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Executive Function in Borderline Personality Disorder in Children and Adolescents

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Abstract

Background: Borderline Personality Disorder (BPD) is one of the most frequently diagnosed but also most differently characterized disorders in the field of child and adolescent psychiatry. Although negative side effects of executive dysfunction are often seen in BPD patients, statistical proof of an association between symptoms of executive dysfunction and BPD is missing thus far.

Methods: From 2011 until 2015, 194 young patients aged 12 to 21 years were examined and treated in an inpatient setting of an institute for child and adolescent psychiatry. Patients were divided into two groups (BPD and pre-BPD) and aspects of executive functions were documented via questionnaires.

Results: The results confirmed the clinical idea of defining BPD as a special complex of emotional dysregulation (subscales: "expression of anger" [p=0.0120], "trait anger" [p<0.0001], "aggressive behavior" [p=0.0183]); dysfunctions in interpersonal relationships (subscale: "problem solving" [p=0.0045]); and high impulsivity (subscale: "control of anger" [p=0.0028], "regulation of impulses" [p<0.0001], "experiencing self-control" [p=0.0325]). The subscale "adaptive strategies total" [p=0.0016] was significantly different between the two groups as well.

The "suppression of anger" [p=0.0358] subscale was significantly higher in the BPD group than in the pre-BPD group; this was most likely due to the answers provided by the patients themselves. Although emotional dysregulation is considered to be characteristic of BPD, "experiencing a regulation of emotions" [p=0.8620] did not differ between the two groups.

Conclusions: Most of these results are statistical proof for the observations made by treating experts, and they offer the possibility for use as elements of the general psychiatric diagnostic approach, serving as verified indicators for the existence of BPD in children and adolescents. Such an approach can aid in everyday clinical practice. Some features of borderline personality disorder differ in a pertinent way from the expectations that have emerged from clinical observations. Studies with larger groups of patients are required to further explore this complex issue.

Abbreviations

AIDA	:	Assessment of Identity Development in Adolescence
BPD	:	Borderline Personality Disorder
DBT-A	:	Dialectic-Behavioral Therapy for Adolescent

HAWIK-IV	:	Hamburg-Wechsler-Intelligenztest Fuer Kinder
SD	:	Standard Deviation
SED	:	Standard Error of Difference
SEM	:	Standard Error of the Mean, Standard Error of the Mean
SKID	:	Structured Clinical Interview for DSM-IV
WIE	:	Wechsler Intelligenztest Fuer Erwachsene (Engl.: Wechsler Intelligence Test for Adults)

Introduction

The prevalence of borderline personality disorder is given at 0.9% of adolescents in the general population, up to 10% of outpatients and up to 50% of all children and adolescents under inpatient treatment in psychiatric institutes [1-3]. In reaction to this high and increasing prevalence of personality disorders in young patients, it is necessary to improve the specificity of diagnostic instruments for them [4]. Studies showed that personality disorder diagnoses are valid and reliable for adolescents older than 14 years [5-9]. Many trained therapists refuse to diagnose young patients to avoid the unnecessary risk of stigmatization and therapeutic nihilism [10]. To avoid a false diagnosis and unnecessary risks, it is important to collect more detailed characterizations of this specific disease.

In the Diagnostic and Statistical Manual of Mental Disorders, 4th edition DSM-IV (American Psychiatric Association, 2000), [11] as well as in the International Statistical Classification of Diseases and Related Health Problems ICD-10 [12], attempts have been made to identify specific characterizations of borderline personality disorder. Furthermore, there are different characterizations of borderline personality disorder. Sanislow, Grilo and McGlashan described the three homogeneous factors -a disturbed ability to maintain relationships, affective dysregulation and behavioral dysregulation - that can be used to differentiate BPD and non-BPD patients [13].

Unstable relationships, chronic feelings of emptiness and an identity disorder characterize the disturbed ability to have relationships. Identity disorder - frequently postulated to co-occur with BPD -develops through an identity diffusion that is described as a labialization in experiencing one's own identity that is created by breaks in relationships to social surroundings. The self-perception and feedback of surroundings become incongruent, and the following loss of a feeling of stable identity creates disorientation, perplexity and uncertainty in actions and decisions [14]. Regarding borderline personality disorder, it is especially difficult to separate a regular identity crisis in adolescence from the personality disorder-specific identity diffusion [15-17]. Various authors have already reported observations of deficits in the executive function in the context of borderline personality disorder [18-21].

