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EMOTIONAL BODY LANGUAGE IN BORDERLINE PERSONALITY DISORDER: AN EYE TRACKING STUDY

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ABSTRACT

Introduction

Available research on emotion recognition in individuals with Borderline Personality Disorder (BPD) suggests that the challenges in personal relationships observed in BPD patients could be attributed to a modified interpretation of social cues. Facial emotion recognition studies found that BPD patients exhibit an enhanced identification of subtle, ambiguous signs of emotions, coupled with the tendency to misattribute negative valence to neutral or low intensity emotional cues (negativity bias).

The present study evaluates whether individuals with BPD also exhibit a biased recognition of the emotions conveyed by body postures: in fact, the accurate interpretation of human gestures is essential to correctly comprehend others' emotions and intentions. To this aim, we used an eye-tracking technique to investigate the visual exploration patterns of emotional body postures, while participants were instructed to execute two distinct emotion recognition tasks.

Materials and methods

The study involved a total of 26 patients with BPD and 26 sex and age matched Healthy Controls (HC). Participants completed two tasks that requested them to evaluate static body postures that were either emotional (Happiness, Anger, Surprise) or non-emotional (Neutral).

Firstly, participants were asked to identify whether the body posture presented conveyed any emotions (Detection Task). Secondly, they were required to rate the valence of the postures utilizing a visual analogue scale (Valence-estimation Task). In both tasks the performance was measured through accuracy and reaction times. Then, we evaluated the visual exploration pattern with different parameters: the latency and the duration of the first fixation in the Detection Task and the number of fixations on salient regions(Head, Right Hand and Left Hand) in the Valence-estimation Task.

Results

In the Detection Task, the accuracy in identifying emotional or neutral stimuli was similar between BPD patients and HC, although HC responded faster when they correctly identified both emotional and neutral postures as compared to BPD patients. Conversely, in the Valence-estimation task, BPD patients rated neutral postures as more negative and angry postures as less negative, as compared to HC.

Considering the eye-tracking results, individuals with BPD showed delayed first fixation to the Left Hand of neutral bodily positions as compared to HC, indicating that BPD patients were slower in directing their attention towards significant areas of neutral stimuli. Additionally, BPD patients exhibited a longer duration of first fixation for neutral stimuli, regardless of the body region, compared to HC. In the Valence-estimation task, BPD patients displayed a lower number of fixations to the Hands as compared with HC, irrespective of the postures' valence.

Conclusions

This preliminary study indicates that BPD patients show a different visual exploration pattern of body postures as compared with HC. Specifically, they exhibit slower reflexive eye movements towards neutral bodily gestures as well as potential difficulties in automatically focusing attention on salient regions normally useful to discriminate threatening signals.

Moreover, once the attention is directed to neutral stimuli the focus of attention is captured for longer time, indicating that neutral stimuli in general seem to be more attention-grabbing for BPD patients as compared to HC.

Furthermore, in the Valence estimation phase of the emotion recognition process, patients with BPD confirmed their tendency to misinterpret neutral cues as more negative (negativity bias) and they showed a low level of interest (i.e. lower number of fixations) to the hands of all the postures. This could lead to speculate that the biased later stages of emotional information processing in BPD patients might be related with difficulties in focusing visual attention on important source of emotional information.

1. INTRODUCTION

1.1 Emotion Regulation in Borderline Personality Disorder

Borderline personality disorder (BPD) is characterized by a pervasive pattern of instability and hypersensitivity in interpersonal relationships, instability in self-image, extreme mood fluctuations, and impulsivity (DSM-V, APA 2013). BPD is a chronic mental disorder that affects almost the 1,6% of the general population and up to 10% of psychiatric outpatients (Dubovsky et al. 2014; Widiger et al. 1991). The comorbidities are multifaceted and relate to various co-occurring mental disorders, including mood disorders, anxiety disorders, eating disorders, post-traumatic stress disorder, or substance use disorders (Shahr. et al 2018).
The core of BDP is emotional dysregulation: it was demonstrated to predict maladaptive interpersonal behaviors, impulsive coping behaviors (Conklin et al. 2006) and reactive aggressive behaviors (Newhill CE et al. 2012).

The biosocial theory that proposed Linehan (1993) explains the development of borderline personality disorder based on the interaction of biological and environmental factors. The theory suggests that people with BPD have a biological disposition that makes them highly reactive to emotional stimuli. Emotional dysregulation can lead people with BPD to experience intense emotions, including anger, sadness, and fear, and they may have difficulty regulating their emotional responses. When someone with emotional dysregulation experiences invalidation, it can exacerbate their symptoms and lead to more severe emotional dysregulation.

Linehan's biosocial theory suggests that the combination of biological vulnerability and invalidating environments can lead to the development of BPD.

