data set, the sample sizes differ between groups. Therefore, we extended the adjustment to an individualized adjustment to improve accuracy.

In detail, we initially counted the frequencies of all emotion sequences $(E1 \rightarrow E2)$ for each subject. As each absolute frequency depends on the frequencies of the two contributing single emotions $E1$ and $E2$, we used the following formula to calculate an adjusted measure called the adjusted relative frequency (of the individual subject):

$$ARF(E1 \rightarrow E2) = \frac{f_S(E1 \rightarrow E2)}{f_S(E1) \times f_S(E2) + 1}$$

In the numerator, $f_S(E1 \rightarrow E2)$ denotes the counted absolute frequency of a specific emotion sequence of the individual subject. We adjusted this absolute frequency by dividing it by the product of the individual's frequencies of the contributing emotions $E1$ and $E2$, as represented in the denominator $[f_S(E1) \times f_S(E2)]$. As an example, the number of counted emotional switches from sadness to anxiety of a single patient with BPD was divided by the product of the number of this patient's reported feelings of sadness and anxiety. We added 1 to the product in the denominator to avoid divisions by zero in the case of non-reported emotions. We calculated the adjusted relative frequency (ARF) for each subject S and each sequence $(E1 \rightarrow E2)$.

Further data analysis comprised three steps: First, to replicate Reisch et al. (2008), we compared the ARFs of the seven hypothesized emotion sequences between the BPD group and the

HC group using t-tests for independent samples. Since the ARFs were not normally distributed but were positively skewed, we conducted nonparametric Wilcoxon rank-sum tests. To compensate for multiple testing, we reduced the alpha level from $\alpha = .05$ to $\alpha = .014$ via the Bonferroni correction. Second, to investigate specificity, we used Kruskal-Wallis nonparametric analysis of variance for the seven hypothesized sequences. In the case of a significant omnibus test, we used Dunn-Bonferroni post hoc tests - again setting the alpha level to .014 - to analyze group contrasts. Third, to explore any further specificity of emotion sequences, we calculated Kruskal-Wallis tests for all possible variants of emotion sequences. To limit alpha inflation, we divided the alpha level by the number of prompted emotions, thus restricting the level to .005. We contend that this ad hoc solution provides a good balance between test power and the problem of multiple comparisons. The data analysis was conducted using the software R (R Core Team, 2017) and the additional R package PMCMR (Pohlert, 2014).

Results

Subjects

The sample of 119 female participants was composed of 43 patients with BPD, 28 patients with PTSD, 20 patients with BN, and 28 HCs. Detailed sample characteristics are provided in Table 2.1. The mean age of the total sample was 28.6 years (range: 18 to 48). There were no significant age differences between the BPD group, the clinical controls, and the HCs (Kruskal-Wallis-H=4.15, p=.16). Among the three clinical groups, 42% of the patients, on average, were on psychotropic medication, on average. The most frequent comorbid current Axis I diagnoses were anxiety disorders (62%), particularly social phobia (40%), followed by major depression (37%). Comorbidity of personality disorders was highest for avoidant personality disorder (36%).

Table 2.1

Sample characteristics by group

Variable	BPD (n = 43)	PTSD (n = 28)	BN (n = 20)	HCs (n = 28)
Age in years				
M (SD)	26.72 (7.07)	35.25 (7.53)	23.70 (5.97)	28.82 (7.47)

Variable	BPD (n = 43)	PTSD (n = 28)	BN (n = 20)	X² test
Psychotropic medication				
n (%)	16 (37%)	17 (60%)	5 (25%)	PTSD>BN
Hospitalization n (%)				
Outpatients	26 (60%)	8 (29%)	9 (45%)	BPD>PTSD
Inpatients	17 (40%)	20 (71%)	11 (55%)	PTSD>BPD
Current Axis I diagnoses n				
Major depression	9 (21%)	15 (54%)	10 (50%)	PTSD, BN>BPD
Anxiety disorders	27 (63%)	19 (68%)	10 (50%)	n.s.
PTSD	22 (51%)	all	3 (15%)	BPD>BN
Bulimia nervosa	9 (21%)	2 (7%)	all	n.s.
Current Axis II disorders n				
Borderline	all	exclusion criterion		not applicable
Avoidant	24 (25%)	6 (21%)	3 (15%)	BPD>PTSD, BN
Obsessive-compulsive	7 (16%)	3 (11%)	2 (10%)	n.s.
Dependent	7 (16%)	0 (0%)	1 (5%)	n.s.
Paranoid	7 (16%)	3 (11%)	1 (5%)	n.s.

BPD, borderline personality disorder; PTSD, posttraumatic stress disorder; BN, bulimia nervosa;

HCs, healthy controls; > signals significant group differences; n.s., no significant group differences

Adjusted Relative Frequencies of Emotion Sequences

Findings regarding the seven hypothesized emotion sequences and their specificity are presented in Figure 2.1. The bars illustrate the means of the ranked ARFs, which serve as the independent variables in the nonparametric testing. Significant group differences are marked via brackets. As indicated by the brackets highlighted in bold print, we could replicate five of the seven hypothesized emotion sequences (hypothesis 1). In detail, comparing the BPD group to the HC group revealed a significantly higher frequency of persistence in anxiety (Wilcoxon rank-sum test W=877.5, p<.001) and sadness (W=808, p=.006) in the BPD group. Compared to the HCs, patients with BPD switched more often from anxiety to sadness (W=742, p=.007) and vice versa (W=826, p<.001), as well as from anxiety to anger (W=851.5, p<.001). No group differences could be found regarding activation of joy (W=555, p=.58) and interest (W=419, p=.03) after the Bonferroni correction.
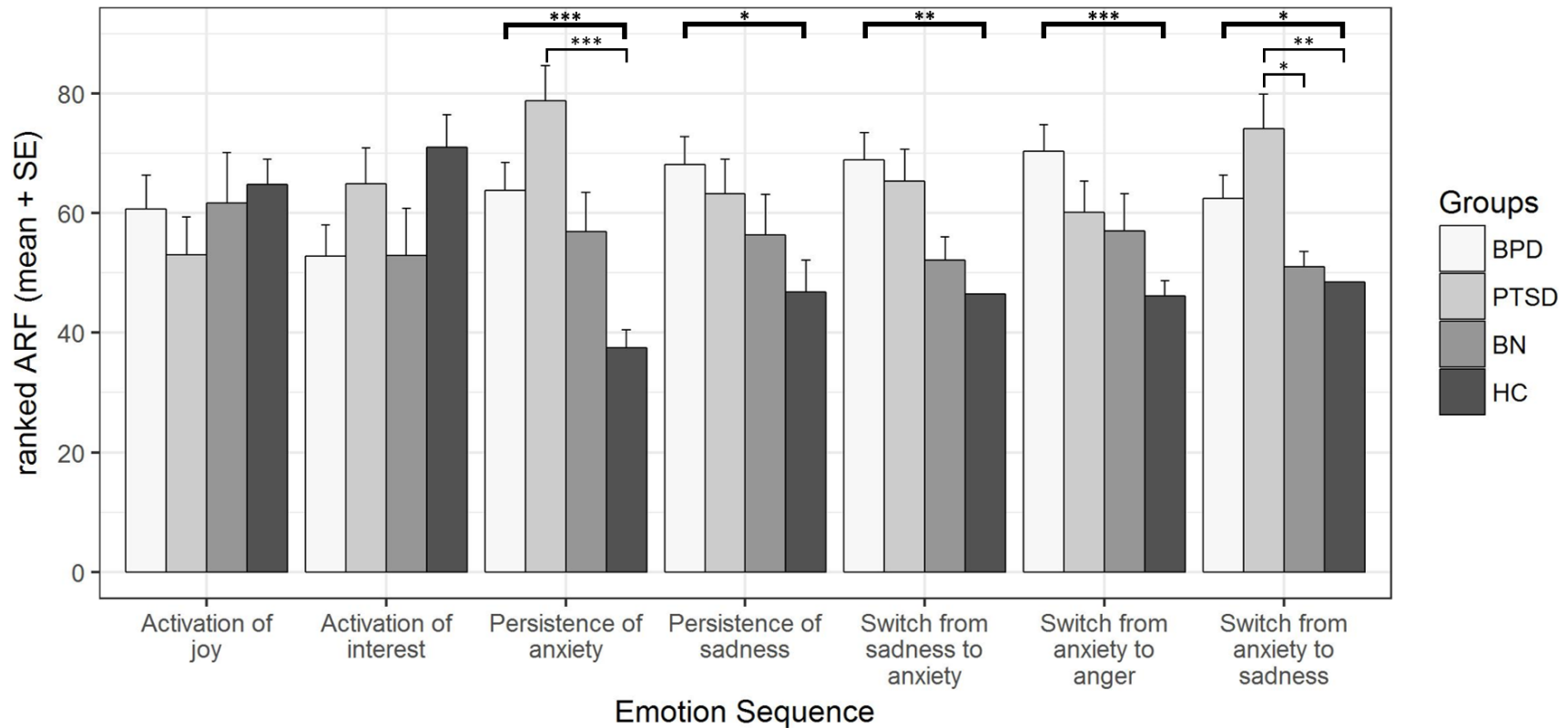
Figure 2.1. Ranks of adjusted relative frequencies of the seven hypothesized emotion sequences: means and standard errors. BPD, borderline personality disorder; PTSD, posttraumatic stress disorder; BN, bulimia nervosa; HC, healthy controls.

(*) Significant group differences on the Wilcoxon rank-sum tests for hypothesis 1 regarding replication (bold print) and the Dunn-Bonferroni tests of the Kruskal-Wallis tests for hypothesis 2 regarding specificity; alpha level Bonferroni corrected (see details in the methods section).

However, in view of the specificity of emotion sequences in patients with BPD (hypothesis 2), none of the hypothesized differences occurred between the patients with BPD and those with PTSD or those with BN (all Dunn-Test-H-values < 2.46, all p-values > .08). Simply said, at first glance, we did not find any evidence of specificity in the BPD sample. In a second step, we compared our clinical control groups to the HCs. With respect to the PTSD group, we found significant group differences regarding two emotion sequences. Similar to the BPD group, the PTSD group exhibited a higher frequency of persistence in anxiety (H=4.97, p<.001) compared to the HC group. In addition, the PTSD group switched more often from anxiety to sadness than did the HC group (H=4.04, p<.001). There were no differences between the BN group and the HC group. As a third step, we compared the two clinical control groups. Data analyses revealed only one significant finding, namely, the PTSD group switched more often from anxiety to sadness in relation to the BN group (H=3.32, p=.005).

In the last step, searching for disorder-specific emotion sequences, we ran certain explorative, hypothesis-free analyses. As presented in Figure 2.2, seven out of the remaining 113 emotional sequences showed significant group differences. Four of the sequences revealed significant differences between the HC group and one clinical disorder. That is, patients with BPD switched more often from anger to sadness (H=3.82, p<.001) and from guilt to anger (H=3.38, p=.004) than did the HCs. Once again, no significant results between the BPD group and the clinical control groups could be found. Patients with PTSD exhibited a higher frequency of switches from anger to anxiety (H=4.41, p<.001) as well as from an unspecific emotion to anxiety than did the HCs (H=3.87, p<.001).
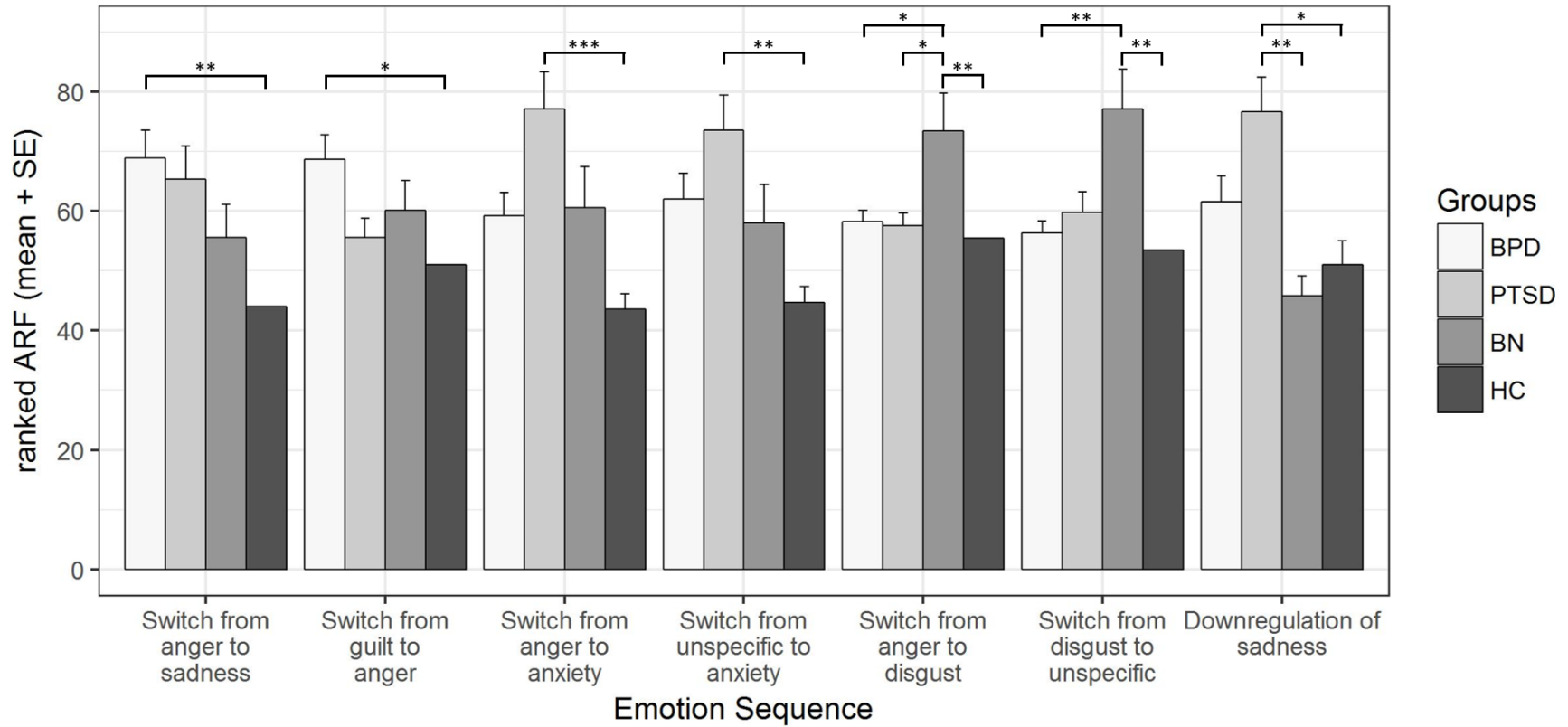
Figure 2.2. Ranks of adjusted relative frequencies: means and standard errors. BPD, borderline personality disorder; PTSD, posttraumatic stress disorder; BN, bulimia nervosa; HC, healthy controls.

(*) Significant group differences on the Dunn-Bonferroni tests of the Kruskal-Wallis tests in hypothesis-free analysis; alpha level restricted to .005.

In three of the emotion sequences, we found at least some evidence of specificity. Switching from anger to disgust occurred significantly more often in the BN group compared to the BPD group (H=3.57, p=.002), the PTSD group (H=3.44, p=.004), and the HC group (H=3.89, p<.001). Furthermore, patients with BN reported more switches from disgust to an unspecific emotion compared to patients with BPD (H=4.11, p<.001) and HCs (H=4.32, p<.001), but not in comparison to patients with PTSD (H=3.17, p=.009). The sequence of down-regulating sadness was more common in the PTSD group compared to both the BN group (H=3.80, p<.001) and the HC group (H=3.46, p=.003).

Discussion

This is the first study to investigate the specificity of emotion sequences in patients with BPD. As hypothesized in hypothesis 1, we replicated five of the seven results of Reisch et al. (2008). The emotion sequences classified as persistence and switch indicated significant differences between the BPD group and the HCs, whereas we could not find the hypothesized differences for activation. Viewed from another perspective, the hypothesized differences occurred with reference to the emotion sequences including negative emotions, but not including positive emotions. Interestingly, the negative sequences covered the three basic emotions, i.e., anxiety, anger, and sadness. These are the same basic emotions, for which Trull et al. (2008) found significant instability in his BPD e-diary study and the same negative basic emotions that are specifically listed in the BPD section of the DSM-5 (American Psychiatric Association, 2013). Regarding the two sequences of activated positive emotions, i.e., joy and interest, revealing significant differences in the study of Reisch et al. (2008), HCs showed higher descriptive values than the BPD group in both cases. Furthermore, without the correction of the alpha level, the difference in activation of interest would reach significance (Cohen's d =.53; Cohen, 1988), which

might indicate a problem with the test power. Hence, considering that we corrected the alpha level to avoid alpha inflation, a rate of 71% of replicated results is clearly above chance and is suggestive of solid differences between patients with BPD and the HCs. Further evidence for this is provided by the explorative analysis. Out of the remaining 113 comparisons of emotion sequences, only two revealed additional significant group differences between patients with BPD and the HCs, which nicely maps the findings of Reisch et al. (2008).

With respect to our second hypothesis, the findings were sobering. None of the seven emotion sequences of Reisch et al. (2008) exhibited specificity. In two cases, the PTSD group exhibited even higher values compared to the BPD group (persistence of anxiety, switch from anxiety to sadness). In three emotion sequences, namely, the persistence of sadness, switch from sadness to anxiety, and switch from anxiety to anger, the BPD group revealed at least the highest descriptive values, and it is the only clinical group, which showed significant differences in comparison to the HC group. Nonetheless, because the effect sizes are small when comparing the BPD group to the clinical groups, we cannot assume test power to be the problem at this point. An alternative explanation could be that while the frequency of sequences does not distinguish BPD from other clinical groups, a larger magnitude of emotional intensity within the sequences will do so. Accounting for the intensities by comparing their mean changes within each of the hypothesized sequences does not, however, result in any group differences. The finding that the seven dysregulated emotion sequences cannot be attributed to a specific diagnosis implies that the emotion sequences could be transdiagnostic mechanisms, which are a topic of lively discussion in current research (e.g., Aldao, 2016). In earlier daily life studies, other disorders also exhibited disturbed affective processing, such as bulimia nervosa (Anestis et al., 2010; Selby et al., 2012; Vansteelandt et al., 2013) and posttraumatic stress disorder (Kashdan et al., 2006). Similarly,

concepts in psychotherapy aiming to improve emotion regulation in BPD have been adapted to the treatment of several other disorders (e.g., Roosen et al., 2012; Steil et al., 2011).

Regarding our purely explorative approach, we found three emotion sequences that potentially display specificity. Two of them apply to the BN group, and both include disgust as a contributing emotion, namely, the switch from anger to disgust and the switch from disgust to an unspecific emotion. This is not entirely surprising given that disgust sensitivity is believed to play a role in eating disorders (Troop et al., 2000). The finding that switches from anger to disgust are specific for BN in comparison to all other groups is excellently consistent with the study of Fox and Harrison (2008), in which it was found that anger and disgust may be coupled in persons with eating pathology inasmuch as disgust may be used to manage the so-called toxic emotion of anger in people with eating pathology. One might also suggest that this emotion sequence could be directly linked to the occurrence of dysfunctional eating behaviors in patients with BN. Anger-induced eating (Appelhans et al., 2011) could, according to the DSM-5 criteria of binge eating episodes, result in feelings of disgust (American Psychiatric Association, 2013). To explain the second emotion sequence that showed some specificity in the BN group, i.e., the switch from disgust to an unspecific emotion, it is conceivable that after finishing a binge episode with its associated cascade of specific negative emotions, disgust may fade and leave behind unspecific negative emotions. This could be consistent with the emotion regulation model of Leehr et al. (2015), which supposes that unspecific emotions play a role in the understanding of binge eating.

While the increased frequency of down-regulation of sadness in PTSD was slightly surprising, it was only partially specific. However, several studies discuss sadness as another dominant emotion in addition to anxiety in PTSD (e.g., Hathaway et al., 2010; Power & Fyvie, 2013). Although Power and Fyvie (2013) describe a sadness-based PTSD, this ambiguous result raises open questions and warrants replication.

Summing up the findings of the explorative approach and hypothesis 2, we conclude that specific emotion sequences are an exception rather than a standard. Compared to our studies using more global measures, such as affective instability (Houben et al., 2016; Santangelo et al., 2016; Santangelo, Reinhard, et al., 2014), we find some specific features, a finding that suggests a need for additional studies and replications.

The results are subject to the following methodological limitations. The sample comprises female patients only, which restricts the representativeness of the results. However, given the literature regarding sex differences and emotion (Fischer, 2000), a pure female sample reduces heterogeneity, which may be useful. Whereas the total sample was large, subdividing it into several clinical groups limited the sample size of the subgroups. Nonetheless, having clinical control groups is a major advantage of this study. The non-significant finding for activation of interest in hypothesis 1 may be a consequence of low test power since it would have reached significance without the alpha adjustment. Nevertheless, we could replicate five of the seven sequences of Reisch et al. (2008) with our given sample and with the used alpha adjustment. With respect to comorbidity, patients with BPD as well as an additional PTSD or BN diagnosis were included in the sample, whereas clinical controls were not allowed to have a comorbid BPD diagnosis However, even after the exclusion of all patients with comorbid PTSD or BN from the BPD group in additional statistical analyses, our findings remained the same (data available upon request). Another common point against e-diary studies is the high variability in daily life. Future studies investigating emotion sequences should capture emotionally relevant events occurring during the assessment period. This would enable researchers to find connections between emotion sequences and potential trigger events. Moreover, it remains unclear whether all patient groups have the same ability to identify and specify emotions. Therefore, future research on emotion sequences could benefit from simultaneously investigating constructs such as emotional clarity (Lischetzke et al.,

2011; Lischetzke & Eid, 2017) or emotional differentiation (Trull et al., 2015). For clinical practice, it would be of major interest whether the found emotion sequences change as a result of treatment. More specifically, future studies should investigate treatment effects of patterns of emotion sequences, i.e., whether successfully completed psychotherapy leads to a lower relative frequency of dysregulated emotion sequences in individuals with BPD. Moreover, it could be useful to directly focus certain emotion regulation strategies, e.g., from the DBT skills training (Linehan, 2014), on emotion sequences dysregulated in BPD.

Conclusions

In summary, patients with BPD were more often trapped between feelings of anxiety and sadness, more often oscillated between anxiety and sadness, and more often experienced anxiety prior to experiencing anger in comparison to HCs. By confirming, in large part, the findings of Reisch et al. (2008), we conducted a successful replication study. Our findings indicate robust differences between patients with BPD and HCs and strengthen the significance of emotion sequences. However, we did not find distinct specificity of emotion sequences in patients with BPD compared to other patient groups, namely, patients with PTSD and patients with BN. The lack of specificity suggests that these emotion sequences could be transdiagnostic features. Nonetheless, finding the first evidence of disorder-specific emotion sequences in the BN group, we deem emotion sequences a promising approach to investigate affective dysregulation. Future studies should address whether emotion sequences change as a result of treatment in the patient groups.

References

Aldao, A. (2016). Introduction to the Special Issue: Emotion Regulation as a Transdiagnostic Process. *Cognitive Therapy and Research*, *40*(3), 257–261. https://doi.org/10.1007/s10608-016-9764-2

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. Washington, DC: American Psychiatric Publishing.

Anestis, M. D., Selby, E. A., Crosby, R. D., Wonderlich, S. A., Engel, S. G., & Joiner, T. E. (2010). A comparison of retrospective self-report versus ecological momentary assessment measures of affective lability in the examination of its relationship with bulimic symptomatology. *Behaviour Research and Therapy*, *48*(7), 607–613. https://doi.org/10.1016/j.brat.2010.03.012

Appelhans, B. M., Whited, M. C., Schneider, K. L., Oleski, J., & Pagoto, S. L. (2011). Response style and vulnerability to anger-induced eating in obese adults. *Eating Behaviors*, *12*(1), 9–14. https://doi.org/10.1016/j.eatbeh.2010.08.009

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2. ed.). Erlbaum.

Ebner-Priemer, U. W., Houben, M., Santangelo, P. S., Kleindienst, N., Tuerlinckx, F., Oravecz, Z., Verleysen, G., van Deun, K., Bohus, M., & Kuppens, P. (2015). Unraveling affective dysregulation in borderline personality disorder: A theoretical model and empirical evidence. *Journal of Abnormal Psychology*, *124*(1), 186–198. https://doi.org/10.1037/abn0000021

Ebner-Priemer, U. W., Kuo, J., Kleindienst, N., Welch, S. S., Reisch, T., Reinhard, I., Lieb, K., Linehan, M. M., & Bohus, M. (2007). State affective instability in borderline personality

disorder assessed by ambulatory monitoring. *Psychological Medicine*, *37*(7), 961–970. https://doi.org/10.1017/S0033291706009706

Ebner-Priemer, U. W., & Sawitzki, G. (2007). Ambulatory Assessment of Affective Instability in Borderline Personality Disorder. *European Journal of Psychological Assessment*, *23*(4), 238–247. https://doi.org/10.1027/1015-5759.23.4.238

Ebner-Priemer, U. W., Welch, S. S., Grossman, P., Reisch, T., Linehan, M. M., & Bohus, M. (2007). Psychophysiological ambulatory assessment of affective dysregulation in borderline personality disorder. *Psychiatry Research*, *150*(3), 265–275. https://doi.org/10.1016/j.psychres.2006.04.014

Fischer, A. (Ed.). (2000). *Gender and emotion: Social psychological perspectives*. Cambridge University Press.

