

# Emotional Processing and Regulation in Borderline Personality Disorder

Yufei Li<sup>1,\*,#</sup>, Kun Wang<sup>2,\*,#</sup> and Yumeng Wang<sup>3,\*,#</sup>

<sup>1</sup>King's College London, London, WC2R 2LS, United Kingdom.

<sup>2</sup>Beijing Institute of Petrochemical Technology University, Beijing, Beijing 102617, China.

<sup>3</sup>University of California, Davis, CA 95616, United States.

\*Corresponding author. Email: Yufei.Li@kcl.ac.uk, valeriewang95@163.com, mymwang@ucdavis.edu

# These authors contributed equally.

## ABSTRACT

Ability to process and regulate emotions in an appropriate way is essential for individuals to establish healthy social interactions and psychological well-being. High level of negative effects ubiquitous for people with borderline personality disorder (BPD), who suffer from intense insecurity, bad self-image, and impulsivity related to risky behaviors. However, the pathogeny and coping process of these negative emotions in BPD patients are discussed discretely and inadequately. Thus, our review aims to fill the gap and explain the importance of emotional processing and regulation in BPD. We first defined emotional processing and regulation along with their correlates in BPD according to their historical and theoretical contexts. Then, the corresponding special characteristics are summarized based on previous clinical studies from the perspectives of the Polyvagal Theory, Attachment Theory, and neuroscience. It is found that BPD patients have a negative bias and delay on emotional processing, while afterwards their poor coping strategies to those negative emotions may lead to out-of-control behaviors. On the other hand, evidence from neural correlates explained BPD patients' neural dysfunction resulting in different emotional processing and regulation from that of normal people. Given the light of those discoveries, we suggested that future studies should focus on developing measurements of dynamic emotions, combining neuro-image with sociability performance. Clinicians should also be aware of the internal variation in BPD group by identifying BPD symptoms from "risk" to "chronic", i.e., intervene BPD patients at a specific time to prevent them forming problematic interpersonal relationships.

**Keywords:** Borderline personality disorder, emotional processing, emotional regulation, attachment theory, neurophysiology

## 1. INTRODUCTION

Borderline personality disorder (BPD) is a serious mental disorder associated with high rates of risky behavior, functional impairment, and mental comorbidities. It is characterized by instable patterns in interpersonal relationships, intrapersonal processes, impulsivity as well as affect panel [1]. The understanding of attributions to this personality disorder has been changing since it was first introduced in DSM- III (1980), transforming from the focus of environmental causes to interaction of environment triggers with genetic predisposition [2]. However, the process of emotional processing and regulation in people with BPD have still not been studied adequately. To be specific, Emotion processing is a spontaneous and deliberate process that leads to fluctuations in emotions (e.g., arising, intensity

and duration), acting as a mediator to influence individuals' self-conception, socialization, and decision-making process [3]. This process is usually interpreted as emotional perception, which reflects our ability to accurately understand emotions (e.g., facial expressions) expressed by other people [4]. Functional emotional processing allows us to avoid overreaction and build trust relationships. Emotional regulation is an automatic or controlled process that involves both positive and negative feelings with controlling, strengthening, and using of individuals [5]. Individual's emotion regulation ability helps them cope with negative emotional arousal and maintain positive daily function, minimizing psychological distress [6]. Moreover, controlling emotions (e.g., curbing impulsivity) is also a useful strategy to establish good relationships with others [7]. In

emotional processing and regulations dominate society, if BPD patient's function in these aspects is problematic, their personal state and interpersonal relationship will be affected. Furthermore, it will probably lead to disconnection to the social environment and poor adaptation to normal social life.