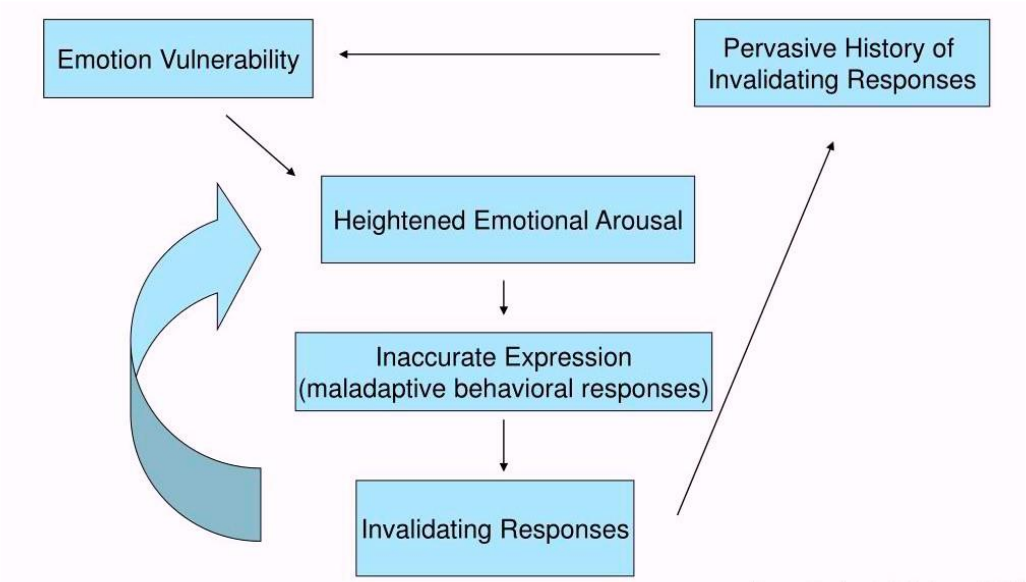

Figure 1: *Biosocial Theory (Linehan, 1993)*

Consequently, people had emotional hypersensitivity, easily triggered intense emotional responses that leads to a state of hyperarousal and a slower return to emotional baseline (Perez-Rodriguez et al., 2018)

According to a study by Porter et al. (2020), individuals with BPD are significantly more prone to reporting adverse childhood experiences than Healthy Controls, with a 13 times greater likelihood of experiencing neglect and emotional abuse. Additionally, attachment difficulties, specifically the disorganizated-ambivalent type, have been identified by Gunderson JC & Lyons-Ruth K (2008) as crucial factors in the development of BPD.

Genetic factors and adverse childhood experiences may cause emotional dysregulation and impulsivity, leading to dysfunctional behaviors like nonsuicidal self-injury (NSSI), suicide and psychosocial conflicts and deficits (Lieb et al. 2004).

NSSI prevalence is 90% in adult samples with BPD (Goodman M et al. 2017), it is performed as an emotion regulation strategy to escape from negative experiences or induce a positive state (Taylor PJ et al. 2018).

It is estimated that at least 75% of patient with BPD will attempt suicide (Goodman M et al. 2017).

The components of emotion dysregulation include heightened emotion sensitivity, negative affect, inadequate emotion regulation strategies, and maladaptive regulation strategies (Carpenter & Trull, 2013). Emotion sensitivity involves an increased emotional response to environmental stimuli, especially negative emotions. This can lead to interpersonal sensitivity, a relational pattern characterized by a need for attention and closeness coupled with fear of abandonment and overreaction to negative cues, ultimately increasing the risk of rejection by others (Gunderson & Lyons-Ruth, 2008).

This fear of rejection is explained by the *Rejection Sensitivity Model* (Downey & Feldman, 1996). It hypothesizes that when individuals are repeatedly excluded, neglected, or rejected by primary caregivers as children, they tend to experience fear, anxiety and the expectation of rejection from others as adults. These fears are exhibited in the individual's hypervigilant responses towards rejection and in the tendency to perceive rejection in subtle and ambiguous cues from others.

In particular, Berenson and collegues (2011) empirically proved high levels of RS in BPD patients comparing to Healthy Controls; furthermore, they found that there was an association between the perception of rejection andhostile behaviors (Berenson et al,. 2011).

The maladaptive response may depend on *Effortful Control* (EC): the "voluntary" part of temperament that allows individuals to strategically regulate contingent emotions, impulses and thoughts for the sake of valued goals (Ayduk et al. 2008; Rothbart et al. 2011; De Panfilis et al. 2013). EC enables individuals to successfully resolve conflicts between immediate reactive tendencies and long-term demands, and to overcome a 8 dominant response in order to produce a more socially appropriate and/or goal directed non dominant response (Casey et al., 2002; Derryberry & Rothbart, 1997; Posner & Rothbart, 2009). EC consists of three components: the capacity to inhibit inappropriate response/behaviors (inhibitory control), to act where there is a strong tendency to avoid the action (activation control), and to focus and shift attention where it is desired to do so (attentional control) (Evans & Rothbart, 2007). The self-regulatory abilities promoted by EC could enable high RS individuals to reappraise the interpersonal situation and inhibit their impulsive, automatic interpersonal response tendencies (Mischel & Ayduk, 2011), thus decreasing the risk of maladaptive behaviors and emotional dysregulation (De Panfilis et al. 2016).