Fox, J. R. E., & Harrison, A. (2008). The relation of anger to disgust: The potential role of coupled emotions within eating pathology. *Clinical Psychology & Psychotherapy*, *15*(2), 86–95. https://doi.org/10.1002/cpp.565

Fydrich, T., Renneberg, B., Schmitz, B., & Wittchen, H. U. (1997). *SKID II. Strukturiertes Klinisches Interview für DSM-IV, Achse II: Persönlichkeitsstörungen. Interviewheft. Eine deutschsprachige, erweiterte Bearbeitung der amerikanischen Originalversion des SCID-I*. Hogrefe.

Hathaway, L. M., Boals, A., & Banks, J. B. (2010). Ptsd symptoms and dominant emotional response to a traumatic event:An examination of DSM-IV Criterion A2. *Anxiety, Stress, and Coping*, *23*(1), 119–126. https://doi.org/10.1080/10615800902818771

Houben, M., Bohus, M., Santangelo, P. S., Ebner-Priemer, U. W., Trull, T. J., & Kuppens, P. (2016). The specificity of emotional switching in borderline personality disorder in comparison

to other clinical groups. *Personality Disorders*, *7*(2), 198–204. https://doi.org/10.1037/per0000172

Kashdan, T. B., Uswatte, G., Steger, M. F., & Julian, T. (2006). Fragile self-esteem and affective instability in posttraumatic stress disorder. *Behaviour Research and Therapy*, *44*(11), 1609–1619. https://doi.org/10.1016/j.brat.2005.12.003

Kohling, J., Moessner, M., Ehrenthal, J. C., Bauer, S., Cierpka, M., Kammerer, A., Schauenburg, H., & Dinger, U. (2016). Affective Instability and Reactivity in Depressed Patients With and Without Borderline Pathology. *Journal of Personality Disorders*, *30*(6), 776–795. https://doi.org/10.1521/pedi_2015_29_230

Leehr, E. J., Krohmer, K., Schag, K., Dresler, T., Zipfel, S., & Giel, K. E. (2015). Emotion regulation model in binge eating disorder and obesity--a systematic review. *Neuroscience and Biobehavioral Reviews*, *49*, 125–134. https://doi.org/10.1016/j.neubiorev.2014.12.008

Linehan, M. M. (1993). *Cognitive-behavioral treatment of borderline personality disorder*. *Diagnosis and Treatment of Mental Disorders*. Guilford Press.

Linehan, M. M. (2014). *DBT skills training manual*. Guilford Publications.

Lischetzke, T., Angelova, R., & Eid, M. (2011). Validating an indirect measure of clarity of feelings: Evidence from laboratory and naturalistic settings. *Psychological Assessment*, *23*(2), 447–455. https://doi.org/10.1037/a0022211

Lischetzke, T., & Eid, M. (2017). The Functionality of Emotional Clarity: A Process-Oriented Approach to Understanding the Relation Between Emotional Clarity and Well-Being. In M. D. Robinson & M. Eid (Eds.), *The Happy Mind: Cognitive Contributions to Well-Being* (1st ed., pp. 371–388). Springer International Publishing. https://doi.org/10.1007/978-3-319-58763-9_20

Lobbestael, J., Leurgans, M., & Arntz, A. (2011). Inter-rater reliability of the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID I) and Axis II Disorders (SCID II). *Clinical Psychology & Psychotherapy*, *18*(1), 75–79. https://doi.org/10.1002/cpp.693

Mombour, W., Zaudig, M., Berger, P., Gutierrez, K., Berner, W., Berger, K., & Bose, M. V. (1996). *International Personality Disorder Examination (IPDE)*. Hogrefe Testzentrale.

Pohlert, T. (2014). *The Pairwise Multiple Comparison of Mean Ranks Package (PMCMR). R package* [Computer software]. http://CRAN.R-project.org/package=PMCMR

Power, M. J., & Fyvie, C. (2013). The role of emotion in PTSD: Two preliminary studies. *Behavioural and Cognitive Psychotherapy*, *41*(2), 162–172. https://doi.org/10.1017/S1352465812000148

R Core Team. (2017). *R: A language and environment for statistical computing* [Computer software]. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Reisch, T., Ebner-Priemer, U. W., Tschacher, W., Bohus, M., & Linehan, M. M. (2008). Sequences of emotions in patients with borderline personality disorder. *Acta Psychiatrica Scandinavica*, *118*(1), 42–48. https://doi.org/10.1111/j.1600-0447.2008.01222.x

Roosen, M. A., Safer, D., Adler, S., Cebolla, A., & van Strien, T. (2012). Group dialectical behavior therapy adapted for obese emotional eaters; a pilot study. *Nutricion Hospitalaria*, *27*(4), 1141–1147. https://doi.org/10.3305/nh.2012.27.4.5843

Santangelo, P. S., Bohus, M., & Ebner-Priemer, U. W. (2014). Ecological momentary assessment in borderline personality disorder: A review of recent findings and methodological challenges. *Journal of Personality Disorders*, *28*(4), 555–576. https://doi.org/10.1521/pedi_2012_26_067

Santangelo, P. S., Limberger, M. F., Stiglmayr, C., Houben, M., Coosemans, J., Verleysen, G., Kuppens, P., Tuerlinckx, F., Vanpaemel, W., & Ebner-Priemer, U. W. (2016). Analyzing

subcomponents of affective dysregulation in borderline personality disorder in comparison to other clinical groups using multiple e-diary datasets. *Borderline Personality Disorder and Emotion Dysregulation*, *3*, 5. https://doi.org/10.1186/s40479-016-0039-z

Santangelo, P. S., Reinhard, I., Mussgay, L., Steil, R., Sawitzki, G., Klein, C., Trull, T. J., Bohus, M., & Ebner-Priemer, U. W. (2014). Specificity of affective instability in patients with borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls. *Journal of Abnormal Psychology*, *123*(1), 258–272. https://doi.org/10.1037/a0035619

Selby, E. A., Doyle, P., Crosby, R. D., Wonderlich, S. A., Engel, S. G., Mitchell, J. D., & Le Grange, D. (2012). Momentary emotion surrounding bulimic behaviors in women with bulimia nervosa and borderline personality disorder. *Journal of Psychiatric Research*, *46*(11), 1492–1500. https://doi.org/10.1016/j.jpsychires.2012.08.014

Siever, L. J., Torgersen, S., Gunderson, J. G., Livesley, W., & Kendler, K. S. (2002). The borderline diagnosis III: Identifying endophenotypes for genetic studies. *Biological Psychiatry*, *51*(12), 964–968. https://doi.org/10.1016/S0006-3223(02)01326-4

Steil, R., Dyer, A., Priebe, K., Kleindienst, N., & Bohus, M. (2011). Dialectical behavior therapy for posttraumatic stress disorder related to childhood sexual abuse: A pilot study of an intensive residential treatment program. *Journal of Traumatic Stress*, *24*(1), 102–106. https://doi.org/10.1002/jts.20617

Tragesser, S. L., Solhan, M. B., Schwartz-Mette, R., & Trull, T. J. (2007). The role of affective instability and impulsivity in predicting future BPD features. *Journal of Personality Disorders*, *21*(6), 603–614. https://doi.org/10.1521/pedi.2007.21.6.603

Troop, N. A., Murphy, F., Bramon, E., & Treasure, J. L. (2000). Disgust sensitivity in eating disorders: A preliminary investigation. *International Journal of Eating Disorders*, *27*(4), 446–451. https://doi.org/10.1002/(SICI)1098-108X(200005)27:4<446::AID-EAT9>3.0.CO;2-W

Trull, T. J., & Ebner-Priemer, U. W. (2014). The Role of Ambulatory Assessment in Psychological Science. *Current Directions in Psychological Science*, *23*(6), 466–470. https://doi.org/10.1177/0963721414550706

Trull, T. J., Lane, S. P., Koval, P., & Ebner-Priemer, U. W. (2015). Affective Dynamics in Psychopathology. *Emotion Review : Journal of the International Society for Research on Emotion*, *7*(4), 355–361. https://doi.org/10.1177/1754073915590617

Trull, T. J., Solhan, M. B., Tragesser, S. L., Jahng, S., Wood, P. K., Piasecki, T. M., & Watson, D. (2008). Affective instability: Measuring a core feature of borderline personality disorder with ecological momentary assessment. *Journal of Abnormal Psychology*, *117*(3), 647–661. https://doi.org/10.1037/a0012532

Vansteelandt, K., Probst, M., & Pieters, G. (2013). Assessing affective variability in eating disorders: Affect spins less in anorexia nervosa of the restrictive type. *Eating Behaviors*, *14*(3), 263–268. https://doi.org/10.1016/j.eatbeh.2013.03.004

Wittchen, H. U., Wunderlich, U., Gruschwitz, S., & Zaudig, M. (1997). *SKID I. Strukturiertes Klinisches Interview für DSM-IV. Achse I: Psychische Störungen. Interviewheft und Beurteilungsheft. Eine deutschsprachige, erweiterte Bearbeitung der amerikanischen Originalversion des SCID-I*. Hogrefe.

World Health Organisation. (1992). *The ICD-10 classification of mental and behavioural disorders: clinical descriptions and diagnostic guidelines*. World Health Organisation.

STUDY 2: THE OCCURRENCE OF EMOTIONS AND THEIR ASSOCIATION WITH DISTRESS IN THE DAILY LIFE OF PATIENTS WITH BORDERLINE PERSONALITY DISORDER

Chapter 3

Abstract

Borderline personality disorder (BPD) is characterized by more frequent and more intense negative emotions and less frequent positive emotions in daily life than healthy controls (HCs) experience, but there is limited empirical evidence regarding whether this is a transdiagnostic or disorder-specific finding and which specific emotions are especially distressing in BPD. We assessed participants' current emotions and distress every 15 min over a 24-h period using e-diaries to investigate the frequency, intensity, and the associated distress of specific emotions. To test the disorder specificity, we used multilevel modeling to compare 43 female patients with BPD, 28 patients with posttraumatic stress disorder (PTSD), 20 patients with bulimia nervosa (BN), and 28 HCs. Patients with BPD exhibited anger more frequently than any of the clinical or healthy control groups, demonstrating specificity. The quality of anger accounted for additional distress beyond the pure emotional intensity. In patients with BPD, joy was associated with reduced distress, which was not the case in HCs or PTSD. However, the majority of the comparisons (anxiety, sadness, shame, disgust, jealousy, guilt, interest) revealed transdiagnostic patterns. The distress-enhancing

or distress-reducing effects of anger and joy might represent an important part of affective dysregulation in BPD.

Introduction

In clinical psychiatry, we are currently witnessing a debate on categorical systems and transdiagnostic mechanisms (Clark et al., 2017). For instance, the categorical definition of borderline personality disorder (BPD) in ICD-10 (World Health Organisation, 1992) as "emotionally unstable personality disorder" points to affective instability as a disorder-specific feature. Yet, empirical evidence has revealed that affective instability is, for example, also present in patients with posttraumatic stress disorder (PTSD) and patients with eating disorders, and that affective instability is not able to distinguish between these categorical disease groups (e.g., Houben et al., 2016; Santangelo et al., 2014; Santangelo et al., 2016). Accordingly, affective instability is now considered to be a transdiagnostic feature.

However, the DSM-5 (American Psychiatric Association, 2013) defines BPD not solely by affective instability but also by other criteria, such as inappropriate anger. It has not yet been extensively investigated whether the frequency and the intensity of emotions are specific for certain disorders, in line with categorical systems, or whether they are present across disorders, in terms of a transdiagnostic approach. For example, the Research Domain Criteria project (RDoC; Cuthbert & Insel, 2013) highlights the domains "Positive Valence Systems" and "Negative Valence Systems" as underlying transdiagnostic mechanisms of affective experience, neglecting the role of specific emotions. However, Schoenleber and Berenbaum (2012b) recommend consistently considering the influence of specific emotions when studying the features of personality disorders, over and above the influence of general negative and positive affect.

Ambulatory Assessment of Specific Emotions in the Everyday Life of Patients with BPD

Ambulatory assessment (AA) methodology has been used in a multitude of studies investigating emotional processes in patients with BPD and is well suited for describing which emotions specifically characterize the everyday experience of patients with BPD (Trull, 2018). AA allows repeated real-time assessments with minimized retrospective bias and is therefore ideally suitable to assess affective experience in the most relevant context, the daily life of patients (Trull & Ebner-Priemer, 2013).

Although altered affective experiences such as anger are an essential part of the pathology of BPD (American Psychiatric Association, 2013), little research has been conducted in daily life, and findings do not clearly favor the categorical or the transdiagnostic model. To the best of our knowledge, only two empirical investigations using AA directly target either the occurrence or the intensities of a broad range of specific emotions in patients with BPD. Trull et al. (2008) found a higher instability of sadness, fear, and hostility in patients with BPD than in depressive patients, but no difference was found between the intensities of these specific emotions. The particular finding that the BPD group did not report more intense hostility than the depression group is surprising, given the DSM-5 diagnostic criterion describing "inappropriate, intense anger" as a feature of BPD (American Psychiatric Association, 2013). Altered intensities of specific emotions, however, were found in the study of Ebner-Priemer et al. (2007). Comparing patients with BPD to healthy controls (HCs), they revealed heightened frequencies and intensities across all the measured negative emotions and lowered frequencies of positive emotions. The lack of clinical controls might have been a possible reason for the largely unspecific differences and precluded statements on specificity.

The Current Study

In our study, to improve on previous designs of AA studies investigating a broad range of specific emotions, we included additional clinical groups and HCs. In detail, using a design similar to the one used by Ebner-Priemer et al. (2007), we compared the everyday frequencies and intensities of specific emotions (joy, interest, anxiety, anger, sadness, shame, disgust, jealousy, guilt) in patients with BPD to those in patients with PTSD and patients with bulimia nervosa (BN) as well as HCs. Thus, we intended to enrich the ongoing debate on categorical vs. transdiagnostic models with empirical evidence of specific emotions as a hitherto understudied aspect of affective experience. Regarding specificity, numerous studies have highlighted the central role of two specific emotions in BPD, namely, anger (e.g., Mancke et al., 2017; Morse et al., 2009; Stepp et al., 2009; Tomko et al., 2014) and shame (e.g., Rüsch et al., 2007; Gratz et al., 2010; Rizvi et al., 2011; Schoenleber & Berenbaum, 2012a; Chapman et al., 2014; Mneimne et al., 2018). Moreover, in BPD symptomatology, anger and shame seem to be related inasmuch as the experience of shame might lead to anger, which was shown in the laboratory (Scheel et al., 2013) and in daily life (Scott et al., 2015). A more recent AA study investigated the association among social rejection, anger, shame, and aggressive urges in participants with BPD symptomatology and revealed that perceived rejection predicted increases in both anger and shame (Scott et al., 2017). Moreover, Lis et al. (2018) reported hypersensitivity to injustice, which mediated the frequency of hostile behavior in subjects with a clinically relevant degree of BPD features.

However, it is largely unclear which specific emotions cause distress in BPD. To have a specific emotion more often or to feel it more intensely does not necessarily mean that this emotion is particularly impairing. For this reason, we were interested in extracting the additional effect of the quality of a specific emotion on distress beyond the mere influence of positive and negative

affect. We consider this to be important for treatment, which should target patients' most impairing affective experiences.

Hypotheses

To replicate previous findings on the frequency and intensity of specific emotions, we tested whether patients with BPD would report negative emotions more frequently, positive emotions less frequently (hypothesis 1a), and negative emotions but not positive emotions more intensely (hypothesis 1b) than HCs. Extending previous research, we hypothesized that anger and shame would occur more frequently (2a) and intensely (2b) in patients with BPD than in clinical controls. In exploratory analyses, we addressed the distress associated with specific emotions beyond the mere influence of positive and negative valence.

Methods

Subjects

The sample of 43 patients with BPD, 28 patients with PTSD related to childhood abuse, 20 patients with BN, and 28 HCs is part of a larger investigation on affective dysregulation, which has already resulted in publications on affective instability (Ebner-Priemer et al., 2015; Santangelo et al., 2014; Santangelo et al., 2016) and emotion sequences (Kockler et al., 2017). Depending on their respective groups, the patients met the DSM-IV criteria for BPD, PTSD, or BN. Trained postgraduate psychologists conducted the German versions of the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID-I; Wittchen et al., 1997) and for DSM-IV Axis II Disorders (SCID-II; Fydrich et al., 1997). The inter-rater reliability of these interviews has been demonstrated to be very good (K = 0.71 for SCID-I; K = 0.84 for SCID-II, Lobbestael et al., 2011). Additionally, we used the BPD section of the German version of the International Personality Disorder

Examination (IPDE, Mombour et al., 1996). We excluded participants of any patient group in case of a history of schizophrenia, bipolar disorder, or current substance abuse. Furthermore, patients from the clinical control groups, that is, patients with PTSD or BN, were not allowed to meet the diagnostic criteria for BPD. We allowed all other comorbidities in the clinical control groups. The BPD group also included patients who were diagnosed with comorbid PTSD or BN. Lifetime or current psychiatric disorder diagnoses, psychotherapeutic treatments, and the use of psychotropic medications constituted exclusion criteria for participation in the HC group.

We collected data at two study centers in Germany, namely, at the Central Institute of Mental Health Mannheim and the Psychosomatic Clinic St. Franziska Stift Bad Kreuznach. We recruited outpatients and inpatients from their outpatient clinics or wards or via advertisements in local newspapers and on the Internet. We selected HCs randomly from the national resident register of the City of Mannheim or recruited them via advertisement. All participants provided written informed consent prior to participation in the study, which had received prior approval from the local ethics committee.

Assessment and Data Acquisition

In previously published studies, the used set of items and the chosen time-based design resulted in satisfactory methodological quality, i.e., low reactivity, high compliance, minimal patient burden, etc. (for details, see Ebner-Priemer et al., 2007). The participants obtained palmtop computers (Tungsten E, Palm Inc., U.S.A.) that we programmed with the e-diary software DialogPad (Gerhard Mutz, Cologne University, Germany). After being carefully instructed in its use by the study staff, the participants carried the e-diary with them for 24 hours.

To capture the rapid dynamics of affective experience in the daily life of the participants, we chose a high-resolution time-based design with a period of 24 hours. Every 15 min (±1 min)

during their waking time, the e-diary prompted the participants, via a beep, to report their current perceived specific emotions. The question, "Do you feel any of the following emotions right now?" could be answered on a list composed of the following: happy, anxious, angry, shame, disgust, sad, guilt, interest, envy/jealousy, emotion but cannot name it, and no emotion. In contrast to Ebner-Priemer et al. (2007), we added two further specific emotions, guilt and jealousy, to broaden the range of emotions. If the participants selected the option "emotion but cannot name it," they were then asked whether the current emotion was pleasant or unpleasant.

Next, the participants were asked how intensely they feel the current specific emotion on an 11-point rating scale ranging from 1 (low intensity) to 11 (high intensity). To determine whether the participants felt a second, concurrent emotion, they were again asked, "Do you feel any other of the following emotions?" followed by the same list of emotions as before except for the previously chosen first emotion. The participants rated the intensity of the second emotion on the same 11-point rating scale.

To assess the momentary level of distress, we asked the participants, "How high is your distress right now?" on an 11-point rating scale ranging from 0 (no distress) to 10 (maximal level of distress). In addition, the participants responded to some behavioral questions characteristic of their disorder that are not reported in this manuscript. After completing the assessment period, participants handed back the device, and the e-diary data with time-stamped prompts were uploaded to our servers. Furthermore, the participants completed a set of paper-and-pencil questionnaires to consider potential control variables.

AA Measures

As outcome measures for the frequencies of specific emotions, we built dummy coded variables for each specific emotion. If an emotion was reported as first or as second emotion, the

dummy variable for this specific emotion was coded as 1 for that assessment; otherwise, it was coded as 0. For graphical representation (figures), we calculated relative frequencies by dividing the sum of the absolute frequencies of each specific emotion by the sum of valid assessments per person. For each specific emotion, we created a variable representing the intensity of the emotion. We set the intensity as missing if the specific emotion did not occur at an assessment point, ensuring that intensity would be independent of frequency in further data analyses. In addition, we created two further variables, namely, momentary positive and negative valence. Positive valence was determined when joy, interest, or nonspecific pleasant emotion were reported as first or as second emotion at an assessment point and corresponds to the mean intensity of these positive emotions. Negative valence corresponds to the mean intensity of the negative emotions reported at an assessment point, i.e., when anxiety, anger, sadness, shame, disgust, jealousy, guilt, or nonspecific unpleasant emotion were reported as first or as second emotion. We split valence into two variables to account for the two RDoC domains of Positive Valence Systems and Negative Valence Systems (Cuthbert & Insel, 2013).

Data Analyses

First, to analyze the group differences of emotion frequencies, we generated mixed effects logistic regression models for each specific emotion using the group variable as the predictor and the dummy-coded variable as the categorical outcome denoting the occurrence of the specific emotion. We used the "glmer" function (generalized linear mixed-effects models) of the R package "lme4" (Bates et al., 2015; R Core Team, 2017) and set the HC group as the reference group of the models. Applying the "contrast" function of the package "contrast" (Kuhn et al., 2016), we determined the remaining group comparisons that were not shown in the main models. We report

the group comparisons by means of differences in their odds. As we generated one model for each specific emotion, we restricted the alpha level to .01 to limit alpha inflation due to multiple testing.

Second, regarding the intensity of the emotion, we generated linear mixed effects models to predict the intensity of each specific emotion by group membership by applying the "lme" function (linear mixed-effects models) of the R-package "nlme" (Pinheiro et al., 2018). Again, we set the HC group as the reference group of the models, determined the remaining group contrasts, and restricted alpha to .01.

Third, we investigated whether specific emotions had an especially impairing effect on the participants' momentary distress. What we call the distressing quality of an emotion stands for the additional effect of a specific emotion on distress that goes beyond the pure influence of valence. To analyze which specific emotions were most impairing in the different groups, we predicted participants' distress from the occurrence of the specific emotions, the group, and the interactions of the specific emotions with the group variable controlling for positive and negative valence. We used the previously used dummy-coded occurrence variable of each emotion and centered the two continuous predictors of positive valence and negative valence around their respective individual means. To avoid inflation of the model, we decided to include only those specific emotions that occurred in at least 5% of the valid assessments over all participants.

Results

Sample Characteristics

Details of the sample of the 119 female participants consisting of 43 patients with BPD, 28 patients with PTSD, 20 patients with BN, and 28 HCs are provided in Table 3.1. The average age of the study participants was 28.6 years (range: 18 to 48). With regard to age, the BPD group did not differ significantly from the clinical controls and the HCs (*Kruskal-Wallis-H* = 4.15, *p* = .13).

On average, 42% of the patients in the clinical groups were treated with psychotropic medication. Among the comorbid Axis I diagnoses, anxiety disorders were most prevalent (62%), especially social phobia (40%), and major depressive disorder was common as well (37%). The most frequent comorbid personality disorder was avoidant personality disorder (36%). The participants provided, on average, 57.55 self-reports ($SD = 7.77$), and the compliance rate, i.e., the number of valid reports divided by the total number of alarms, was 94%.

Table 3.1.