Previous studies mainly focused on attachment theory and cognitive theory in BPD. Attachment types are divided into secure attachment and insecure attachment. The secure attachment is defined as a positive, and consistent self-image and the feeling of being worthy of love, as well as a positive expectation that others will agree and respond in a general manner [8]. Agrawal et al. reviews 13 empirical studies and suggested that the insecure attachment types for the most characteristic of BPD patients are unresolved (loss or trauma experience), preoccupied (termed hyperactivating strategies), and fearful (represent negative model of self and others). Besides, there is a high association between insecure attachment and BPD [8]. John Bowlby postulated that people choose to evolve their behavior patterns that arouse the caretaking behavior of adults under the pressure of nature [9]. Besides, the attachment is constituted by a lasting, affective tie between caregiver and infant. Moreover, according to the response of parents, the infant form an internal working model of the self and others which can affect the relationship in the future [9]. According to Bowlby's study, internal working model of self is associated with the extent to which one is acceptable or lovable to primary attachment figures. In addition, the internal working model of others is linked to the expectation that attachment figures are responsive and available [9]. The study of Sack and colleagues found that 91% of BPD patients had insecure attachment [10], which is about 70.2% from Brennan and colleagues [11]. Ruth and colleagues reviewed the cognitive defect (attention, memory, and thinking bias) in borderline personality disorder [12]. Linehan proposed that individual with BPD have trouble to control their attention and may be centered on the past, the future, or current pain rather than the job at hand [13]. Arntz and colleagues utilized a Stroop task to monitor BPD patients and healthy controls for inhibitory control and realized that BPD patients showed lower levels of inhibitory control than healthy subjects [14]. Additionally, there are two types of memory bias in BPD, which are selective memory for negative information and over-general autobiographical memory. The empirical literature proposes that individual with BPD may have a memory bias for general negative or BPD related material [13]. Pretzer suggested three core beliefs borderline pathology: the world and other person are threatening and malevolent, the self is weak and vulnerable, and the self is internally undesired and deserving of punishment [15]. Contemporarily, attachment theory and cognitive theory are two main theories that have been extensively investigated.

So far, the existing researches are useful for people to understand the etiology and prognosis of BPD. Besides, they are important for psychologists, clinicians and psychiatrists to design more effective treatment approaches as well as intervene in the development of negative symptoms. Moreover, these studies pave paths for understanding the intrapersonal and interpersonal relationships of BPD patients. Although plenty of researches discuss the difference in attachment types and memory bias in emotional cognitive process of BPD patients, few researches investigate the cues of emotional processing and regulation specifically. In addition, combining the aspect of emotion cognition with the biological mechanism and deficits in emotional processing have not been extensively discussed in the previous literatures. In this review, we will briefly summarize the findings of three aspects, which are bias of emotional processing, atypical emotional regulation in BPD and neuro dysfunction of emotional processing in BPD.

## **2. EMOTIONAL PROCESSING BIAS IN BPD**

Emotional processing is divided into two parts, one is processing the emotion of internally generated things. Another part is processing the emotion of generated by external stimuli (situation, cues or others emotion). The emotion should be labeled when generate and judge the intensity. Moreover, people with emotional processing bias will have an impact on social interpersonal. For instance, one is unable to feel friends' sadness when they need your concern, which may lead to loss the relationship. Based on the social-emotion recognition, Mizenberg and colleagues made a hypothesis that patients with BPD have deficits in the perceptions of emotional expressions which can related to the dysfunctional interpersonal relationship [16]. They conducted an experiment with outpatients of BPD and health control on emotional recognition tasks. Lots of measurements have been carried out including Bell-Lysaker Emotion Recognition Test (BLERT) [16], Ekman Facial Emotion Recognition Test [16], Prosodic Emotion Recognition Test [16], Benton Facial Recognition Test--Long Form (BFRT, gray-scale photos of non-famous person's faces) [17], Nonsocial neurocognitive test of RT and Buss-Durkee Hostility Inventory (BDHI) [19]. The results suggest that patients with BPD overall exhibits poorer recognition of social-emotional cues, especially when they are dealing with higher order heteromodal integration of social-emotional expressions. For the BDHI which is a self-report questionnaire measure for suspiciousness, hostility, guilty and aggressive behavior of interpersonal antagonism with BPD patients [18]. The result indicates that patients with BPD shows a significantly higher level of interpersonal antagonism than control group. Moreover, BPD group showed lower recognition than

presented in isolation when facial and vocal emotion were displayed together. With regard to BFRT, the controlling group demonstrated significantly higher accuracy than BPD group, i.e., people with BPD showed impaired distinction of non-emotional facial features [17]. They concluded that BPD patients may have coexisting deficits in both structural and functional pathways which divergently process two kind of information from faces recognition. Overall, people with BPD show negative bias in socially and tend to judge the neutral emotion to negative, which more likely caused over-reaction in social interpersonal.