EC is probably the key feature of emotion regulation, but it isn't a fixed temperamental trait because it is impaired by contextual salient stimuli trough bottom-up processes.

Social dysfunction is a core feature of BPD and according to the alternative DSM-5 model of BPD, "interpersonal hypersensitivity" and "perceptions of others selectively biased towards negative attributes" are the characteristic mostly connected with interpersonal dysfunction but also a "compromised ability to recognize the feelings and needs of others" is implicated so that two effective therapy programs are focused on empathy [mentalization-based therapy (Bateman & Fonagy,2004) and dialectal-behavioral therapy (Linehan, 2018)].

Davis demonstrated that empathy is multifaceted and requires a multidimensional approach. The Interpersonal Reactivity Index (Davis, 1980) was developed to explore four distinct aspects of empathy, including social functioning, emotional responsiveness, self-esteem, and sensitivity. Davis concluded that this assessment tool (Davis M.H., 1983) is the most appropriate method for measuring empathy.

Actually, Empathy is a general term used to describe the ability to understand others, but it includes several dimensions. *Emotional empathy* is the ability to respond to emotional state of others in a sympathetic manner; *cognitive empathy* is the ability to take the perspective of others without experience the emotional state indirectly (Davis, 1983).

The Theory of Mind (ToM) and mentalizing are closely associated with the capacity to recognize and interpret the mental states of oneself and others, thereby facilitating a comprehension of behaviors. Although the terms ToM and mentalizing are often used

interchangeably, they differ in that ToM pertains more to cognitive aspects, while mentalizing involves an affective, self-referential dimension.
At last, *socialcognition* is the ability to process information about "self, others and social rules".
Empathy and related processes dysfunction are widely suggested in patients with BPD. According to Salgado's review (2020), 80% of studies found deficits in empathy or related processes in BPD patients. It is observed that BPD patients have poor abilities to take the perspective of others, while exhibiting high emotional empathy (Harari et al., 2010; Jeung & Herpertz, 2014). This may lead to intense suffering and distress due to empathizing with others' emotions, which is called the Empathy Paradox. Cognition empathy processes, impaired in BPD, may not effectively modulate "emotional contagion".

1.2 Borderline Personality Disorder and Emotional Recognition

Emotion recognition can be described as the ability to correctly identify others' emotions from facial expression or body language, in order to accurately decodify non-verbal social cues, essential to maintain a good socio-relational functioning.
Research on emotion recognition in patients with BPD has mostly focused on emotions expressed via basic facial expression and prosody, yielding to mixed results that involve impaired, enhanced or comparable accuracy relative to healthy control subjects (Domes et al, 2009; Dinsdale & Crespi, 2012).
The Empathy Paradox, that bear increased facial emotion recognition accuracy in BPD, is possibly resulting from a combination of increased attention to social stimuli and dysfunctional processing of social information (Jeung & Herpertz, 2014). Indeed, some studies showed no differences (Franzen et al., 2011; Robin et al., 2012; Schilling et al., 2012) or even evidence of better performance of BPD patients in emotion recognition processes (Lynch et al., 2006; Unoka et al., 2011). It is possible that some patients with BPD may

perceive and respond to subtle emotional cues that healthy subjects might otherwise ignore for the sake of socialization (Salgado et al., 2020).

On the contrary, several studies found that people with BPD recognize emotions less accurately than controls, and that this accuracy decreases with increasing affect intensity (Bland, 2004; Levine et al, 1997, 1992; Minzenberg et al, 2007).

Emotion recognition involves identifying and categorizing an emotion, responding to queries such as "is this an emotion?" and "what type of emotion is this?". The initial stage of emotional signal evaluation entails a reflexive system that generates a spontaneous and rapid response to social cues. The reflective system, on the other hand, generates more nuanced, learned, and deliberate responses, necessitating cognitive processing (Adolphs, 2002).

The reflexive system, including the amygdala, STS, orbitofrontal (OFC) cortex, dorsal anterior cingulate (dACC) and basal ganglia, provides an automatic, fast operating emotional response, while the reflective system, incorporating the lateral and medial prefrontal areas, the medial temporal lobe and the rostral anterior cingulate (rACC), provides a more nuanced, experienced-based, but slower-responding emotional appraisal (Mitchell et al., 2008; Lieberman et al., 2007; Satpute & Lieberman 2006). It has been hypothesized that the increased emotional reactivity characteristic of BPD patients may be a consequence of their inability to adequately engage the reflective system and thus to rely heavily upon the more primitive reflexive system (Koenigsberg et al., 2009).