Sample characteristics by group

Variable	BPD ($n = 43$)	PTSD ($n = 28$)	BN ($n = 20$)	HCs ($n = 28$)
Age in years				
M (*SD*)	26.72 (7.07)	35.25 (7.53)	23.70 (5.97)	28.82 (7.47)
Psychotropic medication				
n (%)	16 (37%)	17 (60%)	5 (25%)	-
Hospitalization *n* (%)				
Outpatients	26 (60%)	8 (29%)	9 (45%)	-
Inpatients	17 (40%)	20 (71%)	11 (55%)	-
Current Axis I diagnoses *n* (%)				
Major depression	9 (21%)	15 (54%)	10 (50%)	-
Anxiety disorders	27 (63%)	19 (68%)	10 (50%)	-
PTSD	22 (51%)	28 (100%)	3 (15%)	-
Bulimia nervosa	9 (21%)	2 (7%)	20 (100%)	-

(continued)

Sample characteristics by group (continued)

Variable	BPD (*n* = 43)	PTSD (*n* = 28)	BN (*n* = 20)	HCs (*n* = 28)
Current Axis II disorders *n* (%)				
Borderline	43 (100%)	exclusion criterion		-
IPDE criterion affective	41 (95%)	17 (61%)	12 (60%)	-
Avoidant	24 (25%)	6 (21%)	3 (15%)	-
Obsessive-compulsive	7 (16%)	3 (11%)	2 (10%)	-
Dependent	7 (16%)	0 (0%)	1 (5%)	-
Paranoid	7 (16%)	3 (11%)	1 (5%)	-
Dimensional scores				
PDS	1.81	1.86	1.09	-
CTQ	66.49	79.31	44.00	30.64
CTQ (sexual abuse subscale)	10.53	17.58	6.78	5.11

BPD = borderline personality disorder; PTSD = posttraumatic stress disorder; BN = bulimia nervosa; HCs = healthy controls; IPDE = International Personality Disorder Examination (Mombour et al., 1996); PDS = Posttraumatic Diagnostic Scale; CTQ = Childhood Trauma Questionnaire

Frequencies of Specific Emotions

In the first step, we analyzed differences in the frequencies of specific emotions between patients with BPD and HCs (hypothesis 1a) using mixed effects logistic regression models. We revealed significant differences for nearly all specific emotions, with the sole exception of joy (see Figure 3.1 for a visualization of the relative frequencies). In detail, patients with BPD had 43% lower odds of reporting interest (β = -0.85, *SE* = 0.32, *p* = .007), 3358% higher odds of reporting anxiety (β = 3.54, *SE* = 0.51, *p* < .001), 464% higher odds of reporting anger (β = 1.53, *SE* = 0.22,

$p < .001$), 1337% higher odds of reporting sadness ($\beta = 2.66$, $SE = 0.40$, $p < .001$), 2390% higher odds of reporting shame ($\beta = 3.21$, $SE = 0.52$, $p < .001$), 1925% higher odds of reporting disgust ($\beta = 3.01$, $SE = 0.76$, $p < .001$), 1254% higher odds of reporting jealousy ($\beta = 2.53$, $SE = 0.92$, $p = .006$), 7642% higher odds of reporting guilt ($\beta = 4.35$, $SE = 0.75$, $p < .001$), and 1456% higher odds of reporting unpleasant negative emotions ($\beta = 2.74$, $SE = 0.42$, $p < .001$) than HCs had. These findings corresponded to our hypothesis and replicated the findings of Ebner-Priemer et al. (2007). Contrary to our hypotheses, patients with BPD did not differ from HCs in their frequency of joy ($\beta = 0.52$, $SE = 0.31$, $p = .09$) or nonspecific pleasant emotion ($\beta = 0.11$, $SE = 0.42$, $p = .79$).
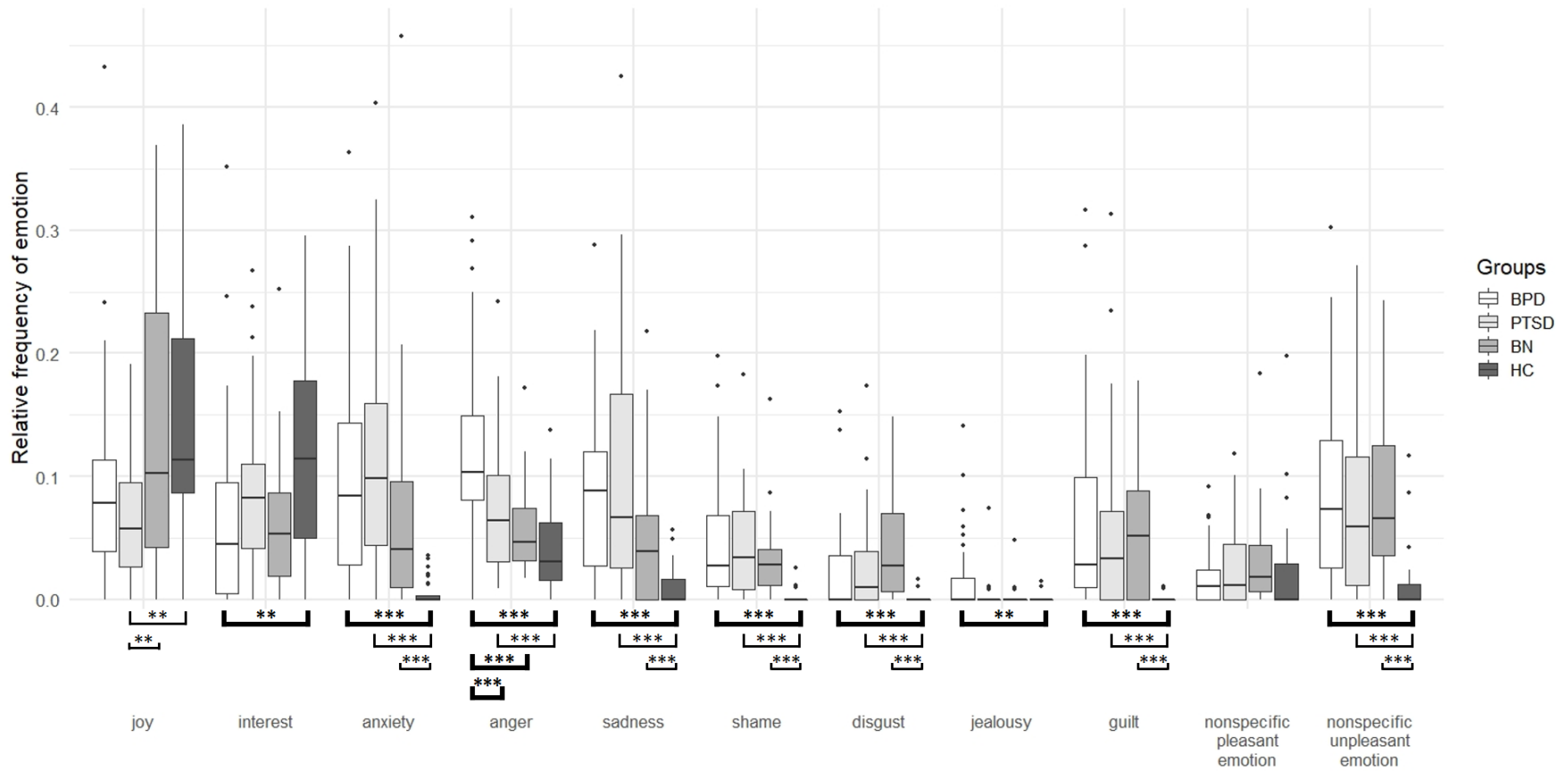
Figure 3.1. Relative frequencies of specific emotions by group.

Note: The brackets illustrate the results of the mixed effects logistic regression models regarding the group differences in the frequencies of specific emotions. The alpha level was restricted to .01 to limit alpha inflation due to multiple testing. ** $p < 0.01$; *** $p < 0.001$; BPD = borderline personality disorder; PTSD = posttraumatic stress disorder; BN = bulimia nervosa; HC = healthy controls. Bold brackets indicate significant differences between the BPD group and other study groups.

In the second step, we analyzed differences in the frequencies of specific emotions between patients with BPD and clinical controls (hypothesis 2a), thereby approaching the concepts of specificity and transdiagnostic patterns. Most often, we found a pattern with significant differences between the clinical controls and the HCs (all p-values $< .001$) but no differences between the clinical controls and the patients with BPD. This applies to anxiety, sadness, shame, disgust, guilt, and nonspecific unpleasant emotion and points to transdiagnostic findings.

Regarding specificity, we found one emotion whose frequency was specifically heightened in the BPD group compared to all other groups. Patients with BPD reported anger more frequently than patients with PTSD (201% higher odds, $\beta = 0.70$, $SE = 0.20$, $p < .001$), patients with BN (260% higher odds, $\beta = 0.95$, $SE = 0.23$, $p < .001$), or HCs (464% higher odds, $\beta = 1.53$, $SE = 0.22$, $p < .001$). This result indicates that an increased frequency of anger may be specific rather than transdiagnostic. In addition, patients with PTSD exhibited more anger than HCs (230% higher odds, $\beta = 0.83$, $SE = 0.24$, $p < .001$).

Interest and jealousy presented a blurry picture. In these two specific emotions, we found significant differences between BPD and HCs, whereas the clinical control groups exhibited no significant differences from the HCs (all p-values $> .06$). The differences between BPD and the clinical controls, in turn, were not significant. Some evidence for specificity was found for a reduced frequency of joy in the PTSD group compared to patients with BN (35% lower odds, $\beta = -1.04$, $SE = 0.37$, $p = .005$) and HCs (34% lower odds, $\beta = -1.09$, $SE = 0.34$, $p = .001$) but not compared to patients with BPD ($\beta = 0.57$, $SE = 0.31$, $p = .07$).

Intensities of Specific Emotions

In the first step of this component, we analyzed differences in the intensity of specific emotions between patients with BPD and HCs (hypothesis 1b) using mixed effects regression

models. Of the eight emotions we hypothesized to be intensified in BPD, we revealed six that differed significantly (see Figure 3.2 for a visualization of the intensities). As hypothesized, and replicating the findings of Ebner-Primer et al. (2007), patients with BPD exhibited higher intensities of anxiety ($\beta = 3.57$, $SE = 0.92$, $p < .001$), anger ($\beta = 2.75$, $SE = 0.52$, $p < .001$), sadness ($\beta = 3.66$, $SE = 0.70$, $p < .001$), shame ($\beta = 4.36$, $SE = 1.13$, $p < .001$), jealousy ($\beta = 4.40$, $SE = 1.51$, $p = .008$), guilt ($\beta = 4.27$, $SE = 1.48$, $p = .005$), and nonspecific unpleasant emotion ($\beta = 2.90$, $SE = 0.72$, $p < .001$) than HCs did.
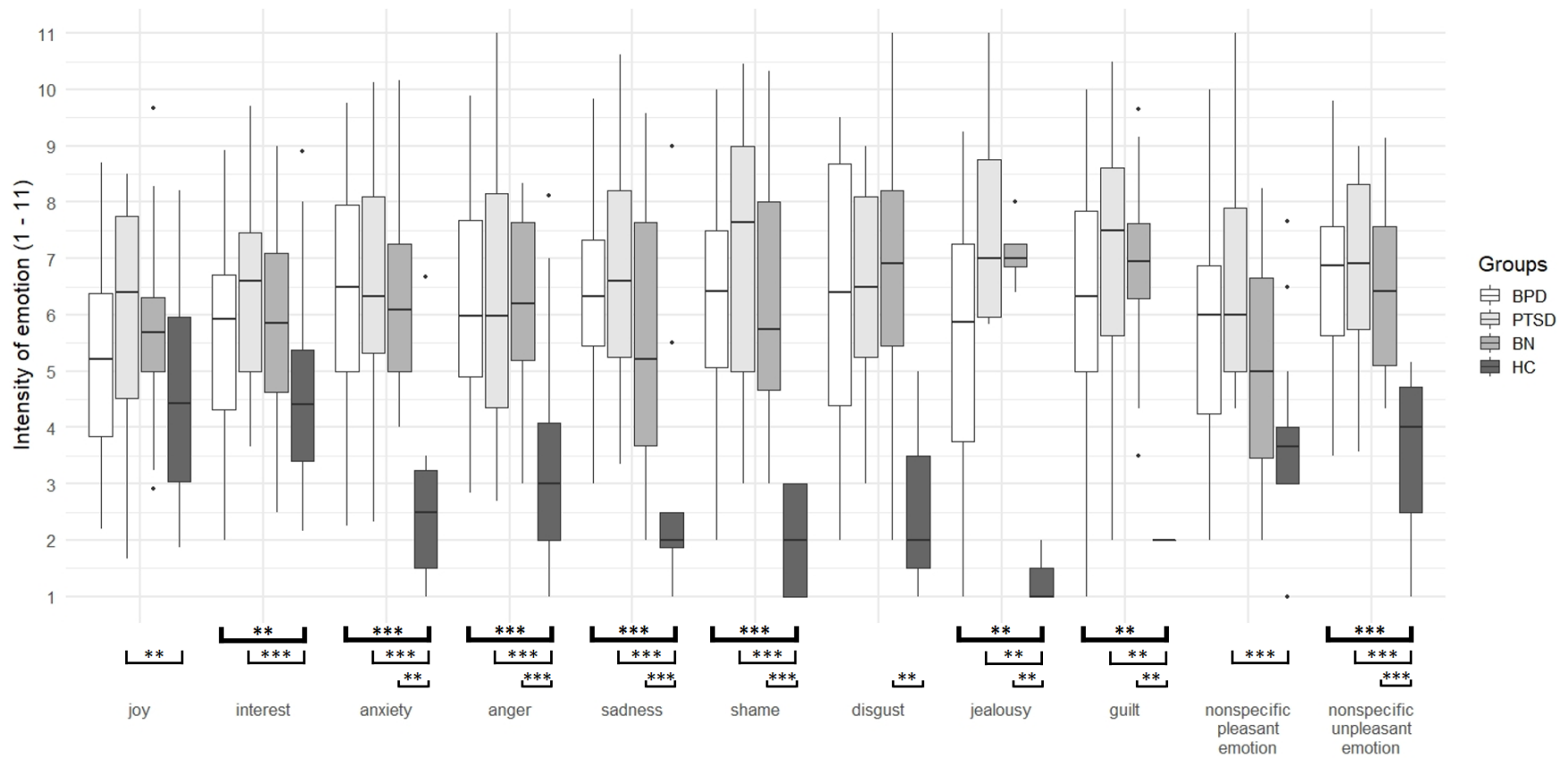
Figure 3.2. Intensity of specific emotions by group.

Note: The brackets illustrate the results of the mixed effects regression models regarding the group differences in the intensity of specific emotions. The alpha level was restricted to .01 to limit alpha inflation due to multiple testing. ** $p < 0.01$; *** $p < 0.001$; BPD = borderline personality disorder; PTSD = posttraumatic stress disorder; BN = bulimia nervosa; HC = healthy controls. Bold brackets indicate significant differences between the BPD group and other study groups.

Contrary to what we expected, patients with BPD missed the adjusted significance level for a heightened intensity of disgust ($\beta = 3.92$, $SE = 1.48$, $p = .011$). Moreover, patients with BPD experienced positive emotion interest more intensely than HCs did ($\beta = 1.25$, $SE = 0.47$, $p = .005$). However, we replicated the result that patients with BPD did not differ from HCs in their mean intensity of joy ($\beta = 0.64$, $SE = 0.44$, $p = .15$).

Second, we analyzed differences in the intensities of specific emotions between patients with BPD and clinical controls (hypothesis 2b) to examine specificity. No significant differences emerged between the three clinical groups for any of the intensities of the specific emotions (all p-values > .07). Moreover, all of the revealed differences referring to anxiety, anger, sadness, shame, jealousy, guilt, and nonspecific unpleasant emotion between the HC group and BPD also held true for the comparison between the HC group and the clinical control groups (PTSD and BN; all p-values < .008), which hints at transdiagnostic findings even more consistently than the results with regard to frequency.

In addition, patients with PTSD exhibited higher intensities of joy ($\beta = 1.52$, $SE = 0.51$, $p = .004$), interest ($\beta = 1.85$, $SE = 0.46$, $p < .001$), and nonspecific pleasant emotion ($\beta = 2.56$, $SE = 0.68$, $p < .001$) than HCs did, and patients with BN experienced more intense disgust than HCs did ($\beta = 4.17$, $SE = 1.50$, $p = .008$). The descriptive values of interest, disgust, and nonspecific pleasant emotion also gave the impression of transdiagnostic differences, but due to the conservative choice of alpha, not all the comparisons between the clinical groups and HCs were significant.

Distress Induced by Specific Emotions

In the final step, we analyzed group differences in the distress associated with specific emotions. In detail, using linear mixed effects regressions, we predicted distress by the interaction

of group and specific emotions, controlling for the occurrence and valence of these emotions. That is, the interaction term of the model represented the additional effect of the quality of the specific emotions on distress above and beyond the influence of pure positive and negative valence. Although we were mainly interested in this interaction effect, we will describe the findings starting with the main effects depicted at the top of Table 3.2.

Table 3.2

Estimates from the multilevel model to predict distress from positive and negative valence, group, the occurrence of specific emotions, and the interaction of group with the occurrence of specific emotions

	β	SE	p	sig.
Intercept	0.31	0.32	.33	
Main effects				
Positive valence	-0.04	0.01	$< .001$	***
Negative valence	0.36	0.01	$< .001$	***
BPD	4.45	0.42	$< .001$	***
PTSD	4.33	0.46	$< .001$	***
BN	3.81	0.50	$< .001$	***
HCs	-	-	-	
Joy	0.03	0.12	.82	
Interest	0.20	0.12	.08	
Anxiety	-0.10	0.41	.80	
Anger	-0.27	0.18	.12	
Sadness	0.25	0.32	.44	
Shame	-0.32	0.65	.62	
Guilt	-0.50	0.91	.58	
Nonspecific negative emotion	-0.32	0.33	.33	
Interaction effects				
BPD × joy	-0.48	0.15	.001	**
PTSD × joy	-0.13	0.18	.46	
BN × joy	-0.57	0.17	.001	**

(continued)

55

Estimates from the multilevel model to predict distress from positive and negative valence, group, the occurrence of specific emotions, and the interaction of group with the occurrence of specific emotions (continued)

	β	SE	p	sig.
BPD × interest	-0.21	0.16	.19	
PTSD × interest	-0.03	0.17	.83	
BN × interest	-0.47	0.20	.02	*
BPD × anxiety	0.56	0.42	.19	
PTSD × anxiety	0.61	0.43	.15	
BN × anxiety	0.72	0.45	.10	
BPD × anger	0.69	0.19	< .001	***
PTSD × anger	0.51	0.21	.02	*
BN × anger	0.83	0.24	< .001	***
BPD × sadness	-0.56	0.34	.10	
PTSD × sadness	-0.12	0.34	.73	
BN × sadness	-0.56	0.37	.12	
BPD × shame	0.43	0.66	.51	
PTSD × shame	0.43	0.66	.52	
BN × shame	0.78	0.68	.25	
BPD × guilt	0.63	0.92	.49	
PTSD × guilt	0.69	0.92	.46	
BN × guilt	0.88	0.93	.34	
BPD × nonspec. neg. emotion	0.41	0.34	.23	
PTSD × nonspec. neg. emotion	-0.23	0.36	.51	
BN × nonspec. neg. emotion	0.58	0.36	.10	
Number of observations	6327			

Note. β = unstandardized coefficient; *SE* = standard error; * $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$;

BPD = borderline personality disorder; PTSD = posttraumatic stress disorder; BN = bulimia nervosa; HCs = healthy controls (reference group).

As expected, positive valence was negatively associated with distress (β = -0.04, *SE* = 0.01, $p < .001$), whereas negative valence was positively associated with distress (β = 0.36, *SE* = 0.01, $p < .001$). All clinical groups exhibited higher distress than HCs (all *p*-values < .001). None of the occurring emotions of joy, interest, anxiety, anger, sadness, shame, guilt, or nonspecific negative

emotion had a significant impact on distress beyond the influence of valence (p-values ranging from .08 to .82) in the HC group. However, in the clinical groups, we found some evidence for additional distress associated with the quality of three specific emotions.

First and most impairing was anger, which was associated with increased distress in patients with BPD ($\beta = 0.69$, $SE = 0.19$, $p < .001$), patients with PTSD ($\beta = 0.51$, $SE = 0.21$, $p = .02$), and patients with BN ($\beta = 0.83$, $SE = 0.24$, $p < .001$), even when we controlled for positive and negative valence. Roughly speaking, the experience of anger increases distress by nearly 0.7 units in patients with BPD (on a scale from 0 to 10), above and beyond the influences of group and valence. This suggests that anger, more than other emotions, might be particularly problematic for patients with BPD.

Second, when reporting joy, patients with BPD and patients with BN felt significantly lower distress than HCs (BPD: $\beta = -0.48$, $SE = 0.15$, $p = .001$; BN: $\beta = -0.57$, $SE = 0.17$, $p = .001$), which implies that patients with BPD (and those with BN) might even benefit more than HCs from experiencing joy. Third, patients with BN had less distress than HCs when interest occurred ($\beta = -0.47$, $SE = 0.20$, $p < .02$). Anxiety, sadness, shame, guilt, and nonspecific negative emotions were not associated with altered distress in the clinical groups (p-values ranging from .10 to .73).

Discussion

This is the first study to investigate the frequency, intensity, and distress associated with specific emotions in patients with BPD compared to clinical controls and HCs. Patients with BPD experience all of the assessed negative emotions more frequently and nearly all of the negative emotions more intensely than HCs, except for disgust. This confirms our hypotheses and largely replicates previous findings (Ebner-Priemer et al., 2007). The findings related to the positive emotions were less consistent. Patients with BPD and HCs differed neither in the frequency nor in

the intensity of reported joy, whereas patients with BPD reported interest less frequently but with a higher intensity than HCs.

Regarding specificity, we found evidence that patients with BPD differed from clinical controls in their experience of anger but not of shame. As hypothesized, standing out from the otherwise largely transdiagnostic patterns, patients with BPD experienced anger more frequently than any of the other study groups (PTSD, BN, HCs). We found no differences in the intensity of anger but revealed that anger was the only specific emotion that contributed to distress above and beyond mere valence. The specificity of a heightened frequency of anger would be noteworthy already, but when combined with the distress-associated effect, the results gain deeper meaning for the understanding of BPD pathology. The occurrence of anger is frequent in BPD specifically and additionally distressing, even after negative valence is statistically controlled for. These findings reflect the particular importance of anger and to some extent substantiate the existence of the respective BPD diagnostic criterion of "inappropriate, intense anger" (American Psychiatric Association, 2013). They are in line with the finding of Morse et al. (2009) that BPD is associated with proneness to anger as well as with a report by Stepp et al. (2009), who found that patients with BPD are, among other altered affective experiences, angrier than patients with other personality disorders in the context of social interactions. Furthermore, working from the assumption of Mancke et al. (2017) that emotion dysregulation may constitute an underlying factor that gives rise to anger, a specifically frequent and impairing occurrence of anger could be the visible result of emotion dysregulation in BPD.

Contrary to what we expected, the clinical groups differed neither in their frequency nor in their intensity of shame. Given the high relevance of shame in BPD research, it is surprising that shame was one of the rarest emotions reported in this study. A possible explanation is provided by Schoenleber and Berenbaum (2012b), who argue that patients tend to circumvent shame as an

especially painful emotion, either by avoidance of and escape from shame triggers or by regulating shame with aggression. This strategy of resorting to anger instead of shame could have contributed to the high frequency of anger, but this is speculative given that our study design does not allow for analyses of the temporal course of specific emotions. However, when examining the intensity of shame and especially the distress associated with that emotion, we found no evidence for an especially impairing role of shame. Another possible explanation for the rare occurrence of shame and its lack of BPD-specificity could be that our assessment of shame might be a too global measure: Scheel et al. (2014) found that mental disorders show different typical aspects of shame, with existential shame being specific to BPD. The authors characterize existential shame as an enduring feeling of shame, which does not need to be evoked by specific situations and which negatively affects a person's self-esteem as a whole. Applied to our AA study, this could mean that patients with BPD might subliminally feel enduring existential shame, which might not be perceived as an acute emotion worth reporting in a daily life protocol.

We were surprised to find that joy was associated with a reduction in distress in patients with BPD compared to HCs. This means that beyond the influence of valence, feelings of joy dissolve distress in patients with BPD even more than in HC participants, suggesting that joy seems to have a particularly relieving impact on patients with BPD. Although this also applies to the BN group, and although we cannot rule out the possibility of a floor effect of distress in the HC group, joy seems to play an important role in the downregulation of patients' distress.

The revealed distress reduction associated with joy might be especially interesting when combined with our finding of heightened distress associated with anger. Having similar affective intensities but experiencing them as more pronounced (because of their distress-enhancing or distress-reducing effects, respectively) might reflect the often-reported clinical picture of reactive mood and rapid mood swings in patients with BPD. This clinical impression is further reinforced

when patients switch between affective states with distress-enhancing and distress-reducing effects. Although we did not capture the temporal dynamics of specific emotions and distress, the alternation of particularly relieving and impairing emotions could possibly constitute affective dysregulation in BPD to a certain extent.