Further analysis of emotional processing found that it is not only important in accuracy, but also in processing time [19]. Time might be an impacting factor that daily life requires a fast recognition of emotion for suitable reactions in social interactions. For example, one is unable to solve the suddenly conflicts in time without a quick and accurate response. In other words, it does not make any sense without time limit even though the accuracy is reached. In another study, Dyck and colleagues suggested that the reason for social difficulties of BPD patients is a deficit in fast and direct discrimination of negative and neutral emotional expressions [19]. They implemented an experiment with BPD patients and healthy subjects on emotion recognition tasks by utilizing the Fear Anger Neutral (FAN) Test [20] and the Emotion Recognition (ER) Test (an accurate decision about achieving default emotions with no time limit) [21]. As for the FAN Test, they evaluated the capacity to rapidly discriminate angry, fearful and neutral facial expressions. All photos of faces were showed for 2s with an interval of 1s, as well as subjects were required for pressing one of two buttons within in 2s to indicate the valence of facial expression [20]. Compared to healthy subjects, BPD patients showed a poor emotion recognition merely in the fast recognition of negative and neutral facial expression. Moreover, BPD patients showed a negative bias in the discrimination of facial expressions, especially less precise in the recognition of neutral facial expressions. Besides, they read into them as negative which is consistent with previous findings. This means BPD patients tend to perceive the world and other people more negative than healthy subjects. With reference to the ER Test, BPD patient did not show differ in recognition of specific emotions with healthy subjects without a distinct time limit [21]. Overall, the accuracies of BPD patients are in the same level than healthy subjects without time limit. Therefore, time limit may result in the difficulties and misapprehensions in social interactions during everyday life when they are required rapid responses.

Both visual cues and acoustic emotional processing are in social interactions. Sound is an important factor of judge the emotion in intensity. For instance, according to the intonation and tone of individual, one can judge his/her attitude (e.g., anger, happy, or sad).

Previous study suggested that BPD patients have difficulties with integrate visual cues and vocal cues [16]. However, there are less studies for demonstrating whether patients with BPD have only auditory processing problems when sensory modes are separated. The studies of Pfaltz and colleagues indicated that BPD patients show abnormal to emotional acoustic stimuli during processing. They conducted an experiment with female BPD patients and female nonclinical controls on emotion recognition tasks by using Likert-type rating scale (one negative valence/low arousal to nine positive valence/high arousal) [22]. Participants are required to listened emotionally negative (e.g., dog-growl, baby-cry, buzzer, and victim etc.), neutral (e.g., crowd, train, walking, and writing etc.), and positive sounds (e.g., shower, beer, guitar, and laughing etc.), which are form International Affective Digitized Sounds (IADS) in two same sessions for 6 seconds each in randomized order [23]. Heart rate (HR), skin conductance (SC), zygomaticus/corrugator muscle, and self-report balance/arousal responses were assessed. For negative sounds, the results showed that higher SC response in controlling group than in BPD patients while BPD patients assigned lower valence for positive sounds. Moreover, comparisons of negative and neutral sounds controlling groups showed high level zygomaticus responses to positive sounds. Nevertheless, BPD patients were absent in this reaction [23]. In the session two, HR indicated that less deceleration for both groups assigned higher valence to positive sounds than BPD patients. Furthermore, BPD patients also recognized fewer positive sounds than controls. Finally, they concluded that people with BPD have hypo reactivity responses of positive emotional sounds which is common in BPD patients. Besides, an emotional acoustic hypersensitivity may lead to the highly aversive emotional states and corresponding physiological hyperarousal in BPD patients [23]. In conclusion, firstly BPD patients have problem with accuracy, which is mainly reflected in rapid recognition. However, the accuracy can be reached as normal without time limit. Additionally, negative bias is both in visual processing and acoustic processing. Besides, they tend to recognize neutral factors as negative factors, as well as very sensitive to emotional acoustic. Therefore, it is not difficult to understand that they have many problems in interpersonal relationships.

### 3. EMOTIONAL REGULATION IN BPD PATIENTS

Emotional regulation is usually defined as the ability to react to emotional demands of experience in a socially tolerable way, with necessary downregulation to influence one's emotional state for better [24]. If emotions are expected to function properly, people need not only to process them accurately and effectively, but also to make judgements and respond relatively well to them. If the other person conveys a neutral emotion but we feel a negative emotional message, this bias requires

us to calm our emotions so as not to overreact. However, if we accurately perceive a dangerous message, emotion regulation will help us find ways to express our feelings and communicate with others in a reasonable manner [25]. There are many mental disorders on the internalizing spectrum partially characterized by the problematic emotional regulating process, e.g., dysthymic disorder (DD) and BPD. To investigate the special characteristics of emotional regulation among BPD patients, Carolyn etc. [26] selected a group of DD patients, who would also self-report high negative affect, as comparison to a group of BPD patients. Based on information provided by randomly selected clinicians on return postcards, researchers assigned them to describe either a BPD or DD patients using the method of Affect Regulation and Experience Q-sort-Questionnaire Version (a psychometric instrument containing expert informants to assess negative affect and affect regulation). As a result, DD patients were characterized by negative effects, while BPD patients were characterized by both negative and dysregulation effects. In terms of affecting regulation differences between two groups, BPD patients showed significantly poor externalizing strategies, reality-focused coping, and disorganized strategies (e.g., self-harm). Therefore, BPD patients have difficulties to reasonably devise and implement a response plan when facing a potentially distressed mental state.