In particular, detection is the result of amygdala and ventral striatum processed information, labelling is made by prefrontal cortex, which allow to discriminate among negative facial expressions (Hariri et al.2000; Narumoto et al. 2000). In view of evidence supporting a dysfunction of prefrontal system when triggered by negative emotions the hypothesis is that the second part of emotional information processing is impaired, when the stimulus as to be evaluated and categorized (Daros et al.,2013; Mitchell et al., 2014; Hepp et al. 2016).

Untill now, studies focused on Emotion recognition were performed using emotion expressedvia basic facial expressions and prosody.

Some of them showed an increased accuracy in recognizing facial emotions (Lynch et al. 2006; Minzenberg et al. 2006; Domes et al. 2008; Schulze et al, 2013) with a bias towards perception of fear and anger (Merkl et al, 2010; Schulze et al, 2013; Veague and Hooley, 2014). Greater accuracy is explained by the presence of the *Empathy Paradox* (Dinsdale and Crespi, 2013): an enhanced Emotional Empathy that makes them good to detect the presence of an emotion because of an enhanced attention toward social salient stimuli and an inadequate sensitivity in perceive emotion express by others. For example, theyresult more able than HC to detect low-intensity negative expression compared to Neutral faces; on the other side, the *Empathy Paradox* could also explain why they were less accurate to detect neutral stimuli, misinterpreting them as emotional (Meehan et al., 2017).

Bearing in mind that some studies showed no differences (Franzen et al., 2011; Robin et al., 2012; Schilling et al., 2012), other findings showed that the accuracy was decreased (Levine et al. 1997; Wagner and Linehan, 1999; Bland et al 2004; Unoka et al. 2011). In particular, the higher was the intensity the lower was the accuracy (Bland et al 2004; Levine et al., 1997; Minzenberg et al., 2007) and this effect was amplified in negative stimuli (Bland et al 2004), especially for rejection-related emotions such as anger and disgust (Daros et al. 2013; Mitchell et al. 2014).

These findings let us presume a lack of confidence regarding recognizing emotion of other people or Impaired Mentalizing (Lis et al, 2018), and it could be related to difficulties in emotion regulation in BPD patients, in which short-term affect regulation takes priority over other self-regulatory goals. In particular, this effect is seen when they are exposed to Negative emotions like anger, disgust and sadness which are the most salient stimuli for BPD patients. *Impaired Mentalizing* is close to the concept of *Frontolimbic impairment*, which seems to be the neurobiological substrate (e.g. Silbersweig etal. 2007).

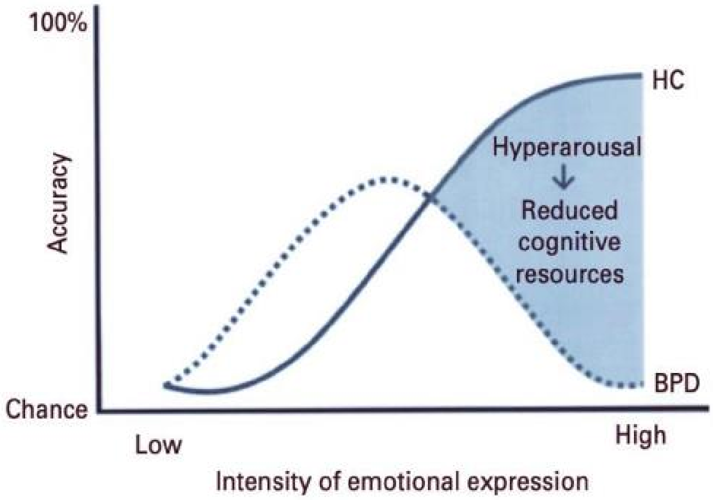

Figure 2*: model of facial emotion recognition in borderline personality disorder and healthy controls (Daros et al 2013)*

The hypersensitivity to negative interpersonal cues is the explanation to this apparent contradiction: it makes people experience a higher level of arousal lowering the threshold to detect negative emotions but, as the intensity increases, hyperarousal disrupts attention and the accuracy of emotion recognizing decreases (Daros et al 2013) **(Fig. 2)**.

Indeed, a part of literature support the threat hypersensitivity hypothesis, evidencing that BPD patients are highly vigilant to social stimuli, especially for social cues that signal social threat or rejection (Linehan, 1995), Mancke, Herpertz and Bertsch (2015) proposed that this threat hypersensitivity may be one of the main causes for interpersonal distress and aggression in BPD patients. They tend to over-attribute negative emotions to neutral faces (e.g., fear, untrustworthiness, disgust or anger): when exposed to neutral or ambiguous stimuli, patients, compared to healthy controls, evaluate others as being more negative, aggressive, or extreme, being more prone to social rejection, social threat cues and negative evaluation (Wagner & Linehan, 1999; Arntz and Veen, 2000; Domes et al, 2008; Dyck et al, 2008; Donegan et al, 2003; Guitart-Masip et al, 2009; Merkl et al., 2010; Arntz and ten Haaf, 2012; Robin et al., 2012; Sieswerda et al., 2005, 2013; Barnow et al., 2009, Miano et al., 2013; Renneberg et al., 2012; Baer at al. 2012; Schulze et al., 2013; Veague and Hooley, 2014). Meta-analytic findings indicate that patients with BPD have few difficulties identifying prototypic emotional facial expressions, but considerable problems recognizing neutral faces (Daros et al., 2013). The Empathy Paradox is therefore probably attributable to a Negativity Bias in social perception, in which information are heightened and distorted in a self-related and negative way.