Executive function contains all top-down domain-specific regulation and control mechanisms providing the ability for goal-oriented and situation-adapted actions that are necessary for situations alternating from a regular routine [22]. The idea of an executive function based on a single mechanism or domain-crossing control factor is controversial [23,24], even though most authors define executive function as a complex of different processes that can be disabled or limited selectively [22]. Executive function unites higher, complex cognitive processes or, rather, a multidimensional complex of different, separated control and regulation mechanisms that regulate the thinking and acting for new, unknown and complex situations or tasks when normal and everyday automatism is not purposeful or useful [25]. For this function, a "working memory" that updates new representations for future actions, a "preparatory set" to keep the organism ready for future operations and "inhibition" for the ability to suppress inappropriate reactions are necessary [26].

A study of patients with differently located injuries resulted in the conclusion that executive function separates into the following three independent processes of attention control: the process of "energization" that initiates and maintains behavior, the process of "task-setting" that mentally connects a stimulus and a response, and the process of "monitoring" that oversees the tasks and improves the adaptation of a behavior [27].

To explain and understand the complexity of acting and behavior regulation in everyday life, it is not sufficient to mainly focus on executive processes based only on cognitive factors [22]. Because executive function depends on current emotions, impulsion and motivation, a strict separation between cognitive and emotional regulation is artificial and describes a false version of real phenomena [28-30]. This discrimination between "cold", cognitive executive functions in the form of the regulation of acting and thinking and the "hot" emotional or motivational executive function relating to the regulation of emotions is made by many authors [31-33]. The possibility of differentiating hot and cold executive functions is not known yet [34]. An existing correlation between hot and cold executive function [35,36] and a positive trend in children between 3 and six years old in both sectors of executive function [37] has already been found in various studies.

As already mentioned, executive function is part of borderline personality disorder symptoms. According to Putnam and Silk, borderline personality disorder is most likely a disorder of the emotional regulation within emotional responses that are inflexible or rigid and accompanied by a decreased or increased level of arousal [38]. In this context, it is known that impulsivity can be seen as one of the core elements that leads to an executive dysfunction [39,40]. Other studies that focused on executive function related to borderline personality disorder showed that neurocognitive deficits play an essential role in the development of this disorder [41,42]. A comparison between the symptoms of schizophrenia and borderline personality disorder regarding executive function performed by Hurtado pointed out that BPD-patients more than those in the schizophrenia-group are more limited in their everyday life due to the increased operational capacity of the borderline-personality disorder. Surprisingly, in the BPD-group, a significant relation between working memory and the management branch was detected. Therefore, the researcher concluded that problems of executive function mainly exist in metacognitive tasks of correctly updating and managing emotional information [19].

Angry outbursts, impulsivity, maladaptive coping mechanisms, suicide attempts and subsequent inpatient treatments show the substantial negative effects on the daily contact of patients and therapists [43]. Up to now, the intensity and the significant relation between symptoms of executive dysfunction and borderline personality disorder have not been described in great detail. This study examines the interrelation of these factors in 194 adolescent patients admitted for treatment of emotional instability with dialectic behavior therapy.

Methods

Methods: Procedure

The Idar-Oberstein clinic for child and adolescent psychiatry specializes in and is certified for the Dialectic-Behavioral Therapy for Adolescent (DBT-A). The clinic treats emotionally unstable adolescents from Germany, Austria and Switzerland. From 12 January 2011 until 21 August 2015, trained psychologists in the inpatient-unit of the clinic for child and adolescent psychiatry in Idar-Oberstein collected data from possible participants for this study. During their admission or while treatment was ongoing, all potential participants were informed about this study and the data to be collected.

To be included in the study, patients had to fulfill the following criteria: age between 12 and 21 years old, signs of Para suicidal behavior patterns in the last 16 weeks or current existing suicidal thoughts or self-harming behavior, a diagnosis of a borderline personality disorder or at least three confirmed DMS-IV criteria for a borderline personality disorder and admission for inpatient or outpatient treatment in the child and adolescent psychiatry clinic of Idar-Oberstein.

Patients who fulfilled five or more BPD diagnostic criteria [44,45] or had a SKID score over 4 for "borderline personality disorder" [46] or had a total value of Identity Diffusion (from the AIDA) of 70 or more [47] were selected for the borderline-group.