The Polyvagal Theory was firstly proposed by Dr. Porges in 1995 [27], describing the process by which our neural circuits read dangerous cues in the environment. The theory states that our automatic nervous system mediates both prosocial and defensive behaviors. When someone suffers trauma, especially during experiences that bring them to a standstill, their ability to scan their surroundings for cues of danger can be distorted. Of course, our body's goal is to help us never experience such a scary time again, i.e., it will do everything it can to protect us. As our surveillance system goes into overdrive and does its best to protect us, it can also see many cues (even neutral or positive ones) in the environment as dangerous [28]. Therefore, based on the Polyvagal Theory, emotional dysregulation found in BPD patients could come from their psychological defense mechanisms which can protect them from threatening situations. To advance the Polyvagal Theory on BPD, Marilyn etc. [29] carried out an experiment between BPD patients and healthy controls, using the amplitude of respiratory sinus arrhythmia (RSA) to index the state of the vagal brake (intensity of inhalation and exhalation), and electrocardiogram (ECG) to monitor heart conditions. The participants were all females and instructed to watch three 10-minute film clips and provide dynamically changing emotional stimuli. Film clips 1 and 3 contained conflict scene while clip 2 was a neutral scene. Through the experiment process, BPD participants displayed a vagal withdrawal, which led to increased metabolic demands of fight/flight behaviors.

Likewise, faster heart rate was also progressively recorded in the BPD group, which might also contribute to developing sympathetic activation. These results explained that BPD patients' automatic nervous system is more actively respond to social stimuli. Therefore, they may overreact to certain emotions which leads to poor performance in terms of social relationships. It likewise supports the idea that the lower order cognitive process of BPD patients is problematic before their beliefs change [30]. The automatic response of their dysfunctional signals' control that occurs at the emotional regulation stage does not rise to the level of beliefs. Thereby, it is a blind spot for CBT therapy [31].

As mentioned earlier, a particular attachment types that people form early in life relates to forming a certain kind of internal working models, which tends to be kept by individuals into adulthood. Internal models lead by anxiety and fear existing in BPD patients put them in the risk of frequent usage of impulsive coping strategies to down-regulate negative emotions [18]. Impulsivity is one of the main facets of emotion regulation in BPD patients. It is strongly related to risky behavior and suicidal ideation [32]. Therefore, examining what is the mediator on the attachment-impulsivity pathway is crucial. Annegret etc. [33] conducted a study to examine the mediating role of emotional regulation between childhood maltreatment and emotion dysregulation in women with BPD. The control groups were clinical controls who would also self-report high score on the impulsive scale (e.g., substance disorder), and healthy controls. After obtaining the results by Childhood Trauma Questionnaire (CTQ), UPPS Impulsive Behavior Scale, and Difficulties in Emotion Regulation Scale (DERS), they conducted a mediation analysis to find out the mediator between childhood trauma severity and impulsivity among BPD patients. Eventually, they found that malfunctioning emotion regulation statistically mediated the effect of childhood maltreatment on impulsivity only in BPD. In other words, even though BPD patients have insecure attachment types influenced by childhood maltreatment, the negative effects on self-control ability which causes impulsivity will be minimized if they can improve abilities and skills in emotional regulation. To conclude, emotional regulation in BPD patients is mainly characterized by the poor coping strategies which don't allow them to respond to emotions in a reasonable manner. Moreover, supporting the Polyvagal Theory, BPD patients adapted to social stimuli in an automatic state where there were more tendencies of fight/flight behaviors, including the intensive respiration and faster heart rate. However, BPD patients can also improve their conditions and social relationship by developing better emotional regulation skills.