Actually, accuracy depended on EC because high level of EC could buffer the negativity bias (Meehan et al. 2017; McRae & Gross 2020): the majority of facial emotion recognition distortions are seen precisely in tasks that require a high level of EC (e.g. fast facial emotion recognition [Dyck et al.2009]) that supports the idea of an impaired top-down control.
In fact, the earliest, automatic process of the positive-negative valence evaluation of facial expressions seems to be intact in BPD patients and they are equally sensitive when recognizing emotion (Domes et al., 2008; Hagenhoff et al.,2013). It is rather the subsequent differentiation of emotion, which needs a more extensive, effortful and controlledprocessing, that is impaired (Adolphs 2002; Ochsner & Gross, 2008; Grandjean & Scherer, 2008).
On the contrary, Meehan and collegues (2017), in the first study that tried to separately investigate detection and labelling, could not find that EC had a role to buffer the association between high borderline traits and emotion identification by labeling: their hypothesis is that EC may play a more important role in the "reflexive" phase instead of the "reflective", providing an adequate top-down control on bottom-up contingent responses (Meehan et al., 2017).
Also recognition of positive emotions has produced conflicting results: Bortolla and collegues' (2020) showed a negative bias in BPD patients' emotion recognition, enhanced for positive pictures, in line with previous studies supporting the hypothesis that BPD individuals misinterpret emotional cues, showing a negative bias in their evaluation especially when they deal with social cues (Fenske et al, 2015) and social-emotional context (Bortolla et al, 2019). This bias could support the negative and extreme views about others manifested by BPD patients, due to a cognitive style characterized by propensity to anticipate rejection and threat

in social situations and to react with negative emotions in response to positive content (Elices et al, 2012; Reichenberg er al, 2017), in line with the RS model.

1.3 Emotional body language

Emotional Body Language (EBL) is a relatively new line of research because previously, studies were focused on emotions conveyed by face but both, face and body, are important to correctly catch others' feelings and intentions (Calbi et al. 2017; Proverbio et al. 2014; de Gelder 2009; de Gelder et al. 2010) and even the recognition of EBL is found to be impaired in several conditions such as Autism Spectrum Disorder (Kruger et al, 2018) and Major Depressive Disorder (Kaletsch et al. 2014a).

When the face primarily expresses empathy, the body's physical actions can also provide important information about the agent's motor tendencies, potentially prompting action (de Gelder, 2009).

Body language cues become crucial in situations where the face is not easily discernible (referred by de Gelder, 200985 and de Gelder, de Borst, & Watson, 2015) or when there are no indications from the face or voice (Wallbott et al. 1998).

Actually, body postures and facial expression can influence each other recognition (Kret et al. 2013a): presenting compound stimuli made of angry-fear faces and body, when the two condition were different, the recognition was biased towards the emotion expressed by the body (Meeren et al. 2005).

In their study, Kaletsch and colleagues (2014b) examined the ability of individuals with BPD to recognize emotions conveyed through body language. They compared BPD patients to a control group using point-light displays, which consisted of recordings of a model's body movements represented by a few pieces of dots. These displays were presented as small dynamic videos. Surprisingly, the study did not find any differences in rating emotional valence between the two groups, contrary to the negativity bias theory. However, individuals with BPD appeared to have less confidence in evaluating ambiguous emotions but felt more confident in evaluating emotions that were clearly expressed.

1.4 Visual exploration of EBL in HC

Bodily postures are crucial to correctly grasp others' emotions and intentions (Calbi et al. 2017; Proverbio et al. 2014; de Gelder 2009; de Gelder et al. 2010). Albeit a growing body of literature about the processing of emotional body language (EBL) has appeared in the last years, very few studies focused on the pattern of eye movements implicated in the recognition of EBL.

The first study aimed at investigating the gaze pattern associated with the perception of EBL was carried out by Fridin and collegues (2009): the authors chose a range of bodily positions indicating varying emotions (joy, sadness, anger and fear) and they recorded eye movements while participants were exploring the body postures. They found that when perceiving anger or fear they mainly gazed at the hand and arms, whereas for happy body postures they focused on the head (Fridinet al., 2009).