Patients who were categorized in the non-borderline-group (as a control group) were characterized by fulfilling four or fewer BPD diagnostic criteria [44,45] or had a SKID score under 5 for "borderline personality disorder" [46] or had a total value of Identity Diffusion (from the AIDA) less than 70 [47].

Patients were excluded from this study in the case of unfinished diagnostics, a cognitive performance according to an intelligence quotient less than 70 (HAWIK-IV / WIE), current psychotic illness or a major depressive episode or mania, addiction as a first diagnosis, significant difficulty reading or expressing oneself verbally, schizophrenic disorder or bipolar disorder or organic brain disease.

Methods: Questionnaires

Eating Disorder Inventory -2 [48]

The Eating Disorder Inventory-2 is an instrument for multidimensional descriptions of specific psychopathologies in patients with symptoms of an anorexia or bulimia nervosa and other pathological eating habits. The inventory is separated into 11 scales (struggles to lose weight, bulimia, dissatisfaction with the body, ineffectiveness, perfectionism, mistrust, interceptive perception, fear of growing up, asceticism, impulse regulation and social insecurity).

Reliability: Retests show a reliability of rtt=0.81-0.89. Tests of a sample of patients with anorectic and bulimic symptoms reached an internal consistency (Cronbach's alpha) of α=0.73 and α=0.93, respectively.

Validity: Good criterion and factorial validity were proved through discriminant analyses to separate different diagnosis-sets, calculating correlations with other test instruments and factor analysis.

Standards: A sample of 246 patients with anorectic symptoms, a sample of 217 bulimic patients and a control group (n=288) were used to perform the standardization of this instrument.

5.2.1.4 Usability: This diagnostic instrument is designed for adults and adolescents older than 14 years. Currently, this instrument may be applied to diagnostic use, therapy planning, change measurement, psychotherapy and pharmaceutic studies.

SEE: Scales for Experiencing Emotions [49]

The Emotional Experience Scales (SEE) are designed for use in individual and group examinations with adolescents age 14

years and older and adults. It is a theory-based, multidimensional measuring instrument for the central constructs of patient-centered personality theory and the concept of emotional intelligence. The scales contain 42 items, which include the following seven independent scales:

1. Acceptance of own emotions

2. Experience of emotion transfer

3. Experiencing emotional deficiency

4. Body-related symbolization of emotions

5. Imaginative symbolization of emotions

6. Experiencing regulation of emotions

7. Experiencing self-control

These scales aim to measure how patients perceive, evaluate and address their feelings.

Reliability: The scales show an internal consistency of 0.70 - 0.86 (Cronbach's alpha), as well as a retest reliability of 0.60 - 0.090 over intervals of 2, 3, 4, 10 and 14 weeks.

Validity: Comparisons with other methods of emotion perception, with clinical tests including self-concept inventories and with plans for the assessment of interpersonal relationships show the hypothesis- and theory-corresponding correlation of the scales. The scale values for men and women differ just as hypothetically as a clinical sample differs from a random sample.

Norms: There are z-values, T-values, percentile rankings and values of the standard scores with nine categories (N=1,047) for different gender- and age-groups; the scales provide similar benefits for patients in psychotherapy and for those using the Italian and Turkish versions.

Usability: The scales are to be used for personality and disorder diagnostics in clinical, occupational, organizational, social and emotional psychology, as well as for psychotherapy, personal development and communication psychology. Single or group examinations are possible for patients older than 14 years.

STAXI: State-Trait Anger Expression Inventory [50]

The state-trait expression inventory is a tool for measuring situational anger and four dispositional anger dimensions (ownership anger, inward anger, outward anger, and anger control). Based on the original American method according to Spiel Berger, this inventory was redesigned for use in those speaking German.

Reliability: The individual subscales have an internal consistency of $\alpha=0.71$ to $\alpha=0.95$.

Validity: There are several findings of convergent and discriminant validity. Factor analysis can separate the three scales of the anger expressions dimensions, as well as the anger state and the anger disposition scales.

Norms: The calculation of the age- and gender-specific stain and percentile ranking values were determined with a group of 990 probands. n for comparison values for the new federal states of Germany, a sample of 106 subjects was used.

Usability: The STAXI is used in clinical diagnostics (especially in the psychosomatic field), for therapeutic progress studies and in first science examinations for adolescents from the age of 14 years and adults.