Limitations

Although we used a high-frequency AA design with clinical and healthy control groups and state-of-the-art multilevel modeling, the results of the study are subject to some limitations. First, our results describe only the occurrence of specific emotions, and we cannot make any statement about the context in which the emotions were reported. For example, in contrast to Tomko et al. (2014), we were not able to investigate in which social environments patients with BPD experienced anger or in which situations their anger led to high distress. Future studies should account for events that could be associated with the occurrence of specific emotions, for example by assessing potentially distressing events at each time of measurement. Second, our statements about specific or transdiagnostic mechanisms are limited to the two clinical control groups we assessed in this study. In order to validate our findings in a broader context, clinical control groups with other diagnoses should be investigated. Traumatization, be it through sexual abuse or nonvalidating rejection by close caregivers, could be one possible explanation for the largely transdiagnostic pattern of dysregulated specific emotions. However, trauma-related questionnaire measures indicate elevated levels of past traumatization only in the PTSD and BPD group and not in the BN group. Therefore, early sexual childhood abuse is not a satisfactory explanation for the transdiagnostic pattern of affective experience. Third, we investigated only female participants, which restricts the representativeness of the results. Given the literature regarding sex differences and emotion (Fischer, 2000), however, the advantage of a purely female sample is reduced

heterogeneity. Fourth, the 24-hour assessment period is short and does not cover the full range of circumstances in the participants' daily lives. However, data from our post-assessment questionnaire did not reveal empirical evidence that the chosen 24-hour segment had low representativeness (on a scale from 0 = very ordinary to 5 = very extraordinary: M = 1.92, Sd = 1.45), and neither representativeness (Kruskal-Wallis-X^2 = 2.18, p=.34) nor reactivity (Kruskal-Wallis-X^2 = 0.74, p=.60) differed between the clinical groups. Fifth, we did not take the variety of comorbidities into account. Given that comorbid disorders are the rule rather than the exception in patients with BPD (Sanislow et al., 2012), patients with comorbidities are seen as representative of the BPD population (Baer et al., 2012). Sixth, subthreshold BPD symptomatology is present in the clinical control groups, and we cannot rule out its potential impact statistically given the small sample size of the subgroups. Although examining the descriptive results of subdivided clinical groups revealed only slight differences, future studies with larger sample sizes should account for subthreshold BPD symptomatology. Seventh, the BPD criterion of anger includes more than the emotional component of anger we assessed in this study (American Psychiatric Association, 2013). For instance, it is also characterized by angry or aggressive behaviors, and we did not assess this behavioral component of anger.

Clinical Implications

In clinical practice, when teaching the management of emotions, it might be particularly helpful for therapists to provide strategies that enable patients to manage anger effectively. The module on emotion regulation in the dialectical behavior therapy skills training (Linehan, 2014) already provides interventions to regulate anger, which should be continuously developed. The distress-relieving character of joy – although it might be part of affective dysregulation – demonstrates the importance of the inclusion of patients' resources in the therapeutic process.

Therapists and patients should develop strategies to actively elicit or perceive joy, be it through positive activities, positive social contacts, or mindfulness-based practices.

Conclusions

Overall, while the majority of the differences revealed in the occurrence of specific emotions were transdiagnostic findings, we were able to identify some important features that might distinguish BPD from other mental disorders. Patients with BPD reported anger more frequently than clinical controls and felt especially distressed by this specific emotion. They experienced joy as often as and more intensely than HCs, and their distress was reduced even more than that of HCs when they felt joy. The altered affective experiences of anger and joy might represent an important part of affective dysregulation in BPD.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. Washington, DC: American Psychiatric Publishing.

Baer, R. A., Peters, J. R., Eisenlohr-Moul, T. A., Geiger, P. J., & Sauer, S. E. (2012). Emotion-related cognitive processes in borderline personality disorder: A review of the empirical literature. *Clinical Psychology Review*, *32*(5), 359–369. https://doi.org/10.1016/j.cpr.2012.03.002

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*(1). https://doi.org/10.18637/jss.v067.i01

Chapman, A. L., Walters, K. N., & Gordon, K. L. D. (2014). Emotional reactivity to social rejection and negative evaluation among persons with borderline personality features. *Journal of Personality Disorders*, *28*(5), 720–733. https://doi.org/10.1521/pedi_2012_26_068

Clark, L. A., Cuthbert, B. N., Lewis-Fernández, R., Narrow, W. E., & Reed, G. M. (2017). Three Approaches to Understanding and Classifying Mental Disorder: Icd-11, DSM-5, and the National Institute of Mental Health's Research Domain Criteria (RDoC). *Psychological Science in the Public Interest : A Journal of the American Psychological Society*, *18*(2), 72–145. https://doi.org/10.1177/1529100617727266

Cuthbert, B. N., & Insel, T. R. (2013). Toward the future of psychiatric diagnosis: The seven pillars of RDoC. *BMC Medicine*, *11*, 126. https://doi.org/10.1186/1741-7015-11-126

Ebner-Priemer, U. W., Houben, M., Santangelo, P. S., Kleindienst, N., Tuerlinckx, F., Oravecz, Z., Verleysen, G., van Deun, K., Bohus, M., & Kuppens, P. (2015). Unraveling affective dysregulation in borderline personality disorder: A theoretical model and empirical evidence. *Journal of Abnormal Psychology*, *124*(1), 186–198. https://doi.org/10.1037/abn0000021

Ebner-Priemer, U. W., Welch, S. S., Grossman, P., Reisch, T., Linehan, M. M., & Bohus, M. (2007). Psychophysiological ambulatory assessment of affective dysregulation in borderline personality disorder. *Psychiatry Research*, *150*(3), 265–275. https://doi.org/10.1016/j.psychres.2006.04.014

Fischer, A. (Ed.). (2000). *Gender and emotion: Social psychological perspectives*. Cambridge University Press.

Fydrich, T., Renneberg, B., Schmitz, B., & Wittchen, H. U. (1997). *SKID II. Strukturiertes Klinisches Interview für DSM-IV, Achse II: Persönlichkeitsstörungen. Interviewheft. Eine*

deutschsprachige, erweiterte Bearbeitung der amerikanischen Originalversion des SCID-I. Hogrefe.

Gratz, K. L., Rosenthal, M. Z., Tull, M. T., Lejuez, C. W., & Gunderson, J. G. (2010). An experimental investigation of emotional reactivity and delayed emotional recovery in borderline personality disorder: The role of shame. *Comprehensive Psychiatry*, *51*(3), 275–285. https://doi.org/10.1016/j.comppsych.2009.08.005

Houben, M., Bohus, M., Santangelo, P. S., Ebner-Priemer, U. W., Trull, T. J., & Kuppens, P. (2016). The specificity of emotional switching in borderline personality disorder in comparison to other clinical groups. *Personality Disorders*, *7*(2), 198–204. https://doi.org/10.1037/per0000172

Kockler, T. D., Tschacher, W., Santangelo, P. S., Limberger, M. F., & Ebner-Priemer, U. W. (2017). Specificity of emotion sequences in borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls: An e-diary study. *Borderline Personality Disorder and Emotion Dysregulation*, *4*(1), 1–8. https://doi.org/10.1186/s40479-017-0077-1

Kuhn, M., Weston, S., Wing, J., & Forester, J. (2016). *The contrasts package. R package* [Computer software]. https://CRAN.R-project.org/package=contrast

Linehan, M. M. (2014). *DBT skills training manual*. Guilford Publications.

Lis, S., Schaedler, A., Liebke, L., Hauschild, S., Thome, J., Schmahl, C., Stahlberg, D., Kleindienst, N., & Bohus, M. (2018). Borderline Personality Disorder Features and Sensitivity to Injustice. *Journal of Personality Disorders*, *32*(2), 192–206. https://doi.org/10.1521/pedi_2017_31_292

Lobbestael, J., Leurgans, M., & Arntz, A. (2011). Inter-rater reliability of the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID I) and Axis II Disorders (SCID II). *Clinical Psychology & Psychotherapy*, *18*(1), 75–79. https://doi.org/10.1002/cpp.693

Mancke, F., Herpertz, S. C., Kleindienst, N., & Bertsch, K. (2017). Emotion Dysregulation and Trait Anger Sequentially Mediate the Association Between Borderline Personality Disorder and Aggression. *Journal of Personality Disorders*, *31*(2), 256–272. https://doi.org/10.1521/pedi_2016_30_247

Mneimne, M., Fleeson, W., Arnold, E. M., & Furr, R. M. (2018). Differentiating the everyday emotion dynamics of borderline personality disorder from major depressive disorder and bipolar disorder. *Personality Disorders*, *9*(2), 192–196. https://doi.org/10.1037/per0000255

Mombour, W., Zaudig, M., Berger, P., Gutierrez, K., Berner, W., Berger, K., & Bose, M. V. (1996). *International Personality Disorder Examination (IPDE)*. Hogrefe Testzentrale.

Morse, J. Q., Hill, J., Pilkonis, P. A., Yaggi, K. E., Broyden, N., Stepp, S. D., Reed, L. I., & Feske, U. (2009). Anger, preoccupied attachment, and domain disorganization in borderline personality disorder. *Journal of Personality Disorders*, *23*(3), 240–257. https://doi.org/10.1521/pedi.2009.23.3.240

Pinheiro, J., Bates, D., DebRoy, S., & Sarkar, D. (2018). *nlme: Linear and Nonlinear Mixed Effects Models. R package version 3.1-137* [Computer software].

R Core Team. (2017). *R: A language and environment for statistical computing [*Computer software]. R Foundation for Statistical Computing, Vienna, Austria. https://www.R-project.org/

Rizvi, S. L., Brown, M. Z., Bohus, M., & Linehan, M. M. (2011). The role of shame in the development and treatment of borderline personality disorder. In R. L. Dearing & J. P. Tangney

(Eds.), *Shame in the therapy hour* (1st ed., pp. 237–260). American Psychological Association. https://doi.org/10.1037/12326-010

Rüsch, N., Lieb, K., Göttler, I., Hermann, C., Schramm, E., Richter, H., Jacob, G. A., Corrigan, P. W., & Bohus, M. (2007). Shame and implicit self-concept in women with borderline personality disorder. *The American Journal of Psychiatry*, *164*(3), 500–508. https://doi.org/10.1176/ajp.2007.164.3.500

Sanislow, C. A., Marcus, K. L., & Reagan, E. M. (2012). Long-term outcomes in borderline psychopathology: Old assumptions, current findings, and new directions. *Current Psychiatry Reports*, *14*(1), 54–61. https://doi.org/10.1007/s11920-011-0250-y

Santangelo, P. S., Limberger, M. F., Stiglmayr, C., Houben, M., Coosemans, J., Verleysen, G., Kuppens, P., Tuerlinckx, F., Vanpaemel, W., & Ebner-Priemer, U. W. (2016). Analyzing subcomponents of affective dysregulation in borderline personality disorder in comparison to other clinical groups using multiple e-diary datasets. *Borderline Personality Disorder and Emotion Dysregulation*, *3*, 5. https://doi.org/10.1186/s40479-016-0039-z

Santangelo, P. S., Reinhard, I., Mussgay, L., Steil, R., Sawitzki, G., Klein, C., Trull, T. J., Bohus, M., & Ebner-Priemer, U. W. (2014). Specificity of affective instability in patients with borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls. *Journal of Abnormal Psychology*, *123*(1), 258–272. https://doi.org/10.1037/a0035619

Scheel, C. N., Bender, C., Tuschen-Caffier, B., Brodführer, A., Matthies, S., Hermann, C., Geisse, E. K., Svaldi, J., Brakemeier, E.-L., Philipsen, A., & Jacob, G. A. (2014). Do patients with different mental disorders show specific aspects of shame? *Psychiatry Research*, *220*(1-2), 490–495. https://doi.org/10.1016/j.psychres.2014.07.062

Scheel, C. N., Schneid, E.-M., Tuescher, O., Lieb, K., Tuschen-Caffier, B., & Jacob, G. A. (2013). Effects of Shame Induction in Borderline Personality Disorder. *Cognitive Therapy and Research*, *37*(6), 1160–1168. https://doi.org/10.1007/s10608-013-9567-7

Schoenleber, M., & Berenbaum, H. (2012a). Aversion and proneness to shame in self- and informant-reported personality disorder symptoms. *Personality Disorders*, *3*(3), 294–304. https://doi.org/10.1037/a0025654

Schoenleber, M., & Berenbaum, H. (2012b). Shame regulation in personality pathology. *Journal of Abnormal Psychology*, *121*(2), 433–446. https://doi.org/10.1037/a0025281

Scott, L. N., Stepp, S. D., Hallquist, M. N., Whalen, D. J., Wright, A. G. C., & Pilkonis, P. A. (2015). Daily shame and hostile irritability in adolescent girls with borderline personality disorder symptoms. *Personality Disorders*, *6*(1), 53–63. https://doi.org/10.1037/per0000107

Scott, L. N., Wright, A. G. C., Beeney, J. E., Lazarus, S. A., Pilkonis, P. A., & Stepp, S. D. (2017). Borderline Personality Disorder Symptoms and Aggression: A Within-Person Process Model. *Journal of Abnormal Psychology*, *126*(4), 429–440. https://doi.org/10.1037/abn0000272

Stepp, S. D., Pilkonis, P. A., Yaggi, K. E., Morse, J. Q., & Feske, U. (2009). Interpersonal and emotional experiences of social interactions in borderline personality disorder. *The Journal of Nervous and Mental Disease*, *197*(7), 484–491. https://doi.org/10.1097/NMD.0b013e3181aad2e7

Tomko, R. L., Brown, W. C., Tragesser, S. L., Wood, P. K., Mehl, M. R., & Trull, T. J. (2014). Social context of anger in borderline personality disorder and depressive disorders: Findings from a naturalistic observation study. *Journal of Personality Disorders*, *28*(3), 434–448. https://doi.org/10.1521/pedi_2012_26_064

Trull, T. J. (2018). Ambulatory Assessment of Borderline Personality Disorder. *Psychopathology*, *51*(2), 137–140. https://doi.org/10.1159/000486604

Trull, T. J., & Ebner-Priemer, U. W. (2013). Ambulatory assessment. *Annual Review of Clinical Psychology*, *9*, 151–176. https://doi.org/10.1146/annurev-clinpsy-050212-185510

Trull, T. J., Solhan, M. B., Tragesser, S. L., Jahng, S., Wood, P. K., Piasecki, T. M., & Watson, D. (2008). Affective instability: Measuring a core feature of borderline personality disorder with ecological momentary assessment. *Journal of Abnormal Psychology*, *117*(3), 647–661. https://doi.org/10.1037/a0012532

Wittchen, H. U., Wunderlich, U., Gruschwitz, S., & Zaudig, M. (1997). *SKID I. Strukturiertes Klinisches Interview für DSM-IV. Achse I: Psychische Störungen. Interviewheft und Beurteilungsheft. Eine deutschsprachige, erweiterte Bearbeitung der amerikanischen Originalversion des SCID-I*. Hogrefe.

World Health Organisation. (1992). *The ICD-10 classification of mental and behavioural disorders: clinical descriptions and diagnostic guidelines*. World Health Organisation.

COMMENT: INVESTIGATING BINGE EATING USING AMBULATORY ASSESSMENT: THE IMPORTANCE OF AN APPROPRIATE SAMPLING FREQUENCY

Chapter 4

With great interest, we read the recently published review on emotion regulation in binge eating disorder (BED) by Dingemans et al. (2017). We fully agree with the authors that (a) in order to better understand binge eating, it is of major importance to delineate its affective consequences; and (b) ambulatory assessment (AA) is the gold standard to track these affective dynamics in patients' everyday lives without retrospective distortions (Trull & Ebner-Priemer, 2013). Whereas Dingemans et al. (2017) are surprised that empirical evidence supporting the theoretical models is inconclusive, yet all models assume a reduction of negative affect after binge eating episodes, we can provide a coherent explication for the lack of evidence - namely the sampling frequency.

Most of the studies included in the meta-analysis reported by Dingemans and colleagues (2017) tracked a highly dynamic process (affective consequences) using a low sampling frequency. However, a low sampling frequency is not able to capture rapid affective dynamics. In detail, the average sampling frequency in the meta-analysis was approximately 7.8 times per day (Haedt-Matt & Keel, 2011), which corresponds to one assessment every two hours during the waking time. Our case example (see Figure 4.1) depicts the underlying velocity of affective dynamics.

We extracted a 1.5-h time segment from an AA study, in which we tracked patients with bulimia nervosa (BN) - among other disorders - every 15 min (±1 min) over a period of 24 h during

their waking time (Santangelo et al., 2014). The extracted 1.5-h time segment covers seven separate assessments and revealed impressive dynamics. In detail, at 4:56 p.m., the patient reported interest as her predominant momentary emotion, a positive emotional valence, and an urge to eat as well as an aversive tension at a medium level. Fifteen minutes later, the patient switched to an angry mood state and intense negative valence. At 5:26 p.m., she began with regular eating accompanied by the feeling of disgust, which then turned to loss-of-control binge eating at the next two assessment points until 5:58 p.m. While binge eating, the patient first felt disgust followed by anxiety. The urge to eat, aversive tension, and negative valence reached their climax in the middle of the eating episode. Whereas the urge to eat was already decreasing at the end of the eating episode, the aversive tension declined immediately afterward. Interestingly, this decline of tension was accompanied by a strong feeling of joy from 6:12 p.m. to 6:26 p.m. We would have missed all these dynamics using a lower sampling frequency, such as one assessment every two hours or assessments just before and after binge eating episodes.

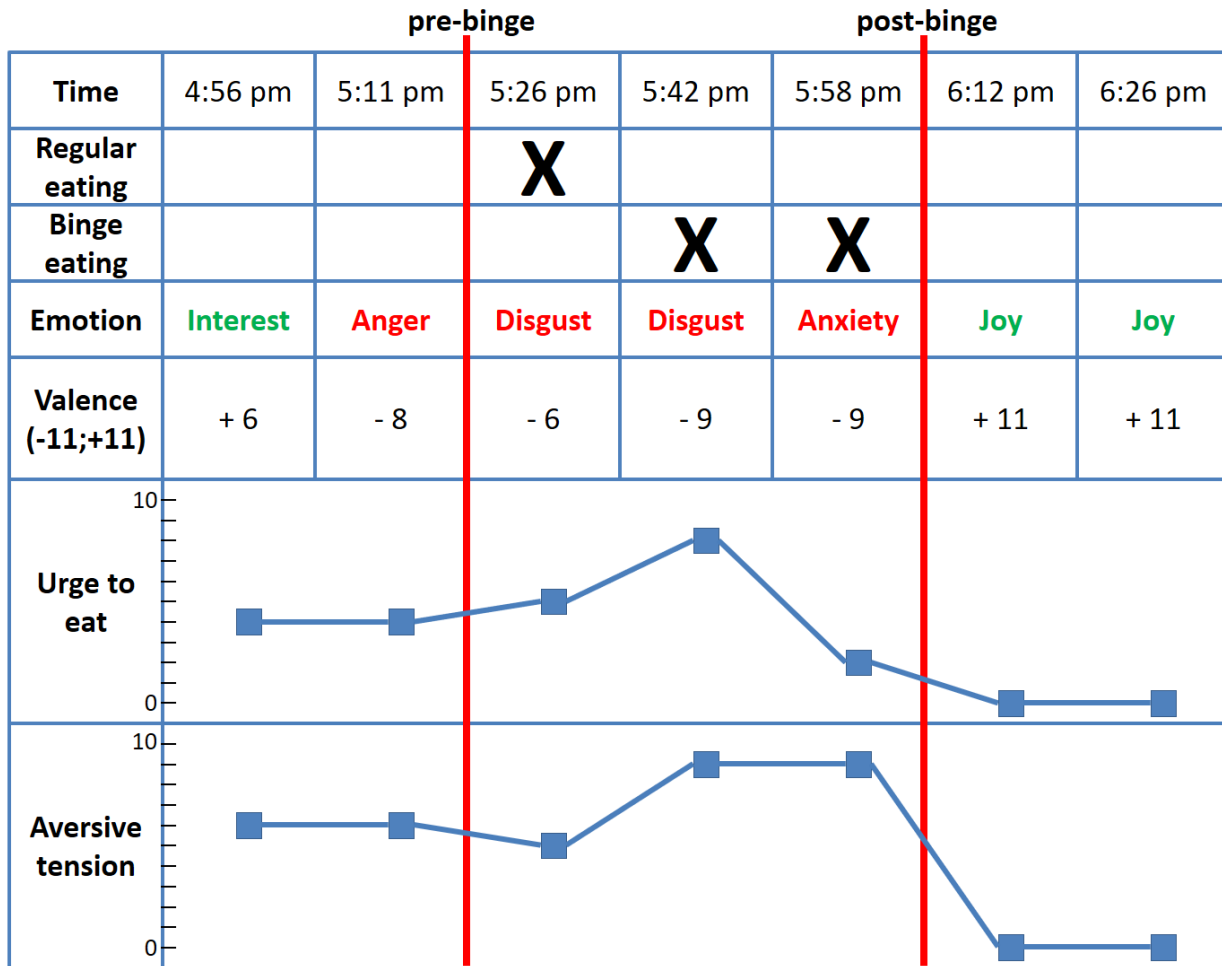|	pre-binge				post-binge		
Time	4:56 pm	5:11 pm	5:26 pm	5:42 pm	5:58 pm	6:12 pm	6:26 pm
Regular eating			X				
Binge eating				X	X		
Emotion	Interest	Anger	Disgust	Disgust	Anxiety	Joy	Joy
Valence (-11;+11)	+ 6	- 8	- 6	- 9	- 9	+ 11	+ 11

Figure 4.1. Affective dynamics and eating behavior of a single patient with bulimia nervosa (BN) before, during, and after a binge eating episode. Valence constitutes the intensity of emotions rated on an 11-point Likert scale from 0-11, whereas the intensity rating was multiplied by -1 in the case of negative emotions; therefore, valence scores range from -11 to +11. Urge to eat and aversive tension were assessed on an 11-point Likert scale from 0-10, with higher values indicating a stronger urge to eat and stronger aversive tension, respectively.

What applies to binge eating episodes also holds true for binge-purge episodes, which we provide an illustrative example of in Figure 4.2. During a 1.5-h binge-purge episode of another patient with BN, we see remarkable dynamics in "urge to eat" and "urge to vomit"

accompanied by a transition from sadness to disgust at the beginning of the purging behavior. This is in line with Dingemans et al. (2017), who conclude that binge eating episodes and binge-purge cycles may be different processes with specific affective dynamics.

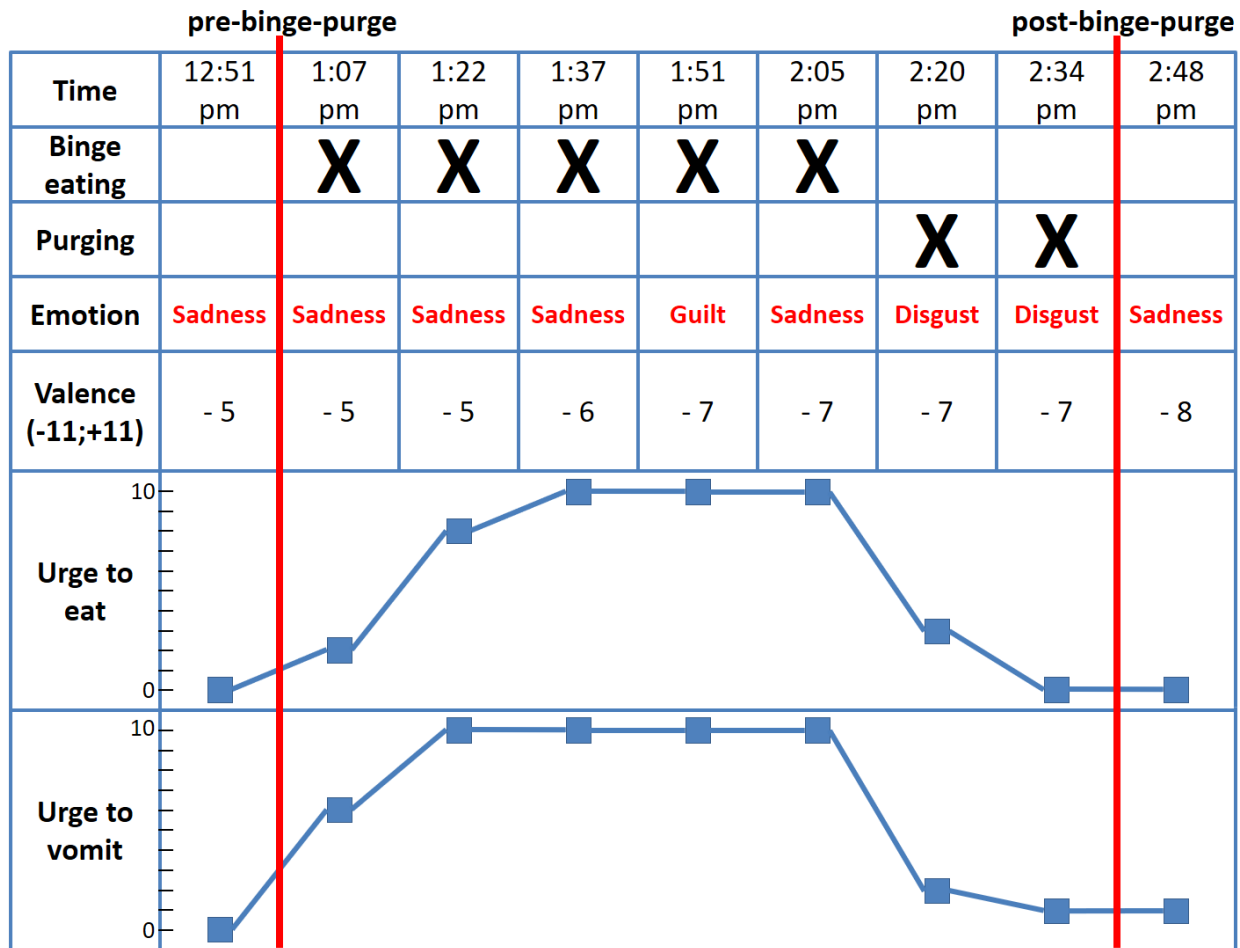| | | pre-binge-purge | | | | | | | post-binge-purge | |
|---|---|---|---|---|---|---|---|---|---|
| Time | 12:51 pm | 1:07 pm | 1:22 pm | 1:37 pm | 1:51 pm | 2:05 pm | 2:20 pm | 2:34 pm | 2:48 pm |
| Binge eating | | X | X | X | X | X | | | |
| Purging | | | | | | | X | X | |
| Emotion | Sadness | Sadness | Sadness | Sadness | Guilt | Sadness | Disgust | Disgust | Sadness |
| Valence (-11;+11) | - 5 | - 5 | - 5 | - 6 | - 7 | - 7 | - 7 | - 7 | - 8 |

Figure 4.2. Affective dynamics, eating behavior, and purging behavior of a single patient with bulimia nervosa (BN) before, during, and after a binge-purge episode. Valence constitutes the intensity of emotions rated on an 11-point Likert scale from 0-11, whereas the intensity rating was multiplied by -1 in the case of negative emotions; therefore, valence scores range from -11 to +11. Urge to eat and urge to vomit were assessed on an 11-point Likert scale from 0-10, with higher values indicating a stronger urge.

In summary, the sampling frequency must fit the dynamics of the process of interest in order to allow for valid conclusions (Ebner-Priemer & Sawitzki, 2007). Future AA studies testing the theoretical models of BED may benefit from an appropriate sampling frequency.

References

Dingemans, A., Danner, U., & Parks, M. (2017). Emotion Regulation in Binge Eating Disorder: A Review. *Nutrients*, *9*(11). https://doi.org/10.3390/nu9111274

Ebner-Priemer, U. W., & Sawitzki, G. (2007). Ambulatory Assessment of Affective Instability in Borderline Personality Disorder. *European Journal of Psychological Assessment*, *23*(4), 238–247. https://doi.org/10.1027/1015-5759.23.4.238

Haedt-Matt, A. A., & Keel, P. K. (2011). Revisiting the affect regulation model of binge eating: A meta-analysis of studies using ecological momentary assessment. *Psychological Bulletin*, *137*(4), 660–681. https://doi.org/10.1037/a0023660

Santangelo, P. S., Reinhard, I., Mussgay, L., Steil, R., Sawitzki, G., Klein, C., Trull, T. J., Bohus, M., & Ebner-Priemer, U. W. (2014). Specificity of affective instability in patients with borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls. *Journal of Abnormal Psychology*, *123*(1), 258–272. https://doi.org/10.1037/a0035619

Trull, T. J., & Ebner-Priemer, U. W. (2013). Ambulatory assessment. *Annual Review of Clinical Psychology*, *9*, 151–176. https://doi.org/10.1146/annurev-clinpsy-050212-185510

STUDY 3: SELF-ESTEEM INSTABILITY DEFINES BORDERLINE PERSONALITY DISORDER MORE THAN AFFECTIVE INSTABILITY

Chapter 5

Abstract

Borderline personality disorder (BPD) is commonly characterized by pervasive instability. While affective instability, despite being a diagnostic criterion in the DSM-5, is commonly seen as a transdiagnostic mechanism, recent studies have brought new attention to the importance of self-esteem instability as a potential defining feature of BPD. However, evidence is lacking regarding whether heightened self-esteem instability is a specific feature of BPD when patients with BPD are compared to clinical controls.

Using ambulatory assessment, we examined self-esteem instability and affective instability in participants' daily lives. We assessed momentary self-esteem and affective state 12 times daily for four consecutive days in 131 patients with BPD, 121 patients with anxiety disorders (ADs), and 134 healthy controls (HCs). To determine group differences, we used established instability indices and analyzed multilevel models.

Compared to HCs, patients with BPD and those with ADs exhibited heightened self-esteem instability and affective instability. Importantly, while the clinical groups did not differ in affective instability, self-esteem instability was significantly higher in patients with BPD than in those with

ADs across all instability indices. Beyond the influence of mean self-esteem, patients with BPD had the highest general instability, the most frequent extreme changes, and the largest decreases in self-esteem, especially from high levels of self-esteem.

Our results support previous findings on affective instability, which may constitute a transdiagnostic mechanism, and they provide the first evidence that heightened self-esteem instability is particularly prominent in BPD, underscoring the importance of self-esteem for the understanding of dysregulation in BPD.

Introduction

Instability is considered the core of borderline personality disorder (BPD), which is reflected by the DSM-5 definition of BPD as a "pattern of instability of interpersonal relationships, self-image, and affects" (American Psychiatric Association, 2013). In the examination of instability, the ambulatory assessment (AA) methodology is ideally suited for tracking symptomology in people's daily lives using electronic diaries (e-diaries; Trull & Ebner-Priemer, 2020). A body of AA studies has highlighted the importance of affective instability, which was found to drive impulsivity (Tragesser et al., 2007), including impulsive eating behaviors (Anestis et al., 2010) and alcohol use (Jahng et al., 2011), and to predict suicidal ideations (Rizk et al., 2019). However, the investigation of self-esteem and its instability in the daily lives of patients with BPD has long been neglected, apart from two early paper-pencil studies, which found heightened self-esteem instability in subclinical samples (Tolpin et al., 2004; Zeigler–Hill & Abraham, 2006). This lack of studies is surprising given the empirical evidence that unstable self-esteem is associated with several BPD-related symptoms in healthy individuals' daily lives. These symptoms include lowered self-concept clarity and self-acceptance; a higher propensity toward anger, hostility, and aggressive outbursts;

higher reactivity to negative and positive daily events; maladaptive coping styles, interpersonal behavior, and cognitions; and suicidal ideations (for an overview, see Santangelo et al., 2017).

In the assessment of dynamic features such as instability, the AA methodology is currently the gold standard, as it allows for capturing people's emotional states in near real time in their everyday lives and for modeling dynamic within-person processes with high ecological validity (Carpenter et al., 2016; Trull & Ebner-Priemer, 2013). In contrast, earlier studies relying on traditional questionnaires had to address the problem of retrospective bias, i.e., limited congruence between retrospective assessments of unstable symptoms and the actual course of symptoms (Solhan et al., 2009). In AA approaches that investigate instability by repeatedly assessing momentary states using e-diaries, it is particularly important for the sampling frequency to correspond to rapid affective dynamics to track people's ups and downs (Kockler et al., 2018).

A multitude of studies have used sophisticated AA methodology to investigate the specificity of affective instability to BPD. While affective instability was shown to be consistently heightened in patients with BPD compared to that in healthy controls (HCs), the overall findings contradicted the BPD specificity of affective instability; that is, they suggested that affective instability may be similarly pronounced across different mental disorders. In a methodologically sound study by Santangelo et al. (2014) that combined high-frequency e-diary assessments in a large sample with multiple instability indices and multilevel modeling, comparisons of the affective instability of BPD patients with that of patients diagnosed with posttraumatic stress disorder (PTSD) or bulimia nervosa revealed no evidence of BPD specificity. Other studies investigating general affective instability showed mixed findings from comparisons of BPD patients to clinical control groups: while Trull et al. (2008) did not find heightened instability of general negative affect in patients with BPD compared to that of patients with depressive disorders, Snir et al. (2017) found heightened affective instability of BPD patients compared to that of patients with avoidant

personality disorder, but regarding only one of two instability indices. Studies investigating the instability of specific emotions also yielded inconsistent findings. In the study by Trull et al. (2008), patients with BPD exhibited higher instability of fear, sadness, and hostility than patients with depressive disorders, while a recent study revealed that BPD patients' instability of anger and irritability did not differ from that of patients with depressive disorders and those with bipolar disorders (Mneimne et al., 2018). Furthermore, neither the subcomponents of affective instability (Santangelo et al., 2016), emotional granularity (Tomko et al., 2015), nor emotional switching, that is, the tendency to make large changes between positive and negative states (Houben et al., 2016), showed BPD-specific patterns of instability. These findings indicate that even though affective instability is solely listed as a diagnostic criterion in BPD (American Psychiatric Association, 2013), it may constitute a transdiagnostic mechanism. Santangelo et al. (2014) assumed that the experience of affective instability could be worsened by simultaneously occurring changes in self-esteem. Accordingly, self-esteem instability rather than affective instability might differentiate BPD from other clinical groups.

Following the reasoning of Santangelo et al. (2014), three AA studies shed light on the role of self-esteem in the understanding of BPD. In the first study, Santangelo et al. (2017) investigated the temporal interplay of affective instability and self-esteem instability in 60 patients with BPD and 60 HCs. Using e-diaries, participants rated their momentary self-esteem and affective state, i.e., valence and tense arousal, at hourly intervals on four consecutive days. The study revealed heightened self-esteem instability in patients with BPD and replicated previous findings on heightened affective instability. Moreover, self-esteem instability and affective instability were highly correlated and intertwined, and the pattern of self-esteem instability was mainly characterized by large decreases from high self-esteem states and slow recovery from periods of low self-esteem.

Santangelo, Kockler, et al. (2020) expanded these findings, extending the sample used by Santangelo et al. (2017) by including 35 additional participants with remitted BPD symptomatology. Cross-sectional comparisons between acute and remitted patients with BPD stages showed that self-esteem instability in patients with remitted BPD, albeit still heightened compared to that of HCs, was significantly lower than that of patients with acute BPD. By contrast, affective instability was heightened both in acute and remitted patients with BPD, exhibiting no differences between the two groups. These findings indicate that self-esteem instability might be more sensitive to changes in BPD symptomatology than affective instability and therefore be especially characteristic of acute BPD stages.

Furthermore, self-esteem in BPD was found to be associated with psychopathology in BPD patients' daily lives. Using dynamic structural equation modeling in a sample comprising 119 patients with BPD, Santangelo, Holtmann, et al. (2020) analyzed the antecedents and consequences of dysfunctional behaviors such as nonsuicidal self-injury. The results showed that low aggregated momentary self-esteem and high momentary negative affect were the strongest predictors of dysfunctional behaviors. Additionally, low momentary self-esteem predicted dysfunctional behaviors, which is in line with previous findings that identified self-esteem instability as a predictor of general psychopathology (Santangelo et al., 2017). Overall, even though highlighting the role of self-esteem instability in BPD, these studies leave the question open whether self-esteem instability is a particularly prominent feature in BPD, and studies with clinical control groups are lacking.

Although affective instability and self-esteem instability are not listed as diagnostic criteria for any anxiety disorder (AD), several studies have investigated instability in AD populations. Using pencil-paper-based visual analog scales, Bowen and colleagues found higher mood variability in patients with ADs than in HCs in two studies (Bowen et al., 2004; Bowen et al.,

2006). Moreover, ADs have been associated with instability of physical anxiety symptoms (Pfaltz et al., 2010), anxious mood (Lamers et al., 2018), and positive and negative affect (Schoevers et al., 2020).

Self-esteem instability in ADs has been investigated in only one AA study: Farmer and Kashdan (2014) found unstable low self-esteem and high negative affect but stable low positive affect in patients with social ADs, but the differences in instability between patients with social ADs and HCs disappeared after controlling for mean levels of self-esteem. Furthermore, patients with social AD had more frequent acute changes in self-esteem and negative (but not positive) affect than HCs.

Hypotheses

In summary, in past AA studies, affective instability was found to be consistently heightened in patients with BPD compared to that in HCs, and some evidence was reported for heightened affective instability in patients with ADs compared to that of HCs. The BPD specificity of affective instability was investigated in several studies and did not seem evident. Although understudied, there is growing evidence of heightened self-esteem instability in patients with BPD compared to that in HCs. In AD populations, evidence for self-esteem instability is even more scarce. Although research recommendations argued for transdiagnostic approaches to psychopathology measurement (Stanton et al., 2020), no study has compared self-esteem instability between patients with different clinical disorders; therefore, evidence of BPD specificity is currently lacking.

This study aimed to investigate disorder specificity by comparing the self-esteem instability and affective instability of BPD patients to that of patients with ADs and HCs in their everyday lives. To reveal patterns of instability, we repeatedly assessed self-esteem and affect in real-time

using e-diaries with a high sampling frequency approach (i.e., hourly assessments over four days) in patients with BPD, patients with ADs, and HCs. We analyzed group differences using three established instability indices.

Based on previous research, we formulated two hypotheses. First, we hypothesized that patients with BPD would report higher self-esteem instability than patients with ADs and HCs, that is, that self-esteem instability would be specifically heightened in the BPD group. Second, we hypothesized that patients with BPD and those with ADs would report higher affective instability than HCs, that is, that affective instability would be transdiagnostically heightened but not differ between the patient groups.

Methods

Sample

The sample comprised 386 female participants, of whom 131 were patients with BPD, 121 were patients with ADs, and 134 were HCs. The participants' ages ranged between 18 and 48 years. Data on subgroups of this sample, including a subgroup with fewer patients with BPD and HCs but without patients with ADs, were published in studies on different research questions (Santangelo et al., 2017; Santangelo et al., 2018; Santangelo, Holtmann, et al., 2020). All patients in the BPD group fulfilled the DSM-IV diagnostic criteria for BPD. Patients with BPD could be included if they had any comorbidities except for schizophrenia, bipolar disorder, or acute intoxication, which constituted general exclusion criteria. The AD group included inpatients who met the criteria for a current DSM-IV diagnosis of either generalized anxiety disorder, social anxiety disorder, agoraphobia, or panic disorder and who did not fulfill the criteria for BPD. Furthermore, to avoid diagnostic overlaps between the AD group and the clinical control groups used by Santangelo et al. (2014), we did not include AD patients with comorbid PTSD or bulimia nervosa. The exclusion

criteria for HCs included any current or past Axis I or Axis II disorder diagnoses, self-reported current psychotherapy, or the current use of psychotropic medications.

Psychiatric Diagnoses

In all study groups, diagnostic interviews were conducted using the German versions of the Structured Clinical Interview for DSM-IV Axis I disorders (SCID-I; Wittchen et al., 1997) and Axis II disorders (SCID-II; Fydrich et al., 1997). Experienced, well-trained postgraduate psychologists administered the diagnostic instruments. The SCID-I and SCID-II are well-validated diagnostic instruments with good psychometric properties (i.e., SCID-I mean $\kappa > .71$; SCID-II mean $\kappa > .84$; Lobbestael et al., 2011).

Procedures

Data were collected at two sites in Germany: The BPD group consisted of outpatients awaiting admission to a residential treatment program at the Central Institute of Mental Health Mannheim, whereas the AD group consisted of patients participating in a six-week inpatient anxiety treatment program at the MEDIAN Clinic for Psychosomatics Bad Dürkheim. To minimize differences due to therapy effects, we recruited inpatients with ADs at the beginning of treatment (within two weeks after admission to therapy). The Ethical Committee of the Medical Faculty, Heidelberg University, and the Rheinland-Pfalz Chamber of Physicians approved the study protocol. The study was carried out in accordance with the Declaration of Helsinki (World Medical Association, 2013). All participants provided written informed consent before being included in the study.

Data on momentary self-esteem and affective state were collected during participants' daily lives. After completing the diagnostic assessments, participants received an e-diary. Slightly more

than half of the participants (56.7%) received a smartphone programmed with the movisensXS app (movisens GmbH, Karlsruhe, Germany), whereas 43.3% of the participants received a palmtop computer (Tungsten-E, Palm Inc., USA) programmed with IzyBuilder software (IzyData Ltd., Switzerland). Response behavior did not differ between the two assessment devices (Santangelo et al., 2018). All participants were thoroughly familiarized with the e-diary. The participants completed the e-diary on four consecutive days, including two workdays and two weekend days. The e-diary emitted a prompting signal according to a pseudorandomized time-sampling schedule at hourly intervals (60 minutes ± 10 minutes) from 10 am to 10 pm. Participants were prompted 12 times daily, resulting in 48 prompts per participant over the four-day assessment period. Each response was automatically time-stamped by the e-diary. After completing four assessment days, participants returned the e-diaries, were debriefed, and were financially compensated based on the number of completed data entries (40 to 50 Euros). All participants received feedback on their personal data collected during the e-diary assessment.

E-Diary Assessment

The items assessing participants' momentary self-esteem and affective states have been successfully used in prior studies with high reliability for within-person changes over time (McDonald's omega coefficients: $\omega_{valence}$=0.75–0.79, $\omega_{tense\ arousal}$ =0.71–0.75, $\omega_{self-esteem}$ =0.83; Santangelo et al., 2017; Santangelo et al., 2018). At each prompt, we assessed participants' current self-esteem using a four-item short form of the Rosenberg Self-Esteem Scale (Rosenberg, 1965). To assess patients' momentary self-esteem state, we adapted items 1, 2, 9, and 10 with the following wording (translated from German): "At the moment": (1) "I am satisfied with myself"; (2) "I think I am no good at all" (reverse coded); (3) "I am inclined to feel that I am a failure" (reverse coded); and (4) "I take a positive attitude toward myself". Patients with a palmtop

computer rated the four items on a 10-point rating scale ranging from 0 to 9, whereas those with a smartphone rated each item on a visual analogue scale ranging from 0 to 100. To yield comparable values, we converted the visual analog scale ratings (0–100) into the 10-point rating scale ratings (0–9).

To assess participants' momentary affective states, we used a specifically designed and validated measure for repeated assessments of momentary affective states in e-diary studies (Wilhelm & Schoebi, 2007). The momentary affective state was conceptualized as varying along two dimensions, and participants rated two bipolar items for each valence (ranging from unpleasant to pleasant) and tense arousal (ranging from restless/under tension to calm/relaxed). The item wordings (translated from German) of the valence and tense arousal scales were as follows: "At this moment I feel": "unwell–well" and "content–discontent" (reverse coded) and "At this moment I feel": agitated–calm" and "relaxed–tense" (reverse coded), respectively. Patients with a palmtop computer rated the four bipolar items regarding their momentary affective state on a 7-point rating scale ranging from 0 to 6, whereas those with a study smartphone rated each item on a visual analog scale ranging from 0 to 100. To yield comparable values, we converted the visual analog scale ratings (0–100) into the 7-point scale ratings (0–6) for the four items.

Data Preprocessing

We created composite scores of self-esteem, valence, and tense arousal by calculating the mean values of the respective items for each prompt. Possible values ranged from 0 to 9 for self-esteem and 0 to 6 for valence and tense arousal. Higher scores corresponded to positive states (i.e., high self-esteem; positive valence; and high calmness and, thus, low tense arousal). We color-coded the intensity of each e-diary rating for each participant over the four-day assessment period

using the R package "bertin", which allowed for the visualization of the full three-dimensional data set, including the subject, time, and intensity.

Analyses of Instability

Following recent guidelines on characterizing instability (Trull et al., 2015), we conducted statistical analyses that consider the temporal structure of the unstable processes under investigation and calculated three instability indices: squared successive difference (SSD), probability of acute change (PAC), and aggregated point-by-point change (APPC). Using the R function for generalized linear mixed models "glmer" (package "lme4"; Bates et al., 2015), we conducted specific multilevel models to analyze the SSD (a gamma model with a log link) and PAC (a logistic model with a logit link) in a two-level model. The equation for comparing SSDs returned the following (for reasons of simplicity, we describe the multilevel model comparing two groups, i.e., BPD patients vs. HCs; the full model only includes additional dummy variables for diagnostic groups):

$SSD\_SE_{ij}/\alpha_j,\beta_j \sim Gamma(\alpha_j,\beta_j)$, $E(SSD\_SE_{ij}/\alpha_j,\beta_j) = \alpha_j\beta_j = \mu_j$, $Var(SSD\_SE_{ij}/\alpha_j,\beta_j) = \alpha_j\beta_j^2$,

Level 1 link function: $\eta_j = \log(\mu_j)$

Level 1 structural model: $\eta_j = b_{0j}$

Level 2 model: $b_{0j} = \gamma_{00} + \gamma_{01}*Group_j + u_{0j}$, $u_{0j} \sim N(0,\tau^2)$,

where SSD_SE_{ij} is the square of the successive difference of self-esteem at the *i*th occasion for the *j*th individual; γ_{01} is the log-transformed group difference in the overall mean of SSD, and *Group_j* is a dummy variable, coding for BPD (*Group_j*=1) or HCs (*Group_j*=0). Further combinations of dummy codings were created to calculate the remaining group contrasts (AD vs. HCs, BPD vs.

AD). To examine affective instability, SSD_SE_{ij} was replaced by $SSD\_valence_{ij}$ or $SSD\_tense\_arousal_{ij}$. The multilevel model for the PAC is as follows:

$AC_{ij}|p_j \sim Binomial(1,p_j)$, $E(AC_{ij}|p_j)=p_j=\mu_j$, $Var(AC_{ij}|p_j)=p_j(1-p_j)$,

Level 1 link function: $\eta_j=\log(\mu_j/(1-\mu_j))$

Level 1 structural model: $\eta_j=b_{0j}$

Level 2 model: $b_{0j}=\gamma_{00}+\gamma_{01}*Group_j+u_{0j}$, $u_{0j} \sim N(0,\tau^2)$,

where $AC_{(i+1)j} = 1$ if the successive difference in self-esteem at the ith occasion for the jth individual is greater than or equal to $c \geq 2.5$ (corresponding to the 90th percentile of successive differences across all participants), and $AC_{(i+1)j} = 0$ otherwise. γ_{01} is the logit transformed group difference in the overall PAC. For valence and tense arousal, the cut-off values that corresponded to the 90th percentile of successive differences were each $c \geq 2.5$. These procedures were similar to those proposed by Jahng and colleagues (2008).

To calculate group contrasts, we used the R package "emmeans". With this package, it is also possible to back-transform the results from the log (or logit) transformed scale to the response scale, which allowed us to report estimated mean differences in SSDs on the original response scale and odds ratio differences in PACs.

As previously reported (Santangelo et al., 2014; Santangelo et al., 2017), to calculate the APPC, we decomposed the self-esteem time series into point-by-point changes and aggregated these changes by their momentary starting state into five nearly equal self-esteem bins. We used multilevel models to analyze group differences in decreases and increases in self-esteem depending on the five starting states (low, mid-low, mid, mid-high, and high). As we conducted ten APPC models, i.e., one model for each of the five bins both for decreases and increases in self-esteem,

we report Bonferroni-Holm corrected p-values to avoid alpha inflation. We applied the same procedures to analyze the APPC of valence.

Results

Preliminary Analyses

Participants' mean age was 28.9 years (SD=7.6), and there were significant age differences among groups (for sample characteristics, see Table 5.1; Kruskal-Wallis-X^2=15.51, df=2, p<.001). On average, patients with ADs were approximately three years older than those with BPD (z=3.76, p<.001) and HCs (z=2.97, p<.01). The overall compliance, i.e., the percentage of participants' valid e-diary assessments, was approximately 88%. From this very high level, compliance moderately declined over the four assessment days (β=-0.16, SE=0.02, z=-7.61, p<.001): compliance was highest on the first day (almost 90%) and lowest on the fourth day (85%), but compliance was still very high on the fourth day. The time of day did not influence participants' compliance (β=0.01, SE=0.01, z=1.65, p=.10). Patients with ADs had especially high compliance (Kruskal-Wallis-X^2=13.38, df=2, p<.01), both compared to BPD patients (z=3.43, p<.01) and HCs (z=2.87, p<.05). Regarding comorbidity, patients with BPD exhibited high rates of current Axis I disorders (particularly ADs, PTSD, and eating disorders). In the AD group, depressive disorders were the most common comorbidity. With only eight patients fulfilling three or four BPD criteria and an average of 0.59 (SD=1.01) fulfilled BPD criteria, BPD symptomatology was very low in the AD group.