A few years later, Kret and colleagues (2013b) published a study on the recognition of emotions from both faces and bodies, isolated or combined together as compound stimuli. Partecipants' eye movements were recorded while performing three different categorization tasks. Based on their results, the authors concluded that angry and fearful expressions attract more attention than happy expressions, suggesting a preferential way that allows to focus the attentional resources to potentially dangerous stimuli. The authors pointed out that it could be explainedby the motivated attention theory (Lang et al. 1997; Bradley et al. 2003) which considersemotion as organized by two old motivational systems (defensive and appetitive): angry andfearful expressions, characterized by a negative valence and a high arousal, are able to activate the defensive system, able to increase the activity in the visual cortex (Bradley et al.2003).

Moreover, the recognition of facial and bodily expressions was enhanced when they were emotionally congruent, demonstrating how they can exert a reciprocal influence, in both directions (Kret et al., 2013b).

Although developed to explore how socially anxious individuals attend to emotional stimuli, a recent study from Kret and collegues (2017) investigated the gazing patterns adopted while viewing different emotional bodily postures (fearful, angry or happy).

Specifically, participants were asked to label the bodily expressions (with blurred face) in a three- alternative forced choice task while their eye-movements were recorded. The analyses on theproportion of time spent looking at two specific regions of interest (hands and head) revealedalso that when looking at negative bodily postures, participants spent more time gazing at thehands than at the head, and this was particularly true in socially anxious people: it could be explained by the tendency of high socially anxious people to avoid eye contact and compensate paying more attention to hands.

Definitely, one important aspect is that hands and arms are important to recognize emotions (Witkower & Tracy, 2018; Cartmill et al., 2012; Dael et al., 2012; Wallbott, 1998, Goldin-Meadow 1999), but how far are hands important? Ross & Flack (2020) asked participants to categorize the emotion of static bodily postures (fearful, angry, happy and sad)with either the hands, arms or both components deleted, and they found that removing hands,but not arms, could decrease accuracy for fear and anger only. These results suggest the specific and crucial role that the hands have in the expression and recognition of threat-basedemotions, likely due to the strong hand motor component characterizing such emotions (Ross& Flack, 2020; de Gelder et al., 2004; Pichon et al., 2008).

Pollux and coworkers (Pollux et al. 2019) investigated whether gaze behavior would change if proposed stimuli (both with or without face) were static or dynamic. Their result showed that, despite subtle differences across emotions in the viewing behavior, participantsadopted the same strategy for both static and dynamic stimuli, by focusing their attention to the upper body (head, torso and arms). Surprisingly, they also revealed the presence of a *"stronger face bias in dynamic compared to static displays when faces were visible"*.

Trough the investigation of the body inversion effect [the reduced visual discrimination performance for inverted compared to upright bodies (e.g., Reed et al., 2003)], in whole and headless bodies, Arizpe and collegues (2017) demonstrated that, while looking at upright body postures, the density of fixations was higher on the head and torso (i.e., upper body), while looking at inverted ones, the density was higher on the pelvis area. In addition, although their results indicated the highly discriminative role of the head in the context of bodies visual processing, it clearly emerged that the head presence was not necessary to let the body inversion effect to realize. Bearing in mind that other authors reported the reduction or the extinction of the body inversion effect for headless bodies (Minnebusch et al., 2009; Brandman & Yovel, 2010; Yovel et al., 2010), further studies are needed to clarify this aspect.

This, together with the presence of a large body of literature which shows a rapid and tight integration of emotional signals from faces and bodies (e.g. Kret et al., 2013a; Meeren et al., 2005; Rajhans et al., 2016), led Calbi and colleagues (Calbi et al., 2020) to employ as stimuli only headless bodies, in order to investigate the eye-movements pattern strictly associated with emotional body postures and not influenced by the presence of the face/head.

The aim of their study was first to explore the modulation of EBL visual exploration mechanism while participants were judging the emotional intensity of body postures (headless angry, happy and neutral static body postures) but also to verify the presence of the "left gaze bias" (i.e., the tendency to look first, to make more fixations and to spend more looking time on the left side of centrally presented stimuli. E.g. Guo et al. 2009; Butler et al. 2005; Guo et al. 2012); the choice of anger as negative emotion was due to the purpose of specifically testing whether the left-gaze bias could be stronger when a potentially threateningaction is upcoming (see Marzoli et al. 2014).

The study consisted in the presentation of the experimental stimulus for two seconds always preceded by a fixation cross randomly presented to the left or right side to avoid a location-related bias of the first fixation (Tatler, 2007; Guo & Shaw, 2015). Participants were invited to visually explore the stimulus only with their eyes, keeping the head steel and to verbally answer the question "How would you judge the emotional intensity of the person?" on a VAS scale (0–100 = not at all intense–very intense), without time limits but as accuratelyas quickly as possible. At the end of the eye tracking recording session, participants were shown the stimuli again in a different randomized order and they were asked to rate the valence of the depicted body posture ("How would you judge the valence of the person?") on a VAS scale (0–100 = negative–positive) by using the mouse, without time limits but as accurately as quickly as possible.

To investigate whether there were a lateralization bias and a modulation of visual exploration patterns by the different emotional conditions, each image was divided into two identical and symmetrical left and right Areas of Interest (AOI) and it was measured the latency of the first fixation as well as the number of fixations directed to them.

Results on first fixation's latency showed the presence of a significant but nonspecific left-gaze bias because for all conditions, participants looked first at the left AOI and the latency of the first fixation was shorter for Angry than Neutral body postures but surprisingly, when they were looking at emotional body postures, especially for happy ones, they made less fixation on the left side.

Trough the evaluation of the heatmaps, the authors could focus on specific regions of interest: the Head's putative region (all the stimuli were headless) and both Hands. They found that, when considering gaze data directed at these specific bodily parts, emotional body postures attracted more fixation than Neutral ones, according to the hypothesis of a higher attentional engagement to emotional visual stimuli (e.g. Nummenmaa et al. 2006).

In addition, they found that gaze pattern was influenced by the affective valence of the emotion. First, when looking at Happy bodily postures, participants made more fixations to the Head's putative region; second, when looking at Angry and Neutral bodily postures, they made more fixation to the Hands; third, when participant were exploring Angry bodily postures, the Hands received a higher number of fixations than in the other two conditions. These observations were in line with the essential role of face and hands in recognition of emotions (e.g., Witkower & Tracy, 2018; Ross & Flack, 2020; Pichon et al., 2008; deGelder et al., 2004) and how affective valence can influence gaze patterns (Fridin et al., 2009; Kret et al., 2017; Pollux et al, 2019).

Taking into account the timing, it emerged that the latency of first fixations directed at the Left Hand was shorter than the latency of first fixations directed at both the Right-Hand and the Head's putative region, thus confirming the presence of a significative left-gaze bias. When they were looking at Happy bodily postures, participants made faster fixations to Head's putative region than to the Right-Hand, while when they were looking at Angry and Neutral bodily postures, they made faster fixations to both the Hands. Furthermore, participants made faster fixations to these latter AOIs when exploring Angry bodily postures than Neutral (only on the Right-Hand) or Happy bodily postures (on both the Hands).

In conclusion, the results of the study revealed significant modulation by the different emotional conditions, and they demonstrate for the first time the presence of a left-gaze bias during EBL processing.

Returning to the left-gaze bias, many studies about visually exploration of non-specific type of images found a leftward bias in the first phase of fixation (Dickinson and Intraub 2009; Foulsham 2013; Nuthmann and Matthias 2014; Ossandon et al. 2014; Hartmann, 2019). It may depend on the higher activity of the right hemisphere (Heilman and Van DenAbell 1980; Mesulam 1999), which dominance has been specifically proved in face processing, too (e.g. Rossion et al. 2003; Anes & Short, 2009).

In particular, the left hemisphere attributes salience predominantly to the right side of the events instead of the right hemisphere which attributes salience to both sides with a slightly contraversive bias. Each hemisphere has the tendency to shift attention toward the contralateral hemispace and the asymmetry is stronger for the left one but, since the right hemisphere has more neuronal resources dedicated to spatial attention, it is more likely to be engaged into attentional tasks (Mesulam 1999).

This phenomenon, also called "pseudoneglect" can be considered an asymmetrical distribution of attention (Jewell and McCourt 2000; Nicholls 2012). Interestingly, afterthe first moments, HCs tend to direct their attention to the right side, spending more time looking at the right side of the images.

Chiffi and collegues (2020) made participants freely observe naturalistic scenes of everyday life recording their eye movements and they found that after 1.5s from the onset of the stimulus, their gaze patterns shifted to the right side where they spent most of the time. In particular, the elder was the participant the weaker was the pseudoneglect (Chiffi et al., 2020; Jewell and McCourt 2000). This finding is consistent with previous study which found the same preference to shift attention to the right side after around 1.5 s from the onset (Hartmann et al.,2019) after an initial leftward bias: it has been proposed to be a compensatory mechanism to further explore regions previously ignored (Nuthmann et al., 2014).

Leonards & Scott-Samuel (2005) argued that the left-gaze bias could specifically take place for social relevant stimuli, and it is sustained by several studies which indicate that the higher is the emotional intensity of the stimulus or the task, the more evident is the polarization to the left part of an observed face (e.g., Mertens et al., 1993; Thompson et al., 2009).

Recently, Marzoli and collegues (2014) hypothesized that the left-gaze bias could be observed even also during bodies visual exploration, arguing that the attentional advantage of the left visual field could have an adaptive function from a communicative point of view: to direct the attention to the region where normally acts the dominant hand of the other.

In particular, to decode threat-based emotions from the body, the hands are the most informative elements because they contain strong motor information: likely through a visuo-motor resonance mechanism, participants specifically looked at the hands to catch that kind of information, essential to correctly understand and decode the emotion (e.g., Gallese, 2003; Gallese et al., 2004; Montgomery et al., 2007). It is also in line with the theory that whenwe look a scene, the brain creates a priority map based on the more salient stimuli. Recently, it has been identified a direct projection from the amygdala, a key structure for processing fearful and threatening visual information, to oculomotor system, which can modulate the direction of the gaze on the hands, the stimuli that in this context carry more emotional, and possibly dangerous, information (Gerbella et al., 2014).

On the contrary, the focus of the participants on the Head’s Putative Region when looking at Happy postures is in line with the tendency to look at the face and the eyes above all during positive and affiliative interactions (see Nikitin & Freund, 2019; Kret et al., 2017; McFarland et al., 2013).

1.5 Visual exploration of emotional stimuli in BPD

1.5.1 Facial Expression

Bertsch and collegues (2013) were the first to employ eye-tracking technique to investigate the visual exploration patters of emotional facial expression in BPD patients.

They presented emotional facial expression (angry, fearful, happy) for 150 ms and asked participants to classify the depicted emotion into the three categories. Results showed that BPD patients made faster fixation changes to the eyes than the mouth for threatening expressions.

Few years later, the same group of researchers (Bertsch et al. 2017) measured eye-movements while participants were shown emotional facial expressions (angry, fearful, happy and neutral) in two different conditions of presentation, brief (150 ms) and long (500 ms), to measure earlyreflexive saccade as measure of initial shifts in attention, and total fixations duration on the eye and mouth region, respectively.

Participants were asked to classify the depicted expression in a forces-choice task. Results showed that BPD patients and Healthy Controls differed only on the latency on the initial saccade: BPD patients made slower initial saccade away from the eyes of fearful faces and faster initial saccade away from the mouth of neutral faces.

Kaiser and collegues (2019) presented ambiguous facial expressions (angry/happiness, sadness/happiness, fear/happiness, anger/fear, anger/sadness and fear/sadness) with different levels of intensity. Eye-movements were recorded while participants were asked to classify the stimulus making a choice between two specific emotions. Stimuli were presented till participants' response. Results showed that BPD made longer fixations to the eyes of anger/happiness facial expressions than Healthy Controls, independently of the intensity.

1.6 Goals.

When talking about emotion recognition, the common mistake is to only consider the face. Despite the numerous studies conducted on emotion recognition through facial expressions, there are very few studies on emotional body language (EBL), and none specifically on EBL in individuals with Borderline Personality Disorder (BPD).

In order to provide a greater understanding of how body expressions are perceived, this research group aimed to investigate emotional body language in patients with BPD and compare it to healthy controls.

We measured the ability to detect emotions in body postures, using a detection task, and the ability to rate the emotional valence of body postures, using a valence-estimation task.

We hypothesized a peculiar visual exploration pattern of emotional body postures in BPD patients, which could reflect either subtle deficits in recognizing emotions or misinterpretations of neutral cues as negative.

We further hypothesize that alterations in visual attentional allocation underlie difficulties in reading social signals, with negative effects on interpersonal functioning.

2 MATERIALS AND METHODS

2.1 Participants

The sample includes 52 participants, 26 patients with Bordeline Personality Disorder (BPD) and 26 Healthy Controls (HC), homogeneous by age and gender.

Theis thesis should be considered as an interim analysis of an ongoing study, in which the final sample will be homogeneous by age and gender.

BPD patients were selected among people seeking treatment at the l'Unità Operativa Complessa Servizi Psichiatrici Ospedalieri a Direzione Universitaria of Parma; HC have been recruited through advertisement in meeting places of the local community and among the staff of the University Hospital, trying to match them for age and sex with patients.

The Local Ethical Authority approved the study protocol, which was conducted according to the Declaration of Helsinki (World Medical Association, 2013).

The study is still in progress.

The participants were not paid for their participation and accepted to enter the study as volunteers.

During the first appointment, the researchers explained the study project and assessed the subjects' interest in participating to the study and their ability to give a valid consent to the study.

Each subject was given the opportunity to read the consent form in the presence of a researcher who provided explanations of the consent form ad answered to all questions.

Participants gave written informed consent to participation and, after completion of the experiment, were extensively debriefed and given detailed information about the study and itspurposes, with the opportunity to have their data deleted should they wish so.

All consented subjects underwent a diagnostic screening to determine their eligibility for the study.

Inclusion criteria were:

- Age between 18 and 65 years old
- For BPD group: BPD diagnosis according to DSM-V criteria (APA, 2013), using the Structured Clinical Interview for DSM-5 Personality Disorders (SCID-5-PD) which is considered the Gold Standard for Personality Disorders.

Exclusion criteria were:

- Diagnosis of other active psychiatric conditions at the time of the observation such as Psychosis, Bipolar Disorder, Major Depