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Structured Review of the Literature

The Neurobiology of Emotion Regulation in Personality Disorders

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Abstract

Background: According to recent estimates, personality disorders (PDs) have a global pooled prevalence of 7.8%, making them an important social and economic burden. Reaching a better understanding of their development and treatment is thus of utmost importance. Research also suggests that individuals with a PD show neurobiological abnormalities that qualitatively deviate from normality in a variety of ways, including emotion regulation.

Methods: In March 2023, a literature search was conducted in five bibliographic databases: Embase.com, Medline Ovid ALL, APA Psycinfo Ovid, Cochrane Library (all databases) and Web of Science Core Collection. Additional studies were identified by reviewing the bibliographic references of the retained articles. To be included, papers should study/report on neural correlates of emotion regulation in PDs in adult populations.

Results: After reading the abstracts and excluding publications prior to 2018, we identified 25 papers. After excluding theoretical papers as well as meta-analyses, the first author selected 13 articles of interest. They all either focused exclusively on borderline personality disorder (BPD) or merely used other PDs as psychopathological control groups.

Discussion: Collectively, the reviewed articles form a coherent theory of dysfunctional emotion regulation in patients with BPD in the form of the fronto-limbic imbalance model, which is characterized by hypoactivity of the prefrontal region and hyperactivity of the limbic region. Thus, it appears that, compared to individuals without BPD, those with the diagnosis have a marked tendency to interpret their environment more negatively and to react with greater emotional intensity.

Keywords: Borderline personality disorder; emotion regulation; neural correlates; neurobiology; personality disorders

Introduction

Personality refers to individual differences in relatively stable characteristic patterns of thinking, feeling, and behaving [1] and is widely accepted to exist along a functional continuum [2]. Evidence indicates that personality disorders (PDs) are merely maladaptive variants of personality traits that are present within everybody [3] rather than distinct categories [4-6]. Following these findings, the 11th International Classification of Diseases (ICD-11) abandoned its previous categorical model of ten distinct diagnoses in favor of an integrated one. It now defines PDs as marked disturbances in personality functioning, which is almost always associated with considerable personal and social disruption. The central manifestations of PD are impairments in self-functioning (e.g., identity, self-worth, capacity for self-direction) and/or problems in interpersonal functioning (e.g., developing and maintaining close and mutually satisfying relationships, understanding others' perspectives, managing conflict in relationships). Maladaptive (e.g., inflexible or poorly regulated) patterns of cognition, emotional experience, emotional expression, and behavior are signs of impaired self- and/or interpersonal functioning [7, 8].

Recent research estimates a global pooled prevalence of 7.8% [9], making PDs an important social and economic burden [9]. Therefore, reaching a better understanding of their development and treatment is of utmost importance.

Despite new developments in classification systems for psychological distress [11], research in recent decades has continued to use categorical diagnoses to sample populations (table 1).

Evidence indicates that people with a PD show neurobiological abnormalities that qualitatively differ from normality in several aspects [12, 13], including emotion regulation.

According to Gross, emotion regulation is a process by which individuals influence the nature of their emotions, when they occur, and how they experience and express them [14]. This ability to exert control over one's own emotional state may include cognitive reappraisal, such as rethinking a challenging situation to reduce anger or anxiety, as well as other strategies such as hiding visible signs of sadness or fear, or focusing on reasons to feel happy or calm (for an overview, see [15]).

Involved in the clinical presentation of numerous psychiatric diagnoses [16], emotion regulation is a concept of particular interest in the research on psychological distress. The Research Domain Criteria (RDoC) project, for example, includes emotional arousal as one of its six domains of investigation [17]. Emotion regulation is also central to several models of understanding borderline personality disorder (BPD) (e.g., Linehan's biosocial theory of [18]) and represents a key target of psychotherapy for BPD, with a demonstrated impact at the neurobiological level [19], making it an ideal candidate for research in the field of PDs [20, 21].

The current paper is a structured review that aims to provide an informed overview of up-to-date studies that contribute to our understanding of the neurobiology of emotion regulation in PDs.

Methods

A literature search was conducted in March 2023 using five bibliographic databases: Embase.com, Medline Ovid ALL, APA Psycinfo Ovid, Cochrane Library (all databases) and Web of Science Core Collection (see appendix for the used search terms). Additional studies were identified by reviewing the bibliographic references of the retained articles. To be considered, papers should have studied/reported on neural correlates of emotion regulation in PDs in adult populations.

Results

Initially, the search yielded 779 results (table 2).

To keep up to date with the rapidly evolving field of neurosciences, we decided to exclude papers published prior to 2018. After reading the abstracts, we identified 25 papers. After excluding theoretical papers and meta-analyses, the first author selected 13 articles of interest for this review. They all either focused exclusively on BPD or merely used other PDs as psychopathological control groups (table 3).

Using an adapted version of a functional magnetic resonance imaging emotion regulation task, Cremers et al. [22] found that BPD participants displayed higher amygdala connectivity strength compared to healthy controls (HC) in their exploratory analyses. When investigating the effects of transcranial magnetic stimulation on BPD participants, Sverak et al. [23] observed significant decreases in amygdala and insula connectivity following treatment, which correlated with symptom reduction. In their study using random forest models based on clinical and neuroimaging data to predict the response to dialectical behavior therapy (DBT), Schmitgen et al. [24] also identified amygdala- and parahippocampus-activation during a cognitive reappraisal task as central regions related to dysfunctional emotion regulation. In a single-arm trial, Zaehringer et al. [25] showed that participants with BPD could downregulate their amygdala activation using neurofeedback and that this normalization was associated with symptom reduction. Similarly, Koenigsberg et al. [26] reported a decrease in right amygdala activity between the first and fifth session in participants with BPD who had learned to enhance their emotion regulation skills when reappraising negative social emotional pictures.

Sampedro et al. [27] used a resting-state functional connectivity paradigm to investi-

Table 1: Specific Types of Personality Disorders (PDs) according to the DSM-5 and ICD-10

Cluster A Odd or eccentric behavior	Cluster B Dramatic or erratic behavior	Cluster C Anxious behavior
Paranoid	Antisocial	Avoidant
Schizoid	Borderline	Dependent
Schizotypal*	Histrionic	Obsessive-Compulsive
	Narcissistic	

Note: Only the DSM-5 arranges PDs in three clusters. The schizotypal* PD does not appear in the ICD-10.
DSM: Diagnostic and Statistical Manual of Mental Disorders; ICD: International Statistical Classification of Diseases and Related Health Problems.

Table 2: Structured Literature Search Results

Database	Research date	Number of references found / after deduplication
Medline Ovid ALL	30.03.23	379 / 377
Embase.com	30.03.23	431 / 161
APA PsycInfo Ovid	30.03.23	236 / 23
Cochrane Library (all databases)	30.03.23	51 / 36
Web of Science Core Collection	30.03.23	442 / 180
Bibliographic references of retained studies	30.03.23	2
Total		1539 / 778

Table 3: Summary of the Reviewed Studies

References	Sample	Brain regions
Denny et al., 2018 [31]	75 BPD, 25 AvPD, 24 HC	SN
Kramer et al., 2018 [29]	8 BPD	Precuneus
Koenigsberg et al., 2019 [26]	19 BPD, 22 AvPD, 18 HC	AMY
Quattrini et al, 2019 [32]	26 BPD, 14 HC	DMN, SN, ECN
Lamers et al., 2019 [30]	20 BPD, 20 HC	Precuneus, HIPP, PCC
Schmitgen et al., 2019 [24]	31 BPD	AMY, parahippocampus
Leit et al., 2019 [33]	50 BPD, 50 HC	ACC, MTG
Zaehringer et al., 2019 [25]	26 BPD	AMY
Molavi et al., 2020 [34]	32 BPD	DLPFC
Cremers et al., 2021 [22]	51 BPD, 26 CC, 44 HC	AMY
Sverak et al., 2022 [23]	14 BPD	AMY, insula, DLPFC
Sampedro et al., 2022 [27]	38 BPD	ACC, DMN, mPFC, PCC, rAI, SN
Fernando et al., 2023 [28]	21 BPD, 23 HC	Insula, caudate nucleus

ACC: Anterior cingulate cortex; AMY: Amygdala; AvPD: Avoidant personality disorder; BPD:
CC: Cluster C personality disorders; DLPFC: Dorsolateral prefrontal cortex; DMN: Default mode network; ECN: Executive control network; HC: Healthy controls; HIPP: Hippocampus; mPFC: Medial prefrontal cortex; MTG: Middle temporal gyrus; PCC: Posterior cingulate cortex; rAI: Right anterior insula; SN: Salience network.

gate the role of the right anterior insula in emotion regulation in a sample of 38 participants with BPD, concluding that its connectivity may play a significant role in poor emotion regulation. Furthermore, they observed that DBT seemed to modulate this functional connectivity. Findings by Fernando et al. [28], that using a healthy emotion regulation technique (namely emotion acceptance) reduced insular activation in individuals with BPD, support this assumption.

In their pilot study, Kramer et al. [29] observed that the change in subjective arousal in patients with BPD when confronted with individualized critical words was associated with neuronal activity in the bilateral precuneus. Similarly, Lamers et al. [30] found that when confronted with negative (vs neutral) stimuli, patients with BPD showed hyperactivation of the precuneus compared to controls.

Denny et al. [31] found a hyperactivation of the salience network in participants with BPD when confronted with negative social stimuli. Using a resting-state paradigm, Quattrini et al. [32] observed that participants with BPD showed lower mean functional connectivity than HC in the default mode network, the salience network, and the executive control network, which correlated significantly with psychometric measures of emotional instability (specifically anger intensity and expression, as well as aggression). In their BPD study, Lei et al. [33] found decreased resting-state functional connectivity between the left anterior cingulate cortex and the left middle temporal gyrus in participants with BPD, suggesting disturbed default mode network and emotional processing.

Finally, in their randomized sham-controlled parallel-group study, Molavi et al. [34] observed that repeated transcranial direct current stimulation of dorsolateral prefrontal regions improved emotion regulation in patients with BPD.

Discussion

BPD was the primary diagnosis in all the studies on the neurobiology of emotion regulation in PDs reviewed in this paper. This reflects the fact that BPD is more extensively studied than any other PD, whether in terms of prevalence, etiology or treatment. The BPD specifier was the only one kept in the latest version of the ICD [35, 36], highlighting the special place it has in the field. Another explanation is that difficulties in emotional processing play a central role in its clinical presentation [37, 38].

Overall, the reviewed articles form a coherent theory of dysfunctional emotion regulation in patients with BPD in the form of the fronto-limbic imbalance model [39-41], which is characterized by hypoactivity of the prefrontal regions and hyperactivity of the limbic ones. Thus, it appears that, compared to individuals without BPD, those with the diagnosis present a marked tendency to interpret their environment negatively and to react with greater emotional intensity. However, although neuroimaging methods are exciting tools that have allowed us to make unprecedented progress in our understanding of the brain and its graphic representation, their ability to accurately reflect its complexity is severely limited (for a discussion, see [42]). In addition to this limitation, each of the 13 reviewed papers used different tasks (and stimuli) to elicit a neurofunctional or neurobiological activation of emotion regulation, with each facing its own methodological challenges (for suggestions on how to develop adequate stimuli for investigating emotional experiences and examples of implementation, see [29, 43, 44]).

Considering both the ongoing shift towards a more dimensional approach of PDs as well as the transdiagnostic relevance of (dysfunctional) emotion regulation, researchers should concentrate their focus on the investigation of dimensional conceptualizations of PDs and associated neurobiological substrates [45]. These neurobiological findings should also encourage clinicians to focus on cognitive biases and emotion regulation techniques during therapy with patients with BPD.

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Conflict of Interest Statement

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LG: Major contribution to design, data acquisition, analysis and interpretation as well as writing and revising article; EMM and UK: significant contributions to analysis, interpretation of data and revising article; JRA: Major contribution to data acquisition; BD: contribution to revising article

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You will find the full list of references online at https://sanp.swisshealthweb.ch/en/article/doi/sanp.2024.1325507538/.