Table 5.1

Sample characteristics by group

Variable	BPD (n=131)	AD (n=121)	HCs (n=134)	*group differences*
Age (in years)				$\chi^2(2)=15.51$, *p<.001*
M (SD)	27.73 (7.71)	31.25 (8.16)	27.91 (6.28)	
median (min - max)	26 (18 - 48)	31 (18 - 45)	26 (18 - 46)	
Total number of self-reports				H(2)=13.38, *p<.01*
M (SD)	40.64 (7.65)	44.21 (3.86)	41.45 (7.23)	
Compliance (%)	85	92	86	
Psychotropic medication n (%)	92 (70%)	62 (51%)	-	$\chi^2(1)=9.27$, *p<.01*
Current Axis I diagnoses n (%)				
Major depression	100 (76%)	49 (40%)	-	$\chi^2(1)=35.01$, *p<.001*
Dysthymia	7 (5%)	22 (18%)	-	$\chi^2(1)=8.57$, *p<.01*
Generalized anxiety disorder	4 (3%)	29 (24%)	-	$\chi^2(1)=21.72$, *p<.001*
Social anxiety disorder	18 (14%)	36 (30%)	-	$\chi^2(1)=8.12$, *p<.01*
Panic disorder without agoraphobia	13 (10%)	19 (16%)	-	$\chi^2(1)=1.25$, *p=.26*

(continued)

Sample characteristics by group (continued)

Variable	BPD (n=131)	AD (n=121)	HCs (n=134)	*group differences*
Panic disorder with agoraphobia	16 (12%)	49 (40%)	-	$\chi^2(1)=23.84$, *p<.001*
Agoraphobia without panic disorder	4 (3%)	13 (11%)	-	$\chi^2(1)=4.54$, *p<.05*
Specific phobia	7 (5%)	41 (34%)	-	$\chi^2(1)=30.48$, *p<.001*
Posttraumatic stress disorder	43 (33%)	exclusion criterion	-	-
Obsessive-compulsive disorder	14 (11%)	6 (5%)	-	$\chi^2(1)=2.26$, *p=.13*
Substance: harmful use	36 (27%)	0 (0%)	-	$\chi^2(1)=37.54$, *p<.001*
Somatization syndrome	10 (8%)	1 (1%)	-	$\chi^2(1)=5.63$, *p<.05*
Anorexia nervosa	9 (7%)	1 (1%)	-	$\chi^2(1)=4.71$, *p<.05*
Bulimia nervosa	18 (14%)	exclusion criterion	-	
Binge eating disorder	12 (9%)	2 (2%)	-	$\chi^2(1)=5.61$, *p<.05*
Other eating disorders	12 (9%)	7 (6%)	-	$\chi^2(1)=0.68$, *p=.41*

Current Axis II disorders□ n (%)

BPD	131 (100%)	exclusion criterion	-	-

Sample characteristics by group (continued)

Variable	BPD (n=131)	AD (n=121)	HCs (n=134)	group differences
BPD criteria fulfilled M (SD)	7.08 (1.27)	0.59 (1.01)	-	W=15488, *p<.001*
Cluster A	31 (24%)	7 (6%)	-	$\chi^2(1)$=15.16, *p<.001*
Cluster B[*]	10 (8%)	1 (1%)	-	$\chi^2(1)$=7.36, *p<.01*
Cluster C	57 (44%)	16 (13%)		$\chi^2(1)$=23.03, *p<.001*

BPD = borderline personality disorder; AD = anxiety disorder, i.e., current *DSM-IV* diagnosis of either generalized anxiety disorder, social anxiety disorder, agoraphobia, or panic disorder; HCs = healthy controls. Test statistics and p-values refer to group differences based on chi-square tests, Kruskal-Wallis tests, and Wilcoxon rank-sum tests. Compliance: the total number self-reports divided by the total number of prompts; [□] based on 120 patients in the BPD group (11 patients with a secured BPD diagnosis refused to undergo the full SCID-II interview); [*] in addition to the BPD diagnosis

Group Differences in Mean Symptomatology

Multilevel analyses of the average intensity of self-esteem showed that patients with BPD exhibited lower self-esteem (M=4.09, SD=1.79) than those with ADs (M=6.07, SD=1.78) and HCs (M=8.22, SD=0.85). Patients with BPD reported their affective states to be more negative; that is, they reported lower valence (M=2.74, SD=1.01) and higher tension (M=2.76, SD=0.95) than those with ADs (M=3.71, SD=0.88 for valence and M=3.41, SD=0.86 for tense arousal) and HCs

(M=5.00, SD=0.74 for valence and M=4.89, SD=0.80 for tense arousal). Across the three constructs, all possible group contrasts (BPD>AD, BPD>HC, and AD>HC) were highly significant (all p-values < .001).

The heatmaps in Figure 5.1 provide a visualization of these group differences, descriptively illustrating each participant's courses of momentary self-esteem (1A), valence (1B), and tense arousal (1C) over the four assessment days. Each horizontal line depicts the repeated assessments of one participant, which are ordered by group membership. Red shades represent low self-esteem; negative valence; and high tension, i.e., low calmness, whereas green shades represent high self-esteem; positive valence; and low tension, i.e., high calmness. Across the three figures, green shades prevail in the HC group, whereas red, orange, and yellow shades occur more frequently in the two clinical groups.
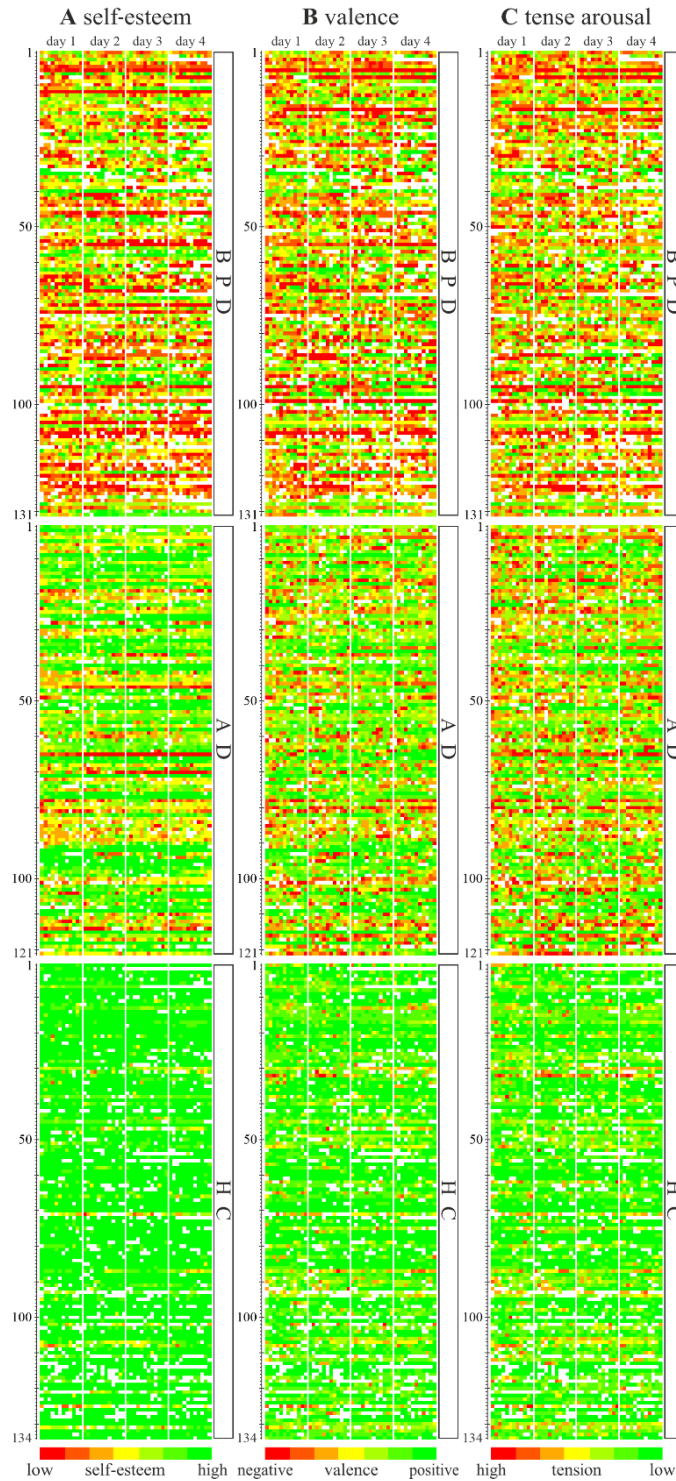
Figure 5.1. Color-coded momentary ratings of patients with borderline personality disorder (BPD), anxiety disorders (ADs), and healthy controls (HCs). Each row represents a subject, and each square represents a self-report at 1-hr intervals. The color denotes the level of (A) self-esteem, (B) valence, and (C) tense arousal. The color ranges from red to green, where shades of green represent ratings of positive momentary states and shades of red represent ratings of negative momentary states. White squares represent missing data.

Group Differences in Self-Esteem Instability

Multilevel analyses of general instability (SSD) and the occurrences of extreme changes (PAC) and APPCs revealed a consistent pattern in group differences in self-esteem instability. First, replicating previous findings, we confirmed that patients with BPD exhibited significantly higher general self-esteem instability, i.e., SSD of self-esteem, than HCs (β=1.84, SE=0.12, z=15.79, p<.001). Expressed as estimated means, 6.31 times higher SSDs were found in the BPD group than in HCs. This trend held true for patients with ADs, who exhibited heightened SSDs of self-esteem compared to HCs (β=1.21, SE=0.12, z=10.20, p<.001), with 3.36 times higher estimated means. Most importantly, contrasting the clinical groups revealed that patients with BPD had higher SSDs of self-esteem than those with ADs (β=0.63, SE=0.12, z=5.28, p<.001). That is, the estimated means of patients with BPD were 1.88 times higher than those of patients with ADs, suggesting BPD specificity of self-esteem instability.

Following the recommendations of Ebner-Priemer (2009), we additionally accounted for individual mean differences in self-esteem. We conducted the same multilevel model, including the person means of self-esteem as an additional predictor in the model. However, controlling for the mean did not notably affect the results (for details, see supplemental material S1).

Second, we compared the group odds to report extreme changes (PAC) in self-esteem. Compared to HCs, patients with BPD had higher odds of the occurrence of extreme changes in self-esteem (β=2.57, SE=0.21, z=12.50, p<.001), with a 13.03 times higher odds ratio in the BPD group. Again, the same applied for patients with ADs, who had a 5.45 times higher odds ratio for extreme changes in self-esteem than HCs (β=1.69, SE=0.21, z=8.10, p<.001). Contrasting the BPD group with the AD group, we found that patients with BPD had higher odds of extreme changes in self-esteem than those with ADs (β=0.87, SE=0.18, z=5.00, p<.001). In other words, the odds ratio

of extreme changes in self-esteem was 2.39 higher for patients with BPD than for patients with ADs. This result suggests BPD specificity of extreme changes in self-esteem.

Third, taking a closer look at participants' fluctuations in self-esteem, we analyzed APPC as they allow to disentangle the time series into drops and increases (repairs) of self-esteem while controlling for floor and ceiling effects (Ebner-Priemer et al., 2007; Santangelo et al., 2014). Figure 5.2A shows that patients with BPD exhibited significantly higher decreases in self-esteem than patients with ADs and HCs from every self-esteem bin (i.e., starting state). Notably, we only used bins with sufficient data for the multilevel group comparisons, i.e., from mid-low to high (bins with insufficient data are marked with crosshatched bars). Patients with ADs also had larger decreases from the high self-esteem bin than HCs, but the decreases in the BPD group were almost two times larger than those in the AD group and more than three times larger than those in the HC group. This finding suggests that patients with BPD report especially large decreases in self-esteem, with strikingly high decreases under a state of high momentary self-esteem.
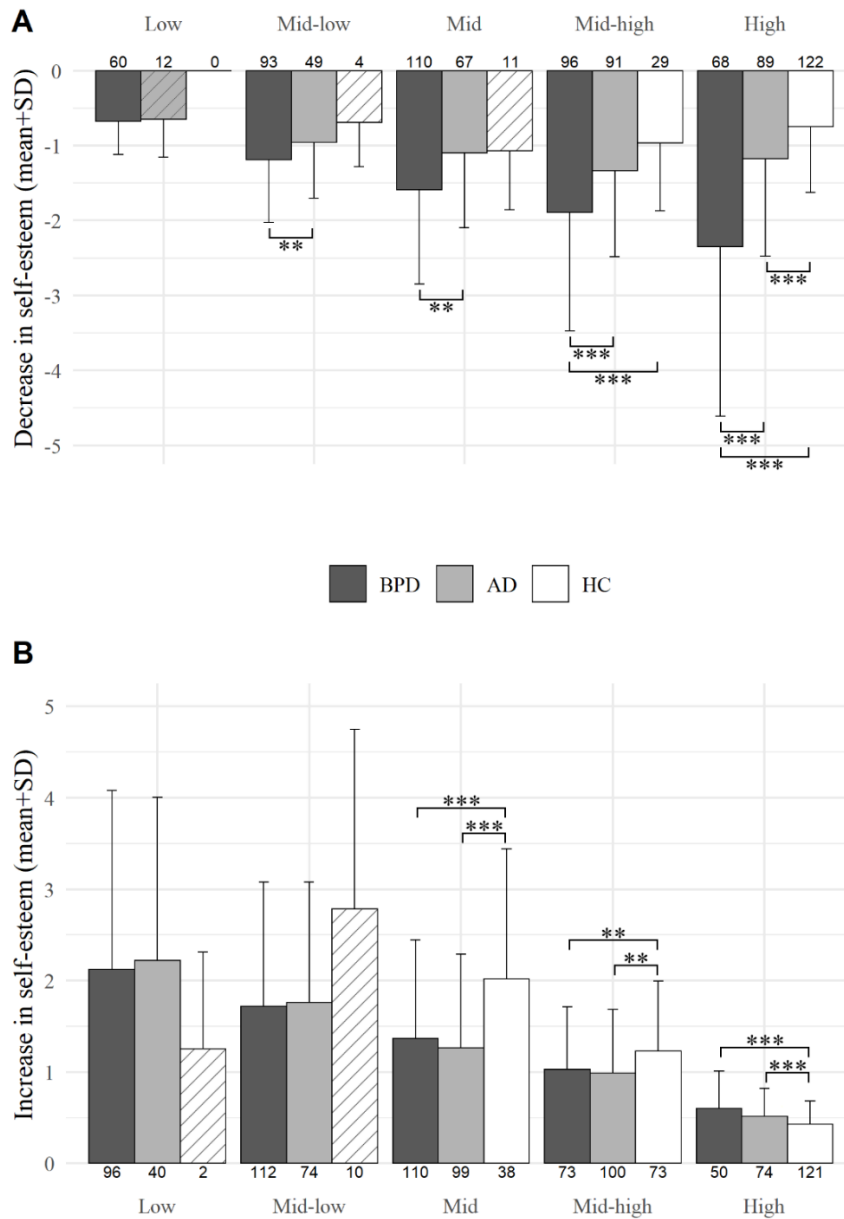
Figure 5.2. Changes in self-esteem in relation to each previous corresponding self-esteem rating across patients with borderline personality disorder (BPD), those with anxiety disorders (ADs), and healthy controls (HCs): (A) decreases in self-esteem from low = 0–2, mid-low = 2.25–3.75, mid = 4–5.5, mid-high = 5.75–7.25, and high = 7.5–9 starting states of self-esteem; (B) increases in self-esteem from low = 0–1.75, mid-low = 2–3.5, mid = 3.75–5.25, mid-high = 5.5–7, and high = 7.25–8.75 starting states of self-esteem. The numbers indicate how many participants' data are included in the mean scores for each bar. * p < .05, ** p < .01, *** p < .001; p-values from the multilevel models were Bonferroni-Holm corrected and were not interpreted when one group of participants was smaller than n = 20 (illustrated with crosshatched bars). We only report significant group comparisons. Differences between bars (that are not crosshatched) without brackets are not significant.

Figure 5.2B shows that only a few HCs reported increases in low self-esteem states and that HCs had larger increases in self-esteem from mid and mid-high states than patients with BPD and those with ADs. Thus, the clinical groups seem to need more time to recover from low self-esteem, which is especially problematic for patients with BPD, given their particularly large decreases in self-esteem. The only exception is that patients with BPD and those with ADs showed significantly higher increases in the high self-esteem bin than HCs, but these group differences were very small.

Across the three statistical indices, our analyses revealed a consistent pattern of dysregulated self-esteem instability in patients with BPD compared to that of clinical controls and HCs. Moreover, patients with ADs also exhibited higher self-esteem instability than HCs, albeit in a weakened form.

Group Differences in Affective Instability

To predict group differences in affective instability, we conducted the same multilevel analyses of the three statistical indices (SSD, PAC, and APPC) using valence and tense arousal as outcomes. First, consistent with previous findings, we confirmed that patients with BPD exhibited higher general instability, i.e., SSDs of valence (β=0.95, SE=0.09, z=10.63, p<.001) and tense arousal (β=0.86, SE=0.09, z=9.93, p<.001), than HCs, with 2.59 times higher estimated means for instability of valence and 2.36 times higher estimated means for instability of tense arousal in the BPD group. Similarly, patients with ADs had heightened SSDs of valence (β=0.94, SE=0.09, z=10.29, p<.001) and tense arousal (β=0.94, SE=0.09, z=10.67, p<.001) compared to that of HCs. That is, AD patients' estimated means of instability were 2.55 times higher for valence and 2.56 times higher for tense arousal. However, clinical patients' affective instability did not differ in terms of instability of valence (β=0.01, SE=0.09, z=0.16, p=.87) or instability of tense arousal (β=-0.08, SE=0.09, z=-0.91, p=.36). The estimated mean for instability of valence was only 1% higher

95

in the BPD group than in the AD group and was even 8% lower for instability of tense arousal, suggesting general affective instability to be transdiagnostically heightened. Similar to the analyses of self-esteem instability, controlling for the person means of valence or tense arousal did not notably affect these results (for details, see S1).

Second, compared to that of HCs, the odds ratio for extreme changes (PAC) of patients with BPD was 3.80 times higher for valence (β=1.34, SE=0.15, z=8.97, p<.001) and 3.47 times higher for tense arousal (β=1.24, SE=0.15, z=8.44, p<.001). The same applied to patients with ADs, who had a 3.64 times higher odds ratio for extreme changes in valence (β=1.29, SE=0.15, z=8.61, p<.001) and a 4.00 times higher odds ratio for extreme changes in tense arousal (β=1.39, SE=0.15, z=9.38, p<.001) than HCs. However, neither the PAC in valence (β=0.04, SE=0.14, z=0.31, p=.76) nor the PAC in tense arousal (β=-0.14, SE=0.13, z=-1.05, p=.29) differed among the clinical groups. Compared to the AD group, BPD patients' odds ratio for extreme changes in valence was only 4% higher and was even 13% lower for extreme changes in tense arousal. Thus, extreme affective changes were as frequent in patients with AD as in patients with BPDs.

Third, depicting the results of the multilevel analyses of group differences in APPCs, Figure 5.3A shows a consistent pattern of larger decreases in valence in patients with BPD and those with ADs than in HCs. Significant differences between the clinical groups emerged in only one bin: Patients with BPD had larger decreases in valence from the high bin than patients with ADs. As depicted in Figure 5.3B, there was no evidence of heightened increases in valence in any of the clinical groups. Rather, the only significant difference was that patients with BPD and those with ADs had lower increases in valence from the mid bin than HCs.
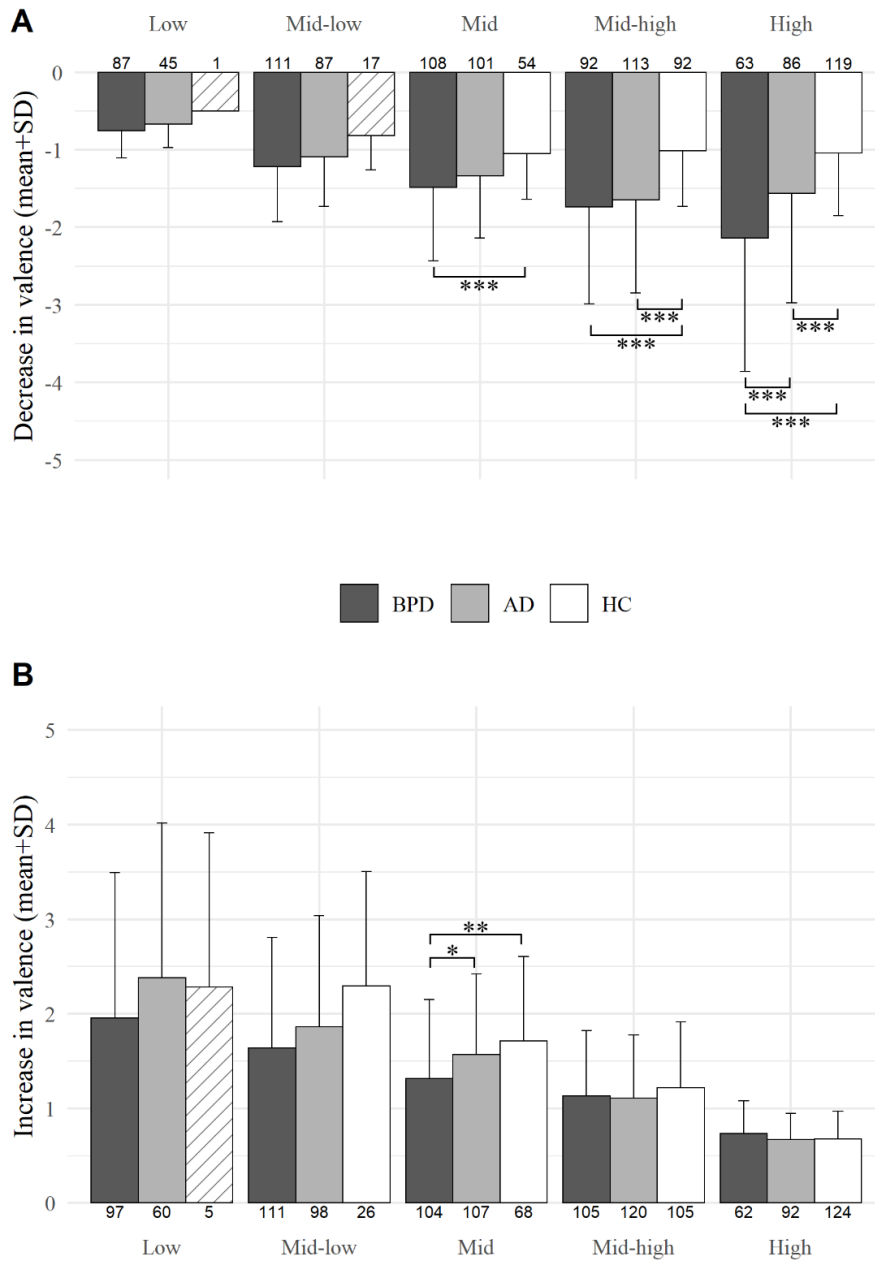
Figure 5.3. Changes in valence in relation to each previous corresponding valence rating across patients with borderline personality disorder (BPD), those with anxiety disorders (ADs), and healthy controls (HCs): (A) decreases in valence from low = 0.5–1.5, mid-low = 2–3, mid = 3.5–4, mid-high = 4.5–5, and high = 5.5–6 starting states of valence; (B) increases in valence from low = 0–0.5, mid-low = 1–1.5, mid = 2–2.5, mid-high = 3–4, and high = 4.5–5.5 starting states of valence. The numbers indicate how many participants' data are included in the mean scores for each bar. * $p < .05$, ** $p < .01$, *** $p < .001$; p-values from the multilevel models were Bonferroni-Holm corrected and were not interpreted when one group of participants was smaller than n = 20 (illustrated with crosshatched bars). We only report significant group comparisons. Differences between bars (that are not crosshatched) without brackets are not significant.

Overall, apart from slightly larger decreases from high-valence states, affective instability did not differ among the clinical groups and was transdiagnostically heightened compared to that of HCs across the different instability indices. In contrast, differences in self-esteem instability between the BPD group and the AD group were consistently evident.

Discussion

In this AA study, we revealed for the first time that patients with BPD, exhibited higher instability of self-esteem across multiple established statistical indices than a clinical control group of AD patients and HCs in their daily lives. Using high-frequency sampling in a large sample, we found that BPD patients' general self-esteem instability was almost twice as high as that of patients with ADs and more than six times higher than that of HCs. This BPD-specific pattern of self-esteem instability was also evident in participants' probability of extreme self-esteem changes and participants' decreases from different self-esteem starting states. Additionally, controlling for participants' mean levels of self-esteem, although a significant predictor, did not considerably change the results and provided further evidence of the BPD specificity of self-esteem instability. Given that the average self-esteem was lowest in the BPD group among the study groups and that self-esteem mostly fluctuated around this low average, we assume that the combination of low and unstable self-esteem may be especially impairing for patients with BPD.

In-depth analyses of decreases and increases in self-esteem explain our findings in more detail. Regarding the decreases, it is evident that patients with BPD suffered from especially large decreases in self-esteem compared to that of clinical controls and HCs. Furthermore, the lack of compensating repairs in self-esteem indicates that they might not recover from these drops or at least might remain longer in negative self-esteem states. This specific, presumably oppressive pattern may explain the association of low self-esteem states and dysfunctional behavior found by

Santangelo, Holtmann, et al. (2020). Moreover, our study is one of the first to show heightened self-esteem instability in patients with ADs compared to that in HCs. In contrast to the findings of Farmer and Kashdan (2014), these findings were robust even when participants' mean self-esteem was controlled. Accordingly, although also elevated in ADs, self-esteem instability was particularly prominent in BPD.

Furthermore, we extended previous findings on affective instability by adding an additional control group and found no evidence that affective instability was specifically heightened in BPD. Although affective instability was higher in patients with BPD than in HCs, it did not differ between patients with BPD and those with ADs. This pattern was consistent across different instability measures: compared to HCs, both patients with BPD and those with ADs had higher general affective instability (independent of participants' mean affect, which was lowest in the BPD group) and a higher probability of extreme changes of affect, and they lacked repairs in large drops from positive valence states. Only decreases from high valence states were somewhat larger in the BPD group. The results align with previous studies providing evidence for a transdiagnostic pattern of affective instability, which was shown in the comparison of patients with BPD to those with PTSD and those with bulimia nervosa (Santangelo et al., 2014; Santangelo et al., 2016) as well as to patients with depression and those with bipolar disorders (Mneimne et al., 2018). Deviations from this transdiagnostic pattern were found only in the comparison of patients with BPD to those with avoidant personality disorder regarding the instability of negative affect (Snir et al., 2017) and those with depressive disorders regarding the instability of some specific negative emotions (Trull et al., 2008).

In summary, heightened self-esteem instability may be a defining, specific feature of BPD, while our results support existing evidence that affective instability is a transdiagnostic mechanism. These patterns were evident independent of the statistical approach. In a synopsis of our findings

and those of Santangelo, Kockler, et al. (2020), namely, that self-esteem instability, unlike affective instability, is lower after remission from BPD, particularly heightened self-esteem instability might differentiate patients in acute BPD disorder stages from those with acute ADs and those in remitted BPD stages.

Our study has several clinical implications. Therapists' clinical picture of especially unstable BPD patients might originate from striking fluctuations in self-esteem rather than fluctuation in affect, which may be confused in patients' reports in therapy sessions. Unlike dialectic behavior therapy in its original form, which strongly focused on the management of negative affective states, state-of-the-art therapy programs, including current dialectic behavior therapy (Linehan, 2014), have prioritized reestablishing patients' self-esteem. Additionally, psychotherapies could be enriched by including coping strategies to regulate large self-esteem fluctuations, especially to repair large decreases in self-esteem. For instance, mindfulness-based exercises could help patients not dwell excessively on their alleged failures. Moreover, our data show that patients with BPD fortunately experience momentary states of high self-esteem, which is a valuable resource and might not have been considered in patients' self-assessment. Knowing that their self-esteem is not persistently low but subject to temporary fluctuations could help patients perform more realistic self-assessment, especially during crises, and enable them to deal with possible setbacks in advance. Furthermore, since self-esteem and affect are highly intertwined, addressing the regulation of both self-esteem and affect in therapies could be effective in reducing dysfunctional behavior (Santangelo, Holtmann, et al., 2020). Our findings also indicate that emotion regulation skills could be integrated into anxiety treatment programs, particularly to help patients with ADs cope with fluctuating tension (Neacsiu et al., 2014). Notably, patients should not focus on skills during exposure therapy, as this might conflict with the aim of habituation to

anxiety. However, particular skills, such as acting in an opposite way to the current emotion, could enable patients to approach anxiety-inducing situations rather than avoiding them (Linehan, 2014).

We acknowledge that our study had several limitations. First, the AD group consisted of inpatients, whereas the patients in the BPD group were outpatients waiting for stationary admission. To avoid group differences due to therapy effects in the AD group, we aimed to complete all the study procedures within the first week of the six-week treatment and not later than two weeks after admission. Notably, all patients in the AD group met the criteria for at least one acute AD in the diagnostic interview. Furthermore, to account for the different settings, we conducted additional analyses of data from weekends only when patients with ADs had no fixed therapy schedule, which revealed the same pattern of results.

Second, we did not consider the context in which the participants' self-esteem and affect fluctuated. Relevant events or triggers, such as external or internal stressors, might have driven patterns of self-esteem and affect. Because events or triggers might have differed between groups and given the growing recognition of the importance of contextual factors in e-diary studies (Aldao & Tull, 2015), assessments of relevant events should be taken into account in future studies.

Third, because patients with ADs were somewhat older than patients with BPD, we conducted additional analyses controlling for age, which did not affect any group comparison. Interestingly, higher age was associated with lower instability of valence but not with instability of self-esteem or tense arousal. This findings is consistent with the findings of a recent AA study that found declining affective instability over the lifespan in patients with BPD (Santangelo et al., 2018). Therefore, the identified age differences support our findings because patients with ADs, although slightly older, exhibited similarly high affective instability as patients with BPD.

Fourth, given the purely female sample, our findings may not be generalizable to male populations. However, including only female participants also reduced the heterogeneity of the

sample. Although this may have been beneficial given the literature on gender differences in affect (Fujita et al., 1991) and self-esteem (Kling et al., 1999), our results should be replicated in a mixed-sex sample.

Fifth, we did not account for the influence of different comorbid disorders on instability. Within the AD group, we did not analyze the separate AD subgroups due to the small sample sizes and frequent presence of multiple comorbid ADs. There were a variety of comorbid Axis I and Axis II diagnoses in our sample, especially in the BPD group. Thus, no statement can be made about whether our findings apply to each AD subgroup or whether they are independent of any comorbidity in the BPD group. However, comorbidity is the rule, not the exception, in BPD (Sanislow et al., 2012), which is why our nonartificial sample of BPD patients with high comorbidity rates can be seen as more representative than a BPD population without comorbid disorders (Baer et al., 2012).

Sixth, our statements on BPD specificity are restricted to comparisons with patients with ADs. Therefore, it remains unclear whether self-esteem instability in BPD also differs from that in other clinical control groups, especially those that have been associated with an equally heightened affective instability compared to that of patients with BPD or fragile self-esteem, i.e., PTSD or bulimia nervosa patients (Kashdan et al., 2006; Linardon et al., 2019; Santangelo et al., 2014; Santangelo et al., 2016).

Despite these limitations, this is the first AA study to investigate the instability of both self-esteem and affect in a very large sample including patients with BPD, a clinical control group of AD patients, and HCs. Across different statistical approaches, we consistently found that patients with BPD had higher general self-esteem instability, more extreme changes in self-esteem, and larger decreases from high self-esteem states than patients with ADs and HCs, indicating BPD specificity. In contrast, affective instability was heightened across clinical groups when compared

to that in HCs, with no differences between patients with BPD and those with ADs. Our findings suggest that self-esteem instability, unlike affective instability, might be the defining feature to describe the unstable symptomatology in the daily lives of patients with BPD. Our findings warrant replication and extension through comparison of patients BPD to those with other mental disorders.

References

Aldao, A., & Tull, M. T. (2015). Putting emotion regulation in context. *Current Opinion in Psychology*, *3*, 100–107. https://doi.org/10.1016/j.copsyc.2015.03.022

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. Washington, DC: American Psychiatric Publishing.

Anestis, M. D., Selby, E. A., Crosby, R. D., Wonderlich, S. A., Engel, S. G., & Joiner, T. E. (2010). A comparison of retrospective self-report versus ecological momentary assessment measures of affective lability in the examination of its relationship with bulimic symptomatology. *Behaviour Research and Therapy*, *48*(7), 607–613. https://doi.org/10.1016/j.brat.2010.03.012

Baer, R. A., Peters, J. R., Eisenlohr-Moul, T. A., Geiger, P. J., & Sauer, S. E. (2012). Emotion-related cognitive processes in borderline personality disorder: A review of the empirical literature. *Clinical Psychology Review*, *32*(5), 359–369. https://doi.org/10.1016/j.cpr.2012.03.002

Bates, D., Mächler, M., Bolker, B., & Walker, S. (2015). Fitting Linear Mixed-Effects Models Using lme4. *Journal of Statistical Software*, *67*(1). https://doi.org/10.18637/jss.v067.i01

Bowen, R., Baetz, M., Hawkes, J., & Bowen, A. (2006). Mood variability in anxiety disorders. *Journal of Affective Disorders*, *91*(2-3), 165–170. https://doi.org/10.1016/j.jad.2005.12.050

Bowen, R., Clark, M., & Baetz, M. (2004). Mood swings in patients with anxiety disorders compared with normal controls. *Journal of Affective Disorders*, *78*(3), 185–192. https://doi.org/10.1016/S0165-0327(02)00304-X

Carpenter, R. W., Wycoff, A. M., & Trull, T. J. (2016). Ambulatory Assessment. *Assessment*, *23*(4), 414–424. https://doi.org/10.1177/1073191116632341

Ebner-Priemer, U. W., Welch, S. S., Grossman, P., Reisch, T., Linehan, M. M., & Bohus, M. (2007). Psychophysiological ambulatory assessment of affective dysregulation in borderline personality disorder. *Psychiatry Research*, *150*(3), 265–275. https://doi.org/10.1016/j.psychres.2006.04.014

Farmer, A. S., & Kashdan, T. B. (2014). Affective and Self-Esteem Instability in the Daily Lives of People with Generalized Social Anxiety Disorder. *Clinical Psychological Science*, *2*(2), 187–201. https://doi.org/10.1177/2167702613495200

Fujita, F., Diener, E., & Sandvik, E. (1991). Gender differences in negative affect and well-being: The case for emotional intensity. *Journal of Personality and Social Psychology*, *61*(3), 427–434. https://doi.org/10.1037/0022-3514.61.3.427

Fydrich, T., Renneberg, B., Schmitz, B., & Wittchen, H. U. (1997). *SKID II. Strukturiertes Klinisches Interview für DSM-IV, Achse II: Persönlichkeitsstörungen. Interviewheft. Eine deutschsprachige, erweiterte Bearbeitung der amerikanischen Originalversion des SCID-I.* Hogrefe.

Houben, M., Bohus, M., Santangelo, P. S., Ebner-Priemer, U. W., Trull, T. J., & Kuppens, P. (2016). The specificity of emotional switching in borderline personality disorder in comparison to other clinical groups. *Personality Disorders*, *7*(2), 198–204. https://doi.org/10.1037/per0000172

Jahng, S., Solhan, M. B., Tomko, R. L., Wood, P. K., Piasecki, T. M., & Trull, T. J. (2011). Affect and alcohol use: An ecological momentary assessment study of outpatients with borderline personality disorder. *Journal of Abnormal Psychology*, *120*(3), 572–584. https://doi.org/10.1037/a0024686

Jahng, S., Wood, P. K., & Trull, T. J. (2008). Analysis of affective instability in ecological momentary assessment: Indices using successive difference and group comparison via multilevel modeling. *Psychological Methods*, *13*(4), 354–375. https://doi.org/10.1037/a0014173

Kashdan, T. B., Uswatte, G., Steger, M. F., & Julian, T. (2006). Fragile self-esteem and affective instability in posttraumatic stress disorder. *Behaviour Research and Therapy*, *44*(11), 1609–1619. https://doi.org/10.1016/j.brat.2005.12.003

Kling, K. C., Hyde, J. S., Showers, C. J., & Buswell, B. N. (1999). Gender differences in self-esteem: A meta-analysis. *Psychological Bulletin*, *125*(4), 470–500. https://doi.org/10.1037/0033-2909.125.4.470

Kockler, T. D., Santangelo, P. S., & Ebner-Priemer, U. W. (2018). Investigating Binge Eating Using Ecological Momentary Assessment: The Importance of an Appropriate Sampling Frequency. *Nutrients*, *10*(1). https://doi.org/10.3390/nu10010105

Lamers, F., Swendsen, J., Cui, L., Husky, M., Johns, J., Zipunnikov, V., & Merikangas, K. R. (2018). Mood reactivity and affective dynamics in mood and anxiety disorders. *Journal of Abnormal Psychology*, *127*(7), 659–669. https://doi.org/10.1037/abn0000378

Linardon, J., Kothe, E. J., & Fuller-Tyszkiewicz, M. (2019). Efficacy of psychotherapy for bulimia nervosa and binge-eating disorder on self-esteem improvement: Meta-analysis. *European*

Eating Disorders Review : The Journal of the Eating Disorders Association, *27*(2), 109–123. https://doi.org/10.1002/erv.2662

Linehan, M. M. (2014). *DBT skills training manual*. Guilford Publications.

Lobbestael, J., Leurgans, M., & Arntz, A. (2011). Inter-rater reliability of the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID I) and Axis II Disorders (SCID II). *Clinical Psychology & Psychotherapy*, *18*(1), 75–79. https://doi.org/10.1002/cpp.693

Mneimne, M., Fleeson, W., Arnold, E. M., & Furr, R. M. (2018). Differentiating the everyday emotion dynamics of borderline personality disorder from major depressive disorder and bipolar disorder. *Personality Disorders*, *9*(2), 192–196. https://doi.org/10.1037/per0000255

Neacsiu, A. D., Eberle, J. W., Kramer, R., Wiesmann, T., & Linehan, M. M. (2014). Dialectical behavior therapy skills for transdiagnostic emotion dysregulation: A pilot randomized controlled trial. *Behaviour Research and Therapy*, *59*, 40–51. https://doi.org/10.1016/j.brat.2014.05.005

Pfaltz, M. C., Michael, T., Grossman, P., Margraf, J., & Wilhelm, F. H. (2010). Instability of physical anxiety symptoms in daily life of patients with panic disorder and patients with posttraumatic stress disorder. *Journal of Anxiety Disorders*, *24*(7), 792–798. https://doi.org/10.1016/j.janxdis.2010.06.001

Rizk, M. M., Choo, T.-H., Galfalvy, H., Biggs, E., Brodsky, B. S., Oquendo, M. A., Mann, J. J., & Stanley, B. (2019). Variability in Suicidal Ideation is Associated with Affective Instability in Suicide Attempters with Borderline Personality Disorder. *Psychiatry*, *82*(2), 173–178. https://doi.org/10.1080/00332747.2019.1600219

Rosenberg, M. (1965). *Society and the Adolescent Self-Image*. Princeton University Press. https://doi.org/10.1515/9781400876136

Sanislow, C. A., Marcus, K. L., & Reagan, E. M. (2012). Long-term outcomes in borderline psychopathology: Old assumptions, current findings, and new directions. *Current Psychiatry Reports*, *14*(1), 54–61. https://doi.org/10.1007/s11920-011-0250-y

Santangelo, P. S., Holtmann, J., Hosoya, G., Bohus, M., Kockler, T. D., Koudela-Hamila, S., Eid, M., & Ebner-Priemer, U. W. (2020). Within- and Between-Persons Effects of Self-Esteem and Affective State as Antecedents and Consequences of Dysfunctional Behaviors in the Everyday Lives of Patients With Borderline Personality Disorder. *Clinical Psychological Science*, 216770262090172. https://doi.org/10.1177/2167702620901724

Santangelo, P. S., Kockler, T. D., Zeitler, M.-L., Knies, R., Kleindienst, N., Bohus, M., & Ebner-Priemer, U. W. (2020). Self-esteem instability and affective instability in everyday life after remission from borderline personality disorder. *Borderline Personality Disorder and Emotion Dysregulation*, *7*(1). https://doi.org/10.1186/s40479-020-00140-8

Santangelo, P. S., Koenig, J., Kockler, T. D., Eid, M., Holtmann, J., Koudela-Hamila, S., Parzer, P., Resch, F., Bohus, M., Kaess, M., & Ebner-Priemer, U. W. (2018). Affective instability across the lifespan in borderline personality disorder - a cross-sectional e-diary study. *Acta Psychiatrica Scandinavica*, *138*(5), 409–419. https://doi.org/10.1111/acps.12950

Santangelo, P. S., Limberger, M. F., Stiglmayr, C., Houben, M., Coosemans, J., Verleysen, G., Kuppens, P., Tuerlinckx, F., Vanpaemel, W., & Ebner-Priemer, U. W. (2016). Analyzing subcomponents of affective dysregulation in borderline personality disorder in comparison to other clinical groups using multiple e-diary datasets. *Borderline Personality Disorder and Emotion Dysregulation*, *3*, 5. https://doi.org/10.1186/s40479-016-0039-z

Santangelo, P. S., Reinhard, I., Koudela-Hamila, S., Bohus, M., Holtmann, J., Eid, M., & Ebner-Priemer, U. W. (2017). The temporal interplay of self-esteem instability and affective instability

in borderline personality disorder patients' everyday lives. *Journal of Abnormal Psychology*, *126*(8), 1057–1065. https://doi.org/10.1037/abn0000288

Santangelo, P. S., Reinhard, I., Mussgay, L., Steil, R., Sawitzki, G., Klein, C., Trull, T. J., Bohus, M., & Ebner-Priemer, U. W. (2014). Specificity of affective instability in patients with borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls. *Journal of Abnormal Psychology*, *123*(1), 258–272. https://doi.org/10.1037/a0035619

Schoevers, R. A., van Borkulo, C. D., Lamers, F., Servaas, M. N., Bastiaansen, J. A., Beekman, A. T. F., van Hemert, A. M., Smit, J. H., Penninx, B. W. J. H., & Riese, H. (2020). Affect fluctuations examined with ecological momentary assessment in patients with current or remitted depression and anxiety disorders. *Psychological Medicine*, 1–10. https://doi.org/10.1017/S0033291720000689

Snir, A., Bar-Kalifa, E., Berenson, K. R., Downey, G., & Rafaeli, E. (2017). Affective instability as a clinical feature of avoidant personality disorder. *Personality Disorders*, *8*(4), 389–395. https://doi.org/10.1037/per0000202

Solhan, M. B., Trull, T. J., Jahng, S., & Wood, P. K. (2009). Clinical assessment of affective instability: Comparing EMA indices, questionnaire reports, and retrospective recall. *Psychological Assessment*, *21*(3), 425–436. https://doi.org/10.1037/a0016869

Stanton, K., McDonnell, C. G., Hayden, E. P., & Watson, D. (2020). Transdiagnostic approaches to psychopathology measurement: Recommendations for measure selection, data analysis, and participant recruitment. *Journal of Abnormal Psychology*, *129*(1), 21–28. https://doi.org/10.1037/abn0000464

Tolpin, L. H., Gunthert, K. C., Cohen, L. H., & O'Neill, S. C. (2004). Borderline personality features and instability of daily negative affect and self-esteem. *Journal of Personality*, *72*(1), 111–137. https://doi.org/10.1111/j.0022-3506.2004.00258.x

Tomko, R. L., Lane, S. P., Pronove, L. M., Treloar, H. R., Brown, W. C., Solhan, M. B., Wood, P. K., & Trull, T. J. (2015). Undifferentiated negative affect and impulsivity in borderline personality and depressive disorders: A momentary perspective. *Journal of Abnormal Psychology*, *124*(3), 740–753. https://doi.org/10.1037/abn0000064

Tragesser, S. L., Solhan, M. B., Schwartz-Mette, R., & Trull, T. J. (2007). The role of affective instability and impulsivity in predicting future BPD features. *Journal of Personality Disorders*, *21*(6), 603–614. https://doi.org/10.1521/pedi.2007.21.6.603

Trull, T. J., & Ebner-Priemer, U. W. (2013). Ambulatory assessment. *Annual Review of Clinical Psychology*, *9*, 151–176. https://doi.org/10.1146/annurev-clinpsy-050212-185510

Trull, T. J., & Ebner-Priemer, U. W. (2020). Ambulatory assessment in psychopathology research: A review of recommended reporting guidelines and current practices. *Journal of Abnormal Psychology*, *129*(1), 56–63. https://doi.org/10.1037/abn0000473

Trull, T. J., Lane, S. P., Koval, P., & Ebner-Priemer, U. W. (2015). Affective Dynamics in Psychopathology. *Emotion Review : Journal of the International Society for Research on Emotion*, *7*(4), 355–361. https://doi.org/10.1177/1754073915590617

Trull, T. J., Solhan, M. B., Tragesser, S. L., Jahng, S., Wood, P. K., Piasecki, T. M., & Watson, D. (2008). Affective instability: Measuring a core feature of borderline personality disorder with ecological momentary assessment. *Journal of Abnormal Psychology*, *117*(3), 647–661. https://doi.org/10.1037/a0012532

Wilhelm, P., & Schoebi, D. (2007). Assessing Mood in Daily Life. *European Journal of Psychological Assessment*, *23*(4), 258–267. https://doi.org/10.1027/1015-5759.23.4.258

Wittchen, H. U., Wunderlich, U., Gruschwitz, S., & Zaudig, M. (1997). *SKID I. Strukturiertes Klinisches Interview für DSM-IV. Achse I: Psychische Störungen. Interviewheft und Beurteilungsheft. Eine deutschsprachige, erweiterte Bearbeitung der amerikanischen Originalversion des SCID-I*. Hogrefe.

World Medical Association (2013). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *JAMA*, *310*(20), 2191–2194. https://doi.org/10.1001/jama.2013.281053

Zeigler–Hill, V., & Abraham, J. (2006). Borderline Personality Features: Instability of Self–Esteem and Affect. *Journal of Social and Clinical Psychology*, *25*(6), 668–687. https://doi.org/10.1521/jscp.2006.25.6.668

GENERAL DISCUSSION

Main Results

The overall aim of this thesis was to use state-of-the-art ambulatory assessment (AA) methodology to unravel features that specifically characterize the emotion dysregulation and instability of patients with borderline personality disorder (BPD). For this purpose, studies 1 and 2 used high-frequency electronic diary (e-diary) assessments every 15 minutes for 24 hours in a sample comprising 43 female patients with BPD, 28 patients with posttraumatic stress disorder (PTSD), 20 patients with bulimia nervosa (BN), and 28 healthy controls (HCs) to assess participants' momentary emotions while they underwent daily life activities. Study 1 examined emotion sequences, i.e., particular patterns of two consecutive emotions, and study 2 investigated the frequency and intensity of emotions as well as the distress associated with these emotions. In study 3, the self-esteem and affective state (valence and tense arousal) of 131 patients with BPD, 121 patients with anxiety disorders (ADs), and 134 HCs were repeatedly assessed in hourly intervals over four days to examine participants' self-esteem instability and affective instability.

The main results across the studies can be roughly divided into three patterns. Those are 1) features being particularly prominent in the BPD group compared to both clinical and healthy controls (BPD-specific patterns), 2) features being similarly heightened in the clinical groups compared to HCs (transdiagnostic patterns), and 3) features being heightened in the BPD group compared to HCs, but with no differences between BPD and clinical controls and no differences between clinical controls and HCs (neither specific nor transdiagnostic).

This thesis revealed two BPD-specific patterns. First and most importantly, study 3 showed that the self-esteem instability of patients with BPD was almost twice as high compared to patients

with ADs and more than six times higher than that of HCs. These findings were consistent across three established statistical instability indices (squared successive differences, probability of acute changes, and aggregated point-by-point differences) and were robust even when controlling for differences in individuals' means. In-depth analyses revealed that BPD patients' instability of self-esteem was mainly driven by specifically large decreases in self-esteem, especially from high states of self-esteem, which were not sufficiently compensated by repairs in self-esteem. These findings replicated and extended earlier results on heightened self-esteem instability in BPD (Santangelo et al., 2017) and provided the first evidence that self-esteem instability is a particularly prominent feature of BPD.

Second, of all emotions assessed in study 2, only anger displayed a particularly increased frequency in the BPD group. Patients with BPD had more than 200% higher odds to report anger than patients with PTSD and those with BN as well as more than 400% higher odds to report anger than HCs. This finding to some extent substantiates the existence of the BPD diagnostic criterion of "inappropriate, intense anger" (American Psychiatric Association, 2013) as well as the assumption of Mancke et al. (2017) that emotion dysregulation in BPD may constitute an underlying factor that gives rise to anger. In contrast, shame, although considered a central emotion in BPD (for example, Scott et al., 2015), was no more impairing for patients with BPD than other negative emotions.

Transdiagnostic patterns were the most common findings across the studies. Notably, study 3 substantiated previous evidence of transdiagnostic affective instability (Mneimne et al., 2018; Santangelo et al., 2014), although affective instability constitutes a core feature of BPD according to Linehan's biosocial theory (1993). The instability of valence and tense arousal was equally heightened in patients with BPD and those with ADs and did not differ between the clinical groups. Moreover, in study 2, the frequency of anxiety, sadness, shame, disgust, guilt, and unspecific

negative emotions was heightened across the clinical groups (BPD, PTSD, BN). The same applied to the intensity of interest, anxiety, anger, sadness, shame, jealousy, guilt, and nonspecific negative emotions. Across diagnoses and beyond emotional intensity, anger was associated with the highest distress, and joy was associated with lower distress compared to HCs. In study 1, persisting anxiety in two consecutive prompts and switches from anxiety to sadness were found to be transdiagnostically frequent emotion sequences.

The third pattern of results - heightened features in the BPD group compared to HCs, but no differences between BPD and clinical controls and no differences between clinical controls and HCs - leaves the largest scope for interpretation. That is, it gives a more ambiguous picture regarding the question of specificity. In study 1, compared to HCs, only patients with BPD exhibited a heightened frequency of a variety of emotion sequences, i.e., persisting sadness, switches from sadness to anxiety, switches from anxiety to anger, switches from anger to sadness, and switches from guilt to anger. However, the frequency of those emotion sequences did not differ among the clinical groups (BPD, PTSD, BN). The same applies to BPD patients' lowered frequency of interest and their heightened frequency of jealousy in study 2.

Across the studies, this third pattern of results was denoted as transdiagnostic, and a pattern was called BPD-specific if a feature was more pronounced in the BPD group than in clinical and healthy controls. However, this definition may be seen as controversial from two different perspectives. First, scholars and practitioners might use a more liberal definition of BPD specificity, namely, when significant differences occurred between the BPD and the HC group that were not apparent when comparing clinical controls to HCs. For example, only patients with BPD - but not those with PTSD or those with BN - switched more frequently from anxiety to anger, with BPD patients having the highest relative frequency among the groups. Nonetheless, we described this pattern as non-specific, although another interpretation would have been conceivable: BPD

patients show a peculiarity, i.e., more frequent switches from anxiety to anger, which is not apparent in other mental disorders. However, to strengthen the robustness of our claims, we chose a conservative definition of BPD specificity.

Second, using an even stricter definition of disorder specificity, one might argue that in order to demonstrate specificity, an elevated feature would have to stand out among various diagnostic groups. One of the strengths of the three studies is the inclusion of multiple clinical control groups that cover several DSM-5 diagnostic categories, i.e., trauma- and stressor-related disorders, eating disorders, and multiple anxiety disorders. Thus, the conclusions drawn about specificity at least relate to more than one control diagnosis. By contrast, about 90% of recent studies in top psychiatric journals focus on a single clinical group, thus limiting the incremental value of elevated psychopathology traits and mechanisms (Stanton et al., 2020). Still, our conclusions are restricted to the investigated clinical groups and do not apply to other personality disorders. Future AA studies should therefore use samples with a wide range of personality characteristics. By working out specific features of personality dysfunctioning in daily life, AA studies might provide a valuable contribution to the debate on the personality disorder (PD) section in the ICD-11 (World Health Organization, 2020), as will be delineated in the chapter on future perspectives.

Viewed from a higher perspective, it becomes more and more evident that even in AA data sets, BPD specificity cannot easily be shown. The best example is affective instability as a core feature of BPD, which has been shown to be transdiagnostically increased in various studies with different clinical control groups (affective disorders, PTSD, eating disorders) and different sampling frequencies (Houben et al., 2016; Mneimne et al., 2018; Santangelo et al., 2014). By replicating this finding in another clinical control group of patients with ADs, study 3 is another piece of the mosaic, indicating that global measures like affective instability have difficulties in

capturing differences between mental disorders. However, the results of this thesis show that a detailed approach to specificity might be promising. In this thesis, BPD specificity was revealed on the level of specific emotions (specifically increased frequency of anger) and self-esteem, a more differentiated and neglected domain of instability (specifically increased self-esteem instability).

Moreover, some results suggest that specificity is hidden deeper in the data and may be revealed by the combined consideration of different features. For example, study 2 did not show evidence of a particularly increased intensity of anger in BPD, but anger was the only specific emotion that contributed to distress above and beyond mere valence. Because this distress-enhancing effect was also shown in the clinical control groups, its contribution to a nuanced understanding of the dysregulation of anger in BPD becomes only apparent in combination with the outstanding frequency of anger in BPD. Going even further, the alternation of the distress-enhancing effect of anger and the distress-reducing effect of joy might represent an important part of emotion dysregulation in BPD. However, as we did not capture the temporal dynamics of specific emotions and distress in study 2, this assumption is speculative.

Correspondingly, a recent study from the same data set as study 3 illustrated that future studies, which aim to unravel disorder specificity, should apply advanced statistical methods that allow for joint consideration of different constructs: Hosoya et al. (2020) investigated the coupling of affect and self-esteem and did not detect strong differences between the BPD group and AD group at first glance. Therefore, the authors argue that when studies aim to differentiate BPD patients from those with ADs, multiple parameters have to be accounted for, including trait-levels and the temporal coupling of affect and self-esteem, as well as the total and unique innovation variances in affect and self-esteem. For this reason, I advocate the collection of rich data sets that enable complex temporal analyses of different constructs in future AA studies. Furthermore, as the

comment in chapter 4 illustrates, future studies should use a sampling frequency that fits the temporal dynamics of the process of interest to allow for valid conclusions on specificity.

Future Perspectives

Contributions of AA to the ICD-11 Classification of Personality Disorders

This section provides an outlook on research avenues for future AA studies to broaden existing knowledge. On the one hand, the ongoing shift in the classification systems seems to threaten the existence of BPD as a diagnosis and, as a consequence, future research on BPD. However, it may also offer opportunities for future research, especially in the field of AA. Dimensional PD diagnoses will presumably be much more nuanced than previous categorical diagnoses. When describing personality deviations on up to five traits (see Bach & First, 2018), clinicians and researchers will obtain individual and unique personality patterns. Consequently, researchers will have access to quite heterogeneous clinical data sets that allow for more differentiated analyses beyond preconceived beliefs in specific diagnoses.

One future direction of AA research could be to bring more granular diagnostic insights into how specific traits or trait patterns unfold in individuals' daily lives. Assuming that cross-sectional diagnostic evaluations will be prone to several biases, such as retrospective bias in traditional questionnaires, patients' reports, and clinicians' own selective perception, it is very likely that AA studies will help to clarify patients' diagnostic picture. If operationalized as AA study items, personality traits could be measured in individuals' daily lives on a state level. Two prior studies used similar approaches to show the benefit of longitudinal methods in disentangling temporal dynamics in personality dysfunction, as classified in the DSM-5 alternative model for personality disorders (American Psychiatric Association, 2013). Roche et al. (2016) addressed the association of daily fluctuations of personality impairments with the Level of Personality

Functioning Scale (LPFS) and the personality inventory for the DSM–5 (PID) (American Psychiatric Association, 2013). Their results indicated that personality impairments oscillated across days, were predicted by both LPFS and PID traits, and were impacted by daily emotions and cognitive distortions. The authors conclude that longitudinal designs and temporally dynamic analyses may provide novel evidence to fully inform psychopathology structures (Roche et al., 2016; Roche, 2018).

Such studies, irrespective of whether they are based on the DSM-5, the ICD-11, or the Research Domain Criteria framework (RDoC; Cuthbert & Insel, 2013), may reveal an adjusted and refined diagnostic picture and allow for individualized therapies targeting particular issues. Put differently, tailor-made therapy modules could be derived from daily life manifestations of personality trait patterns. The construct of self-esteem instability is a well-suited example of how AA data may enrich individuals' diagnostic picture. In the ICD-11, instability of self-worth will be defined as an essential feature in moderate and severe PDs, but not in mild PDs. Comparing the level of daily life self-esteem instability among individuals with different degrees of PD severity could provide additional real-life data, which is especially useful in evaluating dynamic personality features (Solhan et al., 2009). Therefore, future AA studies should use samples covering a wide range of personality patterns to unravel BPD-specific daily life manifestations of personality disorders.

Assessing the Context Surrounding Emotion Dysregulation and Instability

Another direction in future AA studies should be to improve the assessment of the context surrounding emotion dysregulation and instability. In self-report-based AA studies, different assessment strategies might be used to take individuals' everyday life events into account, which will be briefly described in the following.

Unlike time-based designs, event-based designs theoretically allow for a timed assessment of events of interest. In practice, however, event-based designs require higher compliance from the participants who need to initiate the report autonomously at the moment right after the event happened, for example, after alcohol consumption (e.g., Lane et al., 2016). As our comment in chapter 4 pointed out, subsequent entries may skew the temporal relationship between the actual occurrence of an event and the emotional experience before and after the event. Another option to assess contextual factors in time-based designs is to predefine constructs of interest like dysfunctional behaviors (e.g., Santangelo et al., 2020) or interpersonal stressors (e.g., Hepp et al., 2018). In this way, individuals' cognitive appraisals of situations can also be captured (Houben et al., 2018). Repeated time-based assessment ensures continuous and simultaneous assessment of events and emotional experiences. Its disadvantage is that the event categories are restricted to those preselected by the researchers, thereby disregarding other potentially relevant events experienced by the participants.

An alternative to combine the advantages of event-based and time-based designs could be free-text event items in time-based designs, which might expand the scope of event assessments in participants' daily lives. Similar to the day reconstruction method (Kahneman et al., 2004), free-text entries could put the researcher in a position to retrace participants' courses of the day, especially when enhanced with quantitative event appraisals. Screening and classifying events might be tedious work for researchers. However, it may ensure that researchers take an unbiased view of the interrelations between individuals' daily life events and psychological outcomes. As a potential side-effect, researchers may encounter daily life events that may have affected participants' emotional experience, for instance, large drops in self-esteem that have not been considered before. Thus, processing free-text items could contribute to generating new research questions and hypotheses for future studies. A methodological challenge of this approach is the

need for subsequent classification of participants' event entries by the researchers. Therefore, inter-rater reliability should be determined to objectify resulting event categories.

Although high-frequency self-reports are crucial to our understanding of daily life experiences, they also have limitations. For example, in states of very high tension, patients with BPD might not be able to react to an e-diary prompt, although those prompts could be especially interesting for the understanding of BPD symptoms like interpersonal conflicts, nonsuicidal self-injury, or dissociation. Moreover, participants' self-report on their behavior in social situations might be influenced by effects such as social desirability. Therefore, future studies should take advantage of evolving technologies, which will enrich self-report data with more objective data and enable researchers to actually observe human behavior. Methods like the electronically activated recorders (EAR) that randomly record short audio snippets in participants' daily life have already been used to examine interpersonal events or the social context of anger in BPD populations (W. C. Brown et al., 2014; Tomko et al., 2014). After resolving open ethical considerations and privacy issues, EAR could be a beneficial technology to capture participants' social context (Mehl, 2017). The same applies to wearable cameras (N. A. Brown et al., 2017) or the use of Bluetooth technology to objectify the measurement of social contact frequency in BPD.

Furthermore, there exist proven psychophysiological AA methods like electrocardiograms, which continuously measure participants' heart rate variability as an indirect measure of emotional reactivity (Ebner-Priemer et al., 2007). Continuous and objective assessment methods have the potential to overcome not only self-report bias in AA research but also the problem of inappropriate sampling frequency. Nowadays, the use of these methods is still complex and expensive, but technological opportunities will increase and simplify the use of objective AA research methods. Outside the research field of BPD, an ambitious and successful example of integrating objective measures is the study by Tost et al. (2019) that combined several new assessment methods to

investigate the association between mood and green space exposure. In addition to e-diary assessments, the study used location tracking with GPS signals, accelerometry data to measure physical activity, captured situational contexts and weather conditions, and used a geospatial method to capture green space exposure. Similar combinations of AA approaches might be beneficial in BPD research to get a clear picture of the context, in which BPD-specific dysregulation unfolds.

Taken together, the two outlined future directions, that is, the assessment of dimensional personality characteristics on state level and the improvement of capturing individuals' everyday context, might pave the way for individualized mobile health interventions. General treatment apps such as the DBT Coach app (Rizvi et al., 2016) or the mDiary app (Helweg-Joergensen et al., 2019) could be customized to fit patients' individual problem areas. For example, a patient diagnosed with the ICD-11 pattern negative affectivity and disinhibition could be prescribed specific app modules targeting the stabilization of affect and self-esteem as well as providing skills that prevent rash and impulsive behavior. Another patient who is high on detachment could instead benefit from encouraging reminders to actively seek social interactions and support when feeling isolated. In the long run, even passive AA monitoring might enable personalized algorithms that help patients to perceive early warning signs in case of alarming changes in a patient's mental state.

Conclusions

To sum up, I provided several approaches in this thesis that advance the understanding of how patients with BPD are impaired by emotion dysregulation and instability in their daily lives. The studies presented in this dissertation used high-frequency AA sampling designs that fit the rapid dynamics of the emotional processes investigated and large patient samples, including patients with BPD, different clinical control groups, and HCs. The main finding of this dissertation

is that self-esteem instability defines BPD more than affective instability, even though the latter is considered the core feature of BPD. While global affective instability revealed a transdiagnostic pattern, BPD-specific emotion dysregulation was rather evident at the level of specific emotions.

References

American Psychiatric Association. (2013). *Diagnostic and statistical manual of mental disorders (5th ed.)*. Washington, DC: American Psychiatric Publishing.

Bach, B., & First, M. B. (2018). Application of the ICD-11 classification of personality disorders. *BMC Psychiatry*, *18*(1), 351. https://doi.org/10.1186/s12888-018-1908-3

Brown, N. A., Blake, A. B., & Sherman, R. A. (2017). A Snapshot of the Life as Lived. *Social Psychological and Personality Science*, *8*(5), 592–600. https://doi.org/10.1177/1948550617703170

Brown, W. C., Tragesser, S. L., Tomko, R. L., Mehl, M. R., & Trull, T. J. (2014). Recall of expressed affect during naturalistically observed interpersonal events in those with borderline personality disorder or depressive disorder. *Assessment*, *21*(1), 73–81. https://doi.org/10.1177/1073191113504618

Cuthbert, B. N., & Insel, T. R. (2013). Toward the future of psychiatric diagnosis: The seven pillars of RDoC. *BMC Medicine*, *11*, 126. https://doi.org/10.1186/1741-7015-11-126

Ebner-Priemer, U. W., Welch, S. S., Grossman, P., Reisch, T., Linehan, M. M., & Bohus, M. (2007). Psychophysiological ambulatory assessment of affective dysregulation in borderline personality disorder. *Psychiatry Research*, *150*(3), 265–275. https://doi.org/10.1016/j.psychres.2006.04.014

Helweg-Joergensen, S., Schmidt, T., Lichtenstein, M. B., & Pedersen, S. S. (2019). Using a Mobile Diary App in the Treatment of Borderline Personality Disorder: Mixed Methods Feasibility Study. *JMIR Formative Research*, *3*(3), e12852. https://doi.org/10.2196/12852

Hepp, J., Lane, S. P., Wycoff, A. M., Carpenter, R. W., & Trull, T. J. (2018). Interpersonal stressors and negative affect in individuals with borderline personality disorder and community adults in daily life: A replication and extension. *Journal of Abnormal Psychology*, *127*(2), 183–189. https://doi.org/10.1037/abn0000318

Hosoya, G., Holtmann, J., Santangelo, P. S., Kockler, T. D., Eid, M., Bohus, M., & Ebner-Priemer, U. W. (2020). *On the coupling of affect and self-esteem in patients diagnosed with borderline personality disorder as compared to clinical and healthy controls* [Manuscript submitted for publication]. Department of Education and Psychology, Freie Universität Berlin.

Houben, M., Bohus, M., Santangelo, P. S., Ebner-Priemer, U. W., Trull, T. J., & Kuppens, P. (2016). The specificity of emotional switching in borderline personality disorder in comparison to other clinical groups. *Personality Disorders*, *7*(2), 198–204. https://doi.org/10.1037/per0000172

Houben, M., Claes, L., Sleuwaegen, E., Berens, A., & Vansteelandt, K. (2018). Emotional reactivity to appraisals in patients with a borderline personality disorder: A daily life study. *Borderline Personality Disorder and Emotion Dysregulation*, *5*, 18. https://doi.org/10.1186/s40479-018-0095-7

Kahneman, D., Krueger, A. B., Schkade, D. A., Schwarz, N., & Stone, A. A. (2004). A survey method for characterizing daily life experience: The day reconstruction method. *Science (New York, N.Y.)*, *306*(5702), 1776–1780. https://doi.org/10.1126/science.1103572

Lane, S. P., Carpenter, R. W., Sher, K. J., & Trull, T. J. (2016). Alcohol Craving and Consumption in Borderline Personality Disorder: When, Where, and with Whom. *Clinical Psychological Science*, *4*(5), 775–792. https://doi.org/10.1177/2167702615616132

Linehan, M. M. (1993). *Cognitive-behavioral treatment of borderline personality disorder*. *Diagnosis and Treatment of Mental Disorders*. Guilford Press.

Mancke, F., Herpertz, S. C., Kleindienst, N., & Bertsch, K. (2017). Emotion Dysregulation and Trait Anger Sequentially Mediate the Association Between Borderline Personality Disorder and Aggression. *Journal of Personality Disorders*, *31*(2), 256–272. https://doi.org/10.1521/pedi_2016_30_247

Mehl, M. R. (2017). The Electronically Activated Recorder (EAR). *Current Directions in Psychological Science*, *26*(2), 184–190. https://doi.org/10.1177/0963721416680611

Mneimne, M., Fleeson, W., Arnold, E. M., & Furr, R. M. (2018). Differentiating the everyday emotion dynamics of borderline personality disorder from major depressive disorder and bipolar disorder. *Personality Disorders*, *9*(2), 192–196. https://doi.org/10.1037/per0000255

Rizvi, S. L., Hughes, C. D., & Thomas, M. C. (2016). The DBT Coach mobile application as an adjunct to treatment for suicidal and self-injuring individuals with borderline personality disorder: A preliminary evaluation and challenges to client utilization. *Psychological Services*, *13*(4), 380–388. https://doi.org/10.1037/ser0000100

Roche, M. J. (2018). Examining the alternative model for personality disorder in daily life: Evidence for incremental validity. *Personality Disorders*, *9*(6), 574–583. https://doi.org/10.1037/per0000295

Roche, M. J., Jacobson, N. C., & Pincus, A. L. (2016). Using repeated daily assessments to uncover oscillating patterns and temporally-dynamic triggers in structures of psychopathology:

Applications to the DSM-5 alternative model of personality disorders. *Journal of Abnormal Psychology*, *125*(8), 1090–1102. https://doi.org/10.1037/abn0000177

Santangelo, P. S., Holtmann, J., Hosoya, G., Bohus, M., Kockler, T. D., Koudela-Hamila, S., Eid, M., & Ebner-Priemer, U. W. (2020). Within- and Between-Persons Effects of Self-Esteem and Affective State as Antecedents and Consequences of Dysfunctional Behaviors in the Everyday Lives of Patients With Borderline Personality Disorder. *Clinical Psychological Science*, 216770262090172. https://doi.org/10.1177/2167702620901724

Santangelo, P. S., Reinhard, I., Koudela-Hamila, S., Bohus, M., Holtmann, J., Eid, M., & Ebner-Priemer, U. W. (2017). The temporal interplay of self-esteem instability and affective instability in borderline personality disorder patients' everyday lives. *Journal of Abnormal Psychology*, *126*(8), 1057–1065. https://doi.org/10.1037/abn0000288

Santangelo, P. S., Reinhard, I., Mussgay, L., Steil, R., Sawitzki, G., Klein, C., Trull, T. J., Bohus, M., & Ebner-Priemer, U. W. (2014). Specificity of affective instability in patients with borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls. *Journal of Abnormal Psychology*, *123*(1), 258–272. https://doi.org/10.1037/a0035619

Scott, L. N., Stepp, S. D., Hallquist, M. N., Whalen, D. J., Wright, A. G. C., & Pilkonis, P. A. (2015). Daily shame and hostile irritability in adolescent girls with borderline personality disorder symptoms. *Personality Disorders*, *6*(1), 53–63. https://doi.org/10.1037/per0000107

Solhan, M. B., Trull, T. J., Jahng, S., & Wood, P. K. (2009). Clinical assessment of affective instability: Comparing EMA indices, questionnaire reports, and retrospective recall. *Psychological Assessment*, *21*(3), 425–436. https://doi.org/10.1037/a0016869

Stanton, K., McDonnell, C. G., Hayden, E. P., & Watson, D. (2020). Transdiagnostic approaches to psychopathology measurement: Recommendations for measure selection, data analysis, and participant recruitment. *Journal of Abnormal Psychology*, *129*(1), 21–28. https://doi.org/10.1037/abn0000464

Tomko, R. L., Brown, W. C., Tragesser, S. L., Wood, P. K., Mehl, M. R., & Trull, T. J. (2014). Social context of anger in borderline personality disorder and depressive disorders: Findings from a naturalistic observation study. *Journal of Personality Disorders*, *28*(3), 434–448. https://doi.org/10.1521/pedi_2012_26_064

Tost, H., Reichert, M., Braun, U., Reinhard, I., Peters, R., Lautenbach, S., Hoell, A., Schwarz, E., Ebner-Priemer, U. W., Zipf, A., & Meyer-Lindenberg, A. (2019). Neural correlates of individual differences in affective benefit of real-life urban green space exposure. *Nature Neuroscience*, *22*(9), 1389–1393. https://doi.org/10.1038/s41593-019-0451-y

World Health Organization. (2020). *International statistical classification of diseases and related health problems (11th ed.).* World Health Organization. https://icd.who.int/

CURRICULUM VITAE

EDUCATION

Since 2015	Doctoral studies in clinical psychology Chair of Applied Psychology/Mental mHealth Lab, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany
2013 - 2017	Postgraduate psychotherapy training in cognitive behavioral therapy Central Institute of Mental Health, Mannheim, Germany
2013 - 2017	Diploma in psychology University of Koblenz-Landau, Germany
2006	Allgemeine Hochschulreife Martin-von-Cochem-Gymnasium, Cochem, Germany

PROFESSIONAL EXPERIENCE

Since 2017	Research assistant and clinical psychologist Implementation and evaluation of an app-based aftercare program for patients with affective disorders (DE-RENA), Median Clinic for Psychosomatics Bad Dürkheim, Germany
Since 2015	Research assistant, Chair of Applied Psychology/Mental mHealth Lab, Karlsruhe Institute of Technology (KIT), Karlsruhe, Germany
2014 - 2017	Clinical psychologist Psychotherapeutic outpatient clinic, Central Institute of Mental Health, Mannheim, Germany
2013 - 2015	Clinical psychologist Department of Addictive Behaviour & Addiction Medicine, Central Institute of Mental Health, Mannheim, Germany

PUBLICATIONS (PEER-REVIEWED)

Kockler, T. D., Santangelo, P. S., Eid, M., Kuehner, C., Bohus, M., Schmaedeke, S., & Ebner-Priemer, U. W. (2020). *Self-Esteem Instability Defines Borderline Personality Disorder More Than Affective Instability: Findings from an E-Diary Study with Clinical and Healthy Controls* [Manuscript submitted for publication]. Faculty of Humanities and Social Sciences, Karlsruhe Institute of Technology.

Kockler, T. D., Santangelo, P. S., Limberger, M. F., Bohus, M., & Ebner-Priemer, U. W. (2020). Specific or transdiagnostic? The occurrence of emotions and their association with distress in the daily life of patients with borderline personality disorder compared to clinical and healthy controls. *Psychiatry Research*, *284*, 112692. https://doi.org/10.1016/j.psychres.2019.112692

Santangelo, P. S., Holtmann, J., Hosoya, G., Bohus, M., **Kockler, T. D.**, Koudela-Hamila, S., Eid, M., & Ebner-Priemer, U. W. (2020). Within- and Between-Persons Effects of Self-Esteem and Affective State as Antecedents and Consequences of Dysfunctional Behaviors in the Everyday Lives of Patients With Borderline Personality Disorder. *Clinical Psychological Science*, 216770262090172. https://doi.org/10.1177/2167702620901724

Santangelo, P. S., Koenig, J., **Kockler, T. D.**, Eid, M., Holtmann, J., Koudela-Hamila, S., Parzer, P., Resch, F., Bohus, M., Kaess, M., & Ebner-Priemer, U. W. (2018). Affective instability across the lifespan in borderline personality disorder - a cross-sectional e-diary study. *Acta Psychiatrica Scandinavica*, *138*(5), 409–419. https://doi.org/10.1111/acps.12950

Kockler, T. D., Santangelo, P. S., & Ebner-Priemer, U. W. (2018). Investigating Binge Eating Using Ecological Momentary Assessment: The Importance of an Appropriate Sampling Frequency. *Nutrients*, *10*(1). https://doi.org/10.3390/nu10010105

Kockler, T. D., Tschacher, W., Santangelo, P. S., Limberger, M. F., & Ebner-Priemer, U. W. (2017). Specificity of emotion sequences in borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls: An e-diary study. *Borderline Personality Disorder and Emotion Dysregulation*, *4*. https://doi.org/10.1186/s40479-017-0077-1

CONFERENCE TALKS

6th Biennial Conference of the Society for Ambulatory Assessment 2017, Syracuse: "Specific emotions in the daily life of patients with BPD, PTSD, bulimia nervosa, and healthy controls: Frequency, intensity, and associated distress"

XV International Congress of the International Society for the Study of Personality Disorders (ISSPD) 2017, Heidelberg, Germany: "Specificity of emotion sequences in borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls: an e-diary study"

5th Biennial Conference of the Society for Ambulatory Assessment 2019, Luxembourg: "Specificity of emotion sequences in borderline personality disorder compared to posttraumatic stress disorder, bulimia nervosa, and healthy controls: an e-diary study"

REVIEWER

Cognitive Therapy and Research, Psychiatry Research, Depression and Anxiety, Psychopathology, Child and Adolescent Psychiatry and Mental Health, International Journal of Eating Disorders, Nutrition

PROFESSIONAL MEMBERSHIPS

Society for Ambulatory Assessment (SAA)

Landespsychotherapeutenkammer Baden-Württemberg

Landespsychotherapeutenkammer Rheinland-Pfalz

SCHOLARSHIPS

Scholarship of the „Deutscher Akademischer Austauschdienst" (2019)

TEACHING

Emotion regulation in examination situations and in the examination phase for students with test anxiety, House of Competences, Karlsruhe Institute of Technology, Karlsruhe, Germany

Staying relaxed in the examination phase: overcoming test anxiety, House of Competences, Karlsruhe Institute of Technology, Karlsruhe, Germany