#### 4. NEURAL DYSFUNCTION OF EMOTIONAL PROCESSING IN BPD

People with BPD shows a different processing mechanism compared to healthy people. They rely on reflective and automatically process and the activations in brain areas was greater than healthy people when processing with negative emotions. Koenigsberg et al. conduct a study which examine the neural activation of emotional processing when BPD patients are present with social emotional stimuli. Each of the participants were presented with social-emotional content by International Affective Picture System (IAPS), which shows at least two people interact or one is emotionally related to the other. Besides, researchers excluded the pictures which shows emotions of a non-interpersonal situations. Half of the pictures were classified positive while half of the pictures were classified negative by IAPS. The researchers use fMRI to examine the task-dependent activation in the brain, compare the images of different states (rest vs. negative, negative vs. positive, rest vs. positive, negative vs. rest) [34]. The results demonstrated that people with BPD exhibit a greater activation in amygdala and fusiform gyrus when presented with negative stimuli. Activities in amygdala are primarily related to experiencing of emotions. BPD subjects also presented a difference in the activation of primary visual areas compare to the healthy controls, which means people with BPD rely on reflective, automatically responding networks. Meanwhile, healthy individuals' access to a higher level conscious cortical processing. Great differences of activation between N-R (negative vs. rest) and P-R (positive vs. rest) was also found to be related to precuneus and posterior cingulate regions. It initially involved in the process of self-referential, first person perspective and can cause people with BPD overinvolved in interpersonal situations. An EEG-based event-related brain potentials (ERP) study conducted by Izurieta-Hidalgo also reflect a series of facial emotion classification tasks found special neural activity patterns associated with emotion processing among BPD female patients [35]. Through the dominant amplitude they obtained during the experiment of participants' brain, they found that the misclassification of a predominant face shows a lower amount of anger. Besides, it was positively correlate with the manifestation of symptoms of BPD. In other words, people with BPD are more acute with the detection of angry and slower with the recognition of facial happiness when they are in a social-emotional environment. It is harder for people with BPD to correctly distinguish the category (negative, positive, neutral) of emotions and they have pre-tendency recognize emotions with negative cues. In a word, fMRI indicated that BPD subjects exhibited greater amygdala activity when recognizing and processing emotions. Moreover, ERP shows that BPD patients are more sensitive with facial anger and may have impairments in interpersonal function.

People with BPD involved in a lower-order control mechanism when they are undergoing emotional processing and regulation, which is different from health people who utilize higher brain functions. Baczkowski et al. conducted an experiment using resting-state fMRI to find out the lasting effect of emotion regulation on the functional connectivity of amygdala in BPD. Participants were asked to run a resting state fMRI before and after the presentation of negative, positive, erotic and neural pictures. They were also asked to choose from two visual instruction: look at the picture without change the emotion (passive viewing) or regulating their emotion and think about "being safe" (regulation) [36]. The results shows that BPD patients are less able to increase amygdala intrinsic functional connectivity (FC) with regions that are essential for emotional regulation in the brain. In this case, they may have trouble interpret the meaning of emotional stimuli because of impaired regulation regions, i.e., further hindered the subsequent emotional control and expression. The results are also compatible with the study of Koenigsberg et al. They used a similar paradigm which obtained a BOLD image while presenting the participants with negative and neutral pictures as well as letting them either look at the pictures or trained to use a distancing technique (passive viewing) [37]. By comparing the obtained neuroimages of BPD group and health controls, they suggest that there is a difference in the regions of activation between BPD and health control (HC) subjects. BPD subjects showed less activation in the dorsal anterior cingulate cortex (dACC) and intraparietal sulcus (IPS) as well as greater activation in the right superior frontal gyrus. Whereas, HC shows the opposite. Areas concerned of prefrontal cortex are primarily related to the higher brain functions (e.g., voluntary physical action, perception and memory association), which signify that people with BPD do not undergo the same cognitive process as healthy people do. They do not utilize distancing strategy when they perceive an emotion cue, which means they cannot attend the social-emotional situation without interpreting the emotions. Thus, they are less able to regulate the emotional response compare to healthy people.

Dysregulation in the of frontal-limbic interaction and the level of anxiety can also play roles in disturbing the emotional processing and regulation of BPD groups. Holtmann et al. used fMRI to examine the relationship between emotional stimuli and the frontal-limbic neural activities. Participants were scanned when they are performing the modified version of Erikson Flanker task, which contains a central arrow pointed to left/right and the flanker arrow can either point to same (congruent) or different (incongruent) direction with the central arrow [38]. Participants were asked to identify the direction of the target while ignoring the surrounding arrows. At the same time, task-irrelevant pictures of neutral or fearful face will present in the background of the flanker stimuli. According to the results, BPD patients show significant

interactions between emotion and congruency in the right amygdala. Besides, they were able to compensate it by the engagement of dorsal anterior cingulate cortex (dACC) and rostral anterior cingulate cortex (rACC) in emotional processing. They suggested that people with BPD might be able to modulate the activities in right amygdala under the congruent condition but not in incongruent conditions which demand higher cognitive resources. The experiment also indicated a positive relationship between the trait anxiety and the reactions time in BPD group. Therefore, high anxiety can contribute to the distraction when processing an emotion and subsequently lead to a deficient inhibition in the processing of negative emotions in BPD people.

Furthermore, it might be possible for BPD patients to train to downregulate their BOLD responses, i.e., results in a decreased of BPD symptoms as well as less activations when dealing with negative emotion pictures. Zaehring et al. conducted an experiment to find out if BPD symptoms (e.g., affective instability) can be decreased by letting participants learn to downregulate their BOLD responses independently. They asked participants to either look at a negative picture or use their own way to downregulate a thermometer which represent the brain activation [39]. Although the research needs further replication and confirmation, the amygdala neurofeedback training presents us an idea that symptoms of affective instability can be generally improved after the training of downregulation. In this case, it could be considered as a intervention in treating with BPD patients.

In a word, people with BPD processing emotions in a social-emotional environment are more likely to wrongly distinguish and perceive the emotions from others as negative signal. The reason is that they utilize an automatically and reflective processing system different from health people. The dysfunction of neural areas (e.g., frontal-limbic interaction and amygdala intrinsic functional connectivity) further prevent them to control emotions and express.

## 5. LIMITATION AND FUTURE DIRECTION

In this perspective, we detailed examine emotional processing and regulation of BPD, involved several important roles of BPD from different aspects as well as demonstrated the reasons for the different behaviors of people with BPD. Nevertheless, it is important to inform the limitations as well. First, the research and literature reviews of emotional processing we presented above only focus on using static paradigms (e.g., presenting pictures to measure and observe the reaction and results from the experiments). Second, most of the experiments of processing and regulation specially focus on the provided experiment conditions to obtain neuro-images instead of obtaining results from real social-emotional environment. Moreover, many different dimensions of emotional

processing and regulation in BPD are not covered in this review. Last but not least, all of the research we presented above conduct experiments of diagnosed BPD patients without specify the phase and severity of symptoms of these patients.

Many different dimensions can be further researched in emotional processing and regulation of BPD. Future research is ought to develop more dynamic measurements of emotions. For example, we can ask participants to watch a video instead of attending a static picture. We can also make two people interact with each other and see how does their neuro-images change. Different from the current paradigm mentioned in the review that provide participants with pictures of categorized emotions, providing testers the chance to interact with dynamic emotional cues can improve the understanding of the differences in emotional processing between normal people and people with BPD. Furthermore, prior experiments focus on investigating the activation areas when BPD patients performing the tasks of emotional processing and regulations. Research can also be done with a measurement of the sociability performance in real social-emotional environment. With a combination of the neuro-image and sociability performance, one obtains a detailed connection between activations in brain area and the real-world performance. Besides, it would definitely benefit them to make treatment approach and take interventions targeted to people with BPD. Lastly, since the lack of experiments focusing on development of BPD symptoms from “risk” to “chronic”, future research can take this as one dimension to explore. If differences in emotional processing and regulation of patients in different developing phases are able to explore clearly, it would be much easier for researchers and clinicians to intervene at a specific time to prevent severer consequences in interpersonal relationships.

## 6. CONCLUSION

In summary, people with BPD show poorer identification of social emotional cues in interpersonal relationships, which leads to overreaction or misunderstand others’ attitude. To be specific, they exhibit a deficit in rapid recognition of emotional expressions under time limit that make difficulties in social interactions. BPD patients have high level reaction of visual stimuli and acoustic stimuli during daily life that results in make easier to conflict with others. Moreover, BPD patients indicate a dysfunction in emotional regulation when facing a distressed situation, i.e., they are hard to implement a reasonable response plan. Likewise, they have insecure attachment types that lead to effect the social interpersonal in the future, which is impacted by childhood trauma. Even though the insecure attachment types affect the symptoms of borderline, it may be less serious if they have good emotional

regulation functions. In addition, negative stimuli BPD patients show a higher activation in amygdala and fusiform gyrus. Besides, they may modulate the activities in right amygdala under the congruent condition. BPD patient's dysfunction leads to inaccessible to the higher-order brain function, i.e., they have difficulties to utilize distancing strategy to modulate the emotional response. Meanwhile, the limitations of previous studies are also discussed that people restricted to have research on the response of single emotion. As for further studies, one needs to focus on the changes in emotional processing and regulation during the different stage of BPD (e.g., at risk, diagnosed, and chronic).

## REFERENCES

- [1] Leichsenring, F., Leibing, E., Kruse, J., New, A. S., & Leweke, F. (2011). Borderline personality disorder. *The Lancet*, 377(9759), 74-84.
- [2] White, C. N., Gunderson, J. G., Zanarini, M. C., & Hudson, J. I. (2003). Family studies of borderline personality disorder: A review. *Harvard Review of Psychiatry*, 11(1), 8-19.
- [3] Schmahl, C., Herpertz, S. C., Bertsch, K., Ende, G., Flor, H., Kirsch, P., & Bohus, M. (2014). Mechanisms of disturbed emotion processing and social interaction in borderline personality disorder: state of knowledge and research agenda of the German Clinical Research Unit. *Borderline Personality Disorder and Emotion Dysregulation*, 1(1), 1-17.
- [4] Suvak, M. K., Sege, C. T., Sloan, D. M., Shea, M. T., Yen, S., & Litz, B. T. (2012). Emotional processing in borderline personality disorder. *Personality Disorders: Theory, Research, and Treatment*, 3(3), 273.
- [5] Gross, J. J. (1998). The emerging field of emotion regulation: An integrative review. *Review of general psychology*, 2(3), 271-299.
- [6] Thompson, R. A. (1991). Emotional regulation and emotional development. *Educational Psychology Review*, 3(4), 269-307.
- [7] Marroquín, B., Tennen, H., & Stanton, A. L. (2017). Coping, emotion regulation, and well-being: Intrapersonal and interpersonal processes. In *The happy mind: Cognitive contributions to well-being* (pp. 253-274). Springer, Cham.
- [8] Agrawal, H.R., Gunderson, J., Holmes, B. M., & Lyons-Ruth, K. (2004). Attachment Studies with Borderline Patients: A Review. *Harv Rev Psychiatry*. 2004; 12(2): 94-104.
- [9] Bowlby, J. (1973). Attachment and loss. Vol. II: Separation: anxiety and anger. *Basic Books; New York: 1973*.
- [10] Sack, A., Sperling, M.B., Fagen, G., & Foelsch, P. (1996). Attachment style, history, and behavioral contrasts for a borderline and normal sample. *J Personal Disord* 1996; 10:88-102.
- [11] Brennan, K.A., Shaver, P.R. (1998). Attachment styles and personality disorders: their connections to each other and to parental divorce, parental death, and perceptions of parental caregiving. *J Pers* 1998; 66:835- 78. [PubMed: 9802235]
- [12] 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 (2012) 359-369.
- [13] Linehan, M. M. (1993). Cognitive-behavioral treatment of borderline personality disorder. NY: Guilford.
- [14] Arntz, A., Appels, C., Sieswerda, S. (2000). Hypervigilance in borderline disorder: A test with the emotional Stroop paradigm. *Journal of Personality Disorders*, 14, 366-373.
- [15] Pretzer, J. (1990). Borderline personality disorder. In A. T. Beck, & A. Freeman (Eds.), *Cognitive therapy of personality disorders*. NY: Guilford.
- [16] Mizenberg, M. J., Poole, J. H., & Vinogradov, S. (2006). Social-emotion recognition in borderline personality. *Comprehensive Psychiatry*. 47(6), 468-474.
- [17] Benton, A.L., Van Allen, M.W. (1968). Impairment in facial recognition in patients with cerebral disease. *Cortex* 1968; 4:344 - 58.
- [18] Buss, A.H., & Durkee, A. (1957). An inventory for assessing different kinds of hostility. *J Consult Psychol* 1957; 21(4):343 - 9.
- [19] Dyck, M., Habel, U., Slodczyk, J., Schlummer, J., Backes, V., Schneider, V., & Reske, M. (2008). Negative bias in fast emotion discrimination in borderline personality disorder. *Psychological Medicine*, Page 1 of 10. f.
- [20] Gur, R.C., Sara, R., Hagendoorn, M., Marom, O., Hughett, P., Macy, L., Turner, T., Bajcsy, R., Posner, A., & Gur, R.E. (2002). A method for obtaining 3-dimensional facial expressions and its standardization for use in neuropsychiatric studies. *Journal of Neuroscience Methods* 115, 137-143.
- [21] Kohler, C.G., Turner, T., Stolar, N.M., Bilker, W.B., Brensinger, C.M., Gur, R.E., & Gur, R.C. (2004).

- Differences in facial expressions of four universal emotions. *Psychiatry Research* 128, 235–244.
- [22] Pfaltz, M.C., Schumacher, S., Wilhelm, F.H., Dammann, G., Seifritz, E., & Martin-Soelch, C. (2015). Acoustic Emotional Processing in Patients with Borderline Personality Disorder: Hyper- or Hypo reactivity? *Journal of Personality Disorders*, 29, 2015, 176.
- [23] Bradley, M. M., Lang, P. J. (2000). Affective reactions to acoustic stimuli. *Psychophysiology*, 37(2), 204–215.
- [24] Cole, P. M., Michel, M. K., & Teti, L. O. D. (1994). The development of emotion regulation and dysregulation: A clinical perspective. Monographs of the society for research in child development, 59(2-3), 73-102.
- [25] Verzeletti, C., Zammuner, V. L., Galli, C., & Agnoli, S. (2016). Emotion regulation strategies and psychosocial well-being in adolescence. *Cogent Psychology*, 3(1), 1199294.
- [26] Conklin, C. Z., Bradley, R., & Westen, D. (2006). Affect regulation in borderline personality disorder. *The Journal of nervous and mental disease*, 194(2), 69-77.
- [27] Porges, S. W. (1995). Orienting in a defensive world: Mammalian modifications of our evolutionary heritage. A polyvagal theory. *Psychophysiology*, 32(4), 301-318.
- [28] Jodi Clarke. (2019). Polyvagal Theory and How It Relates to Social Cues. *Verwellmind*.
- [29] Austin, M. A., Riniolo, T. C., & Porges, S. W. (2007). Borderline personality disorder and emotion regulation: Insights from the Polyvagal Theory. *Brain and cognition*, 65(1), 69-76.
- [30] Sharp, C. (2014). The social-cognitive basis of BPD: A theory of hypermentalizing. In *Handbook of borderline personality disorder in children and adolescents* (pp. 211-225). Springer, New York, NY.
- [31] Rudge, S., Feigenbaum, J. D., & Fonagy, P. (2020). Mechanisms of change in dialectical behaviour therapy and cognitive behaviour therapy for borderline personality disorder: a critical review of the literature. *Journal of Mental Health*, 29(1), 92-102.
- [32] Bakhshani, N. M. (2014). Impulsivity: a predisposition toward risky behaviors. *International journal of high-risk behaviors & addiction*, 3(2).
- [33] Krause-Utz, A., Erol, E., Broussianou, A. V., Cackowski, S., Paret, C., Ende, G., & Elzinga, B. (2019). Self-reported impulsivity in women with borderline personality disorder: the role of childhood maltreatment severity and emotion regulation difficulties. *Borderline personality disorder and emotion dysregulation*, 6(1), 1-14.
- [34] Koenigsberg, H.W., Siever, L.J., Lee, H., Pizzarello, S., New, A.S., Goodman, M., Cheng, H., Flory, J., & Prohovnik, I. (2009). Neural Correlations of Emotion Processing in Borderline Personality Disorder. *Psychiatry Res.* 172 (3): 192-199.
- [35] Izurieta-Hidalgo, N.A., Oelkers-Ax, R., Nagy, K., Mancke, F., Bohus, M., Herpertz, S. C., & Bertsch, K. (2016). Time course of facial emotion processing in women with borderline personality disorder: an ERP study. *Psychiatry Neurosci* 2016; 41(1)
- [36] Baczowski, B. M., van Zutphen, L., Siep, N., Jacob, G. A., Domes, G., Maier, S., Sprenger, A., Senft, A., Willenborg, B., Tüscher, O., Arntzl, A., & van de Ven, V. (2017). Deficient amygdala–prefrontal intrinsic connectivity after effortful emotion regulation in borderline personality disorder. *Eur Arch Psychiatry Clin Neurosci*: (2017) 267: 551-565.
- [37] Koenigsberg, H. W., Fan, J., Ochsner, K., Liu, X., Guise, K. G., Pizzarello, S., Dorantes, C., Guerreri, S., Tecuta, L., Goodman, M., New, A., & Siever, L. J. (2009). Neural Correlates of the Use of Psychological Distancing to Regulate Responses to Negative Social Cues: A Study of Patients with Borderline Personality Disorder. *Biol Psychiatry*. 2009 November 1; 66(9): 854.
- [38] Holtmann, J., Herbort, M. C., Wüstenberg, T., Soch, J., Richter, S., Walter, H., Roepke, S., & Schott, B. H. (2013). Trait anxiety modulates fronto-limbic processing of emotional interference in borderline personality disorder. *Frontiers in Human Neuroscience*: March 2013, Volume 7, Article 54.
- [39] Zaehring, J., Ende, G., Santangelo, P., Kleindienst, N., Ruf, M., Bertsche, K., Bohus, M., Schmahl, C., & Paret, C. (2019). Improved emotion regulation after neurofeedback: A single-arm trial in patients with borderline personality disorder. *Neuroimage: Clinical* 24 (2019) 102032.