FEEL-KJ: Questionnaire for the assessment of emotion regulation for children and adolescents [51]

The questionnaire for the evaluation of emotion regulation in children and adolescents, FEEL-KJ (German: "Fragebogen zur Erhebung der Emotionsregulation bei Kindern und Jugendlichen"), focuses on the multi-dimensional and emotion-specific strategies of emotion regulation for fear, grief and anger. It explores adaptive strategies such as problem-oriented action, dispersion, mood-raising, acceptance, forgetting, revaluation, and cognitive problem-solving, as well as maladaptive strategies such as abandonment, aggressive behavior, withdrawal, self-devaluation and perseveration. It also identifies procedures that do not assign with either of the two groups (expression, social support and emotion control). The FEEL-KJ aims to provide a valuation of risk regarding the development of psychopathological abnormalities. Therefore, it is used to create a profile of personal resources.

Reliability: The test has a retest reliability (6-week reliability) of rtt=0.62 - trr=0.81 for the strategy scales, rtt=0.81 for the adaptive strategies and rtt=0.73 for the maladaptive strategies. The 15 comprehensive emotion strategy scales show an internal consistency (Cronbach's alpha) of $\alpha=0.69$ (for "giving up") and $\alpha=0.91$ (for "social support"). The internal consistency (Cronbach's alpha) for the secondary scales of comprehensive emotion is $\alpha=0.93$ (adaptive strategies) and $\alpha=0.82$ (maladaptive strategies).

Validity: The calibration and validation were done with a sample of N=1,446 children and adolescents. The findings on the construct validity, factorial structure, and the differential and criteria-related validity are available.

Standards: T-values, T-value bands and percentile values (standardization sample N=800) are available.

Usability: The questionnaire is focused on children aged 10 to 19.11 years. Single and group testing is possible. In practice, one can find the FEEL-KJ in use in psychotherapy, educational counselling, school psychology research on primary and secondary prevention, and in the clinical-psychological and pedagogical-psychological practice and study.

Methods: Statistical Methods

For the calculations in this study, exploratory data analyses were used. Between the 12 January 2011 and the 21 August 2015, trained professionals collected the data for the child and adolescent psychiatry patients in the clinic at Idar-Oberstein. These data were

processed to meet the criteria for the BPD- or pre-BPD-group.

To explore executive function, the modalities "experiencing a regulation of emotions" and "experiencing self-control" from the Scales For Experiencing Emotions (SEE); "control of anger", "suppression of anger" and "expression of anger" from the State-Trait-Anger Expression-Inventory (STAXI); the "regulation of impulses" from the Eating Disorder Inventory (EDI-2); and the "problem solving", "aggressive actions" and "adaptive strategies total" that contain the adaptive strategies of anger, fear and grief from the questionnaire for the assessment of Emotion Regulation For Children And Adolescents (FEEL-KJ) were examined.

For the further calculation, the distribution of the data was estimated with IBM SPSS Statistics for each modality. In the next step, the BPD and the pre-BPD groups were compared by the T-test (when the data showed normality of distribution) or a Mann-Whitney U-test (when the data showed no normality of distribution).

Both analyses will provide an arithmetic mean of the questionnaires that will be compared between the two groups. The results are calculated using IBM SPSS Statistics and Microsoft Excel.

Results

Results: Participants

This study included 171 females and 23 male patients who contacted the institute for child and adolescent psychiatry Idar-Oberstein for inpatient (n=169) or outpatient or ambulatory therapy. The treatment setting of one patient was unknown.

Most of the patients received primary diagnoses of "borderline-personality-disorder" (n=60), "anorexia nervosa" (n=35), "posttraumatic stress disorder" (n=25), "depressive disorder" (n=24), "anxiety disorder" (n=13) or "bulimia nervosa" (n=9). There were 28 patients with a primary diagnosis described as "other disorders" (n=28).

The patients were between 12.7 years (152 months) and 20.9 years (251 months) old. The average age was 16,64 years or 199.6 months (SD=1.44 years or SD=17.33 months). The majority of the patients (n=91) were between 16 and 18 years old. In the sample, 66 patients were younger, and only 37 patients were older than the group of 16- to 18-year-olds. The children and adolescents were students in the 6th to 12th grades in high schools (German: "Gymnasium", n=47), vocational schools (German: "Berufsschule", n=10), schools for vocational preparation (German: "Berufsvorbereitungsjahr", n=3), vocational elementary schools (German: "Berufsgrundschule", n=5), junior high schools or extended junior high schools (German: "Realschule / Realschule Plus", n=59), middle schools (German: "Hauptschule",

n=15), state special schools (German: "Staatliche Förderschule", n=3) comprehensive schools (German: "Gesamtschule"; n=25) or pre-vocational initiatives in business (German: "Handelsschule"; n=2) or individual schools for children with difficulties in learning (German: "Sonderschule"; n=6).

Results: Statistics

The data of the modules "experiencing a regulation of emotions" and "experiencing self-control" from the Scales For Experiencing Emotions (SEE); "control of anger", "suppression of anger", "expression of anger" and "trait-anger" from the State-Trait-Anger Expression-Inventory (STAXI); "regulation of impulses" from the Eating Disorder Inventory (EDI-2); and "problem solving", "adaptive strategies total" and "aggressive actions" from the questionnaire for the assessment of emotion regulation for Children And Adolescents (FEEL-KJ) in the BPD and the pre-BPD group showed a normality of distribution. Therefore, the data of the groups were compared by an independent samples t-test.

The modality "control of anger" (STAXI) of the BPD group (n=91, M=18.23, SD=4.51, SEM=0.47) showed a very statistically significant difference (t (127) =3.0469, p=0.0028, SED=0.926) compared to the pre-BPD group (n=38, M=21.05, SD=5.42, SEM=0.88) when compared through the two tailed t-test for independent samples. The expectancy mean value of a verifiable random sample is 22.4 ± 3.5 [50].

The comparison of the "Suppression of Anger" (STAXI) between the BPD group (n=91, M=20.32, SD=4.70, SEM=0.49) and the pre-BPD group (n=38, M=18.00, SD=7.49, SEM=1.21) resulted in a statistically significant difference (t (127) =2.1223, p=0.0358, SED=1.093). A verifiable random sample shows an expectancy mean value of 16.0 ± 3.6 [50].

When the "expression of anger" (STAXI) of the BPD group (n=91, M=16.98, SD=6.04, SEM=0.63) and the pre-BPD group (n=38, M=13.98, SD=6.20, SEM=1.01) were collated in a two-tailed t-test for independent samples, the results were statistically significant as well (t (127) =2.5479, p=0.0120, SED=1.176). The expectancy mean value of a verifiable random sample amounted to 13.0 ± 3.0 [50].

Only the collation of the STAXI-modality "trait-anger" among the BPD group (n=70, M=24.71, SD=7.21, SEM=0.86) and the pre-BPD group (n=27, M=17.52, SD=6.23, SEM=1.20) resulted in an extremely statistically significant outcome (t (95) =4.5671, p < 0.0001, SED=1.576). A verifiable random sample resulted in an expectancy mean value of 18.1 ± 3.6 [50].

In terms of "problem solving" (FEEL-KJ), the BPD group (n=124, M=15.13, SD=4.70, SEM=0.42) and the pre-BPD group (n=67, M=17.22, SD=4.99, SEM=0.61) differed with results that were very statistically significant (t (189) =2.8747, p=0.0045,

SED=0.729). A study of the validity of the FEEL-KJ with 1102 Dutch-speaking Belgian children and adolescents between the ages of 8 and 18 years old showed a mean value of "problem solving" of 20.19 ± 4.48 [52].

A similar statistically significant difference (t (189) =2.3804, p=0.0183, SED=0.869) was observed regarding "aggressive actions" (FEEL-KJ) among the BPD group (n=124, M=13.22, SD=5.97, SEM=0.54) and the pre-BPD group (n=67, M=11.15, SD=5.26, SEM=0.64). The aforementioned study shows a mean value for "aggressive actions" of 17.45 ± 4.37 in 1102 Dutch-speaking Belgian children and adolescents between 8 and 18 years old [52].

The collation of the modality "adaptive strategies total" (FEEL-KJ) showed a very statistically significant distinction (t (189) =3.2040, p=0.0016, SED=4.383) between the BPD group (n=124, M=101.23, SD=28.18, SEM=2.53) and pre-BPD group (n=67, M=115.27, SD=30.21, SEM=3.69). The modality "adaptive strategies total" provides units for the scales of the adaptive strategies for anger, fear and grief. Therefore, the mean has to be divided into thirds; the adjusted mean amounted to approximately 33.74 for the BPD group (n=124) and 38.42 for the pre-BPD group (n=67). Values of the adaptive strategies lower than 40 are related to a subnormal, deficit use of the analogical strategy of emotion regulation [53].

When the aspect "experiencing a regulation of emotions" (SEE) was compared between the BPD group (n=121, M=10.08, SD=3.49, SEM=0.32) and the pre-BPD group (n=64, M=10.17, SD=2.95, SEM=0.37), there was no statistically significant difference detected (t (183) =0.1740, p=0.8620, SED=0.513).

The comparison of the modality "experiencing self-control" (SEE) revealed a statistically significant difference (t (183) =2.1548, p=0.0325, SED=0.731) between the BPD group (n=121, M=17.05, SD=4.66, SEM=0.42) and the pre-BPD group (n=64, M=18.63, SD=4.86, SEM=0.61).

The "regulation of impulses" (EDI-2) of the BPD-group (n=119, M=35.92, SD=9.79, SEM=0.897) and of the pre-BPD group (n=55, M=25.50, SD=9.11, SEM=1.229) differed even more extremely in their statistical significance (t (172) =6.6682, p< 0.0001, SED=1.562). A standardization with a German non-clinical group of 1754 students aged between 10 and 20 years showed a mean of the "regulation of impulses" measures of 13.96 (SD=4.25) for female and 13.54 (SD=4.02) for male students [54].

Discussion

These data reveal a close association between an executive function deficit and BPD in adolescents. The scales used to verify the significant characteristics of these patient groups are standardized and validated for research on borderline personality disorder in the form of instruments to test the effects of therapy. For example, the STAXI scales "state-anger", "trait-anger", "expression of anger" and "suppression of anger" were used to verify the success of topiramate treatment for aggression in female patients with borderline personality disorder [55].

The finding of a statistically significant difference regarding "Suppression of Anger" (STAXI) between the BPD and pre-BPD groups aligns with current research results. Patients diagnosed with borderline personality disorder and high values of identity diffusion show a significantly higher level of psychiatric symptoms and higher scores for anxiety, anger and depression than do patients with lower levels of diffusion [56]. When one implies that the number of symptoms increases while the level of identity diffusion rises, then it is surprising that probands of the BPD group show a statistically significantly higher mean in "suppression of anger" than do those in the pre-BPD group. An explanation of this result could be a limitation inherent in the questionnaires due to their self-administered format. In the future, it is necessary to explore this phenomenon in more detail in a more extensive sample.

On the other hand, the mean value of outside-directed "expression of anger" (STAXI) in the BPD group is statistically significantly higher than the mean of this modality in the pre-BPD group. This finding fits the hypothesis that the number of symptoms or, rather, the prevalence of typical symptoms such as outbursts of rage increase with the level of identity diffusion and the seriousness of the illness.

The third examined modality of the STAXI in this study is "trait-anger". This modality showed an extremely statistically significant difference between the higher mean value of the BPD group and the lower mean of the pre-BPD group. This result is congruent with observations of young BPD-patients who show a higher intensity and frequency of angry outbursts than do children and adolescents in the general population.

Impulsivity and outbursts of anger are two of the core symptoms of a disorder in executive function [39,40]. This hypothesis is proven by this study. The mean value of the modality "control of anger" in the BPD group is significantly lower than this modality in the pre-BPD group. This result could lead to the assumption that there is a decreasing control of anger in the course of disease development. For more detailed statements in terms of the importance and formation of this modality, a prospective study with more probands could be helpful.

Drechsler defined executive function as a mechanism of regulation and control that provides the ability to act purposefully and appropriately [22]. Up to now, emotional dysregulation, dysfunctions in interpersonal relationships and high impulsivity characterize borderline personality disorder [57]. This study

shows that patients with the more intense symptoms of borderline personality disorder complex show significantly higher "regulation of impulses" (EDI-2), on average, than do patients in the pre-BPD group but a significantly lower mean of the modality "Experiencing Self-Control" (SEE). One explanation could be a higher frequency of inner anger outbursts experienced by patients of the BPD group. Patients with a higher intensity level of BPD symptoms perceive a proper regulation of their impulses subjectively due to habituation to the disorder and its symptoms such as intense inner tension. On the other hand, these patients do not feel like controlling their thinking and acting, owing to maladaptive strategies in the form of self-harming and suicidal thought or actions.

Additionally, the modality "Adaptive Strategies Total" (FEEL-KJ) containing all adaptive strategies regarding anger, anxiety or grief differs significantly between the lower mean value of the BPD group and the higher mean of the pre-BPD group. This result could also explain the lower mean of the modality "experiencing self-control" of the BPD group regarding missing coping mechanisms to control or regulate impulses and outbursts.

Regarding the regulation and control of emotions, in this study, it is fascinating that there was no statistically significant difference visible between the BPD and the pre-BPD group regarding the modality "Experiencing A Regulation of Emotions" (SEE). The mean value of the BPD group was just fractionally lower than the mean value in the pre-BPD group. This result is surprising because, as mentioned above, emotional dysregulation is one of three central characteristics of borderline personality disorder [57]. On the other hand, the higher mean of the mode "Aggressive Behavior" (FEEL-KJ) in the BPD group compared to pre-BPD group harmonizes with the hypothesis or, rather, with the characterization of the three main features of borderline personality disorder by Drechsler (2007) [22].

The comprehensive modality "problem solving" (FEEL-KJ) that can be attributed to the cognitive or "cold" executive function shows a significant difference between the lower mean value of the BPD group and the higher mean in the pre-BPD group. This observation is one of the basic problems in every phase of the disease. A limited identity crisis normally dissolves when the adaption in a new situation or surrounding is completed. In borderline personality disorder, this adaption is never plenary. Erikson defined this problem as the core phenomenon in borderline personality disorders [58]. The findings of this study show that a low ability for "problem-solving" already exists in patients with mild symptoms of borderline personality disorder and is not a specific feature in patients with a BPD diagnosis.

Conclusion

As mentioned in the introduction, the frequently observed symptoms of borderline personality disorder complex such as angry outbursts, impulsivity, maladaptive coping mechanisms, and suicide attempts, not only regularly following inpatient treatments, but they also can have adverse effects on the therapy of those patients [43]. Up to now, those behaviors represent symptoms with negative results, but they could also be used as indicators and tools for the discrimination between exhausting physiological phases that are necessary for the development of a healthy self and symptoms of problematic personality disorders. Therefore, it is imperative to explore the significance of the signs pertinent to the patients with a high level of symptoms belonging to borderline personality disorder.

Through the results of this study, the definition of borderline personality disorder as a very complex system of emotional dysregulation can be statistically verified in most of its investigated aspects.

The verification of the degree of statistically significant differences between patients with mild or severe symptoms of borderline personality disorder complex in terms of other modalities such as "expression of anger", "trait anger", "aggressive behavior", "problem solving", "control of anger", "regulation of impulses" "experiencing self-control" or "adaptive strategies total" can be the impulse for new assessments and categorizations for borderline personality disorder in children and adolescents.

Although some features of borderline personality disorder seem to differ from the expectations that have emerged from clinical observations, the higher "suppression of anger" of the BPD group and, additionally, the similarity of the level of "experiencing a regulation of emotions" between the two groups create new aspects of borderline personality disorder regarding self-awareness and experiencing one's own emotions and abilities. It is necessary to investigate these characteristics in young patients with BPD symptoms in more detail in a more prominent study population.

In clinical praxis, these observations should change the assessment of adverse BPD symptoms from adverse side effects to diagnosis indicators.

Bias / Limitation

In the psychiatric and psychological fields, questionnaires often depend on evaluation completed in professional, private and social surroundings. These evaluations are subjectively given information and individually defined understandings that are not evaluable regarding objectivity and truth. The patients, their parents or trained professionals answered most of the scores and questionnaires in this study. It is not contestable that the answers given by the patients or their social environment are not relentlessly exact.

The large sample size in a consistent setting makes the study strong. Future studies on instruments for the diagnosis of

borderline personality disorder in children and adolescents that primarily focus on executive function can be accredited by the results in this article. More focused objectivation of the executive function in borderline personality disorder can improve specific and effective therapy forms to reach children and adolescents with borderline symptoms even better in the therapeutic setting.

Key Points

Although the effects of a troubled executive function - often noticed when disabling the therapeutic setting and relations - are seen mainly in BPD patients, the association between symptoms of executive dysfunction and BPD is unproven thus far. By comparing patients with severe and mild BPD symptoms, this study shows that the definition of BPD as a complex of emotional dysregulation can be mostly confirmed. Surprisingly, "suppression of anger" in the BPD group was significantly higher than in those patients with milder symptoms; additionally, "experiencing a regulation of emotions" did not differ between the two groups. In clinical praxis, these observations can change the assessment of adverse BPD-symptoms from negative side effects to diagnosis indicators. (Table 1)

	"Control of anger" (STAXI)		"Suppression of anger" (STAXI)		"Expression of anger" (STAXI)		"Trait-anger" (STAXI)		"Problem solving" (FEEL-		"Aggressive actions" (FEEL-KJ)		"Adaptive strategies total" (FEEL-KJ)		"Experiencing a regulation of		"Experiencing self-control" (SEE)		"Regulation of impulses" (EDI-2)	
	BPD	Pre-BPD	BPD	Pre-BPD	BPD	Pre-BPD	BPD	Pre-BPD	BPD	Pre-BPD	BPD	Pre-BPD	BPD	Pre-BPD	BPD	Pre-BPD	BPD	Pre-BPD	BPD	Pre-BPD
number	91	38	91	38	91	38	70	27	124	67	124	67	124	67	121	64	121	64	119	55
mean	18.23	21.05	20.32	18	16.98	13.98	24.71	17.52	15.13	17.22	13.22	11.15	101.23	115.27	10.08	10.17	17.05	18.63	35.92	25.5
standard deviation	4.51	5.42	4.7	7.49	6.04	6.2	7.21	6.23	4.7	4.99	5.97	5.26	28.18	30.21	3.49	2.95	4.66	4.86	9.79	9.11
SEM	0.47	0.88	0.49	1.21	0.63	1.01	0.86	1.2	0.42	0.61	0.54	0.64	2.53	3.69	0.32	0.37	0.42	0.61	0.897	1.229
Difference of mean		-2.82		2.32		3		7.2		-2.09		2.07		-14.04		-0.09		-1.58		10.418
95% confidence interval of the difference	[-4.65 ; -0.99]		[0.16 ; 4.48]		[0.67 ; 5.32]		[4.07 ; 10.32]		[-3.53 ; -0.66]		[0.35 ; 3.78]		[-22.69 ; -5.4]		[-1.10 ; 0.92]		[-3.02 ; -0.13]		[7.33 ; 13.50]	
p-value		0.0028		0.0358		0.012	< 0.0001		0.0045		0.0183		0.0016		0.862		0.0325	< 0.0001	
t-value		3.0469		2.1223		2.5479		4.5671		2.8747		2.3804		3.204		0.174		2.1548		6.6682
df		127		127		127		95		189		189		189		183		183		172
Standard error of difference		0.926		1.093		1.176		1.576		0.729		0.869		4.383		0.513		0.731		1.562

Table 1: Statistical Results.

Ethics Approval and Consent to Participate

The ethical approval was granted by the Ethics Committee of the Medical Faculty Heidelberg, Germany (S-668/2017).

Applicable legal requirements were met for this study. The study follows the provisions of the Helsinki Declaration in its current version. The study protocol was submitted to the Ethics Committee of the Medical Faculty of Heidelberg for professional counselling before the start of the study.

The participation of patients in the study was voluntary. Their consent could be withdrawn at any time, without giving reasons and without any disadvantages for further medical care. Upon withdrawal from the study, data material already obtained were to be destroyed or there will be an inquiry whether the patient agrees with the evaluation of the article.

The data used for this study were originally collected for another research project by the psychiatric institution in Idar-Oberstein. Within that research project, the patients / participants, etc., as well as their parents or the guardian of children younger than 16 years old, were informed in writing and orally about the nature and scope of the planned examination, in particular about the possible benefits for the patients' health and potential risks. They were also informed about the possible use of the data for future studies and research projects. A signature documenting their consent was required on a consent form.

Competing Interests

Funding

Consent for Publication

Not applicable.

Availability of Data and Materials

The datasets generated and analyzed during the current study are not publicly available due to the protection of individual privacy of the patients but are available from the corresponding author on reasonable request.

Authors' Contributions

L.F., E.M. and F.R. conceived of the presented idea. L.F. developed the theory and performed the computations.

L.F. verified the analytical methods. E.V. encouraged L.F. to investigate the social cognition in borderline personality disorder and supervised the findings of this work. All authors discussed the results and contributed to the final manuscript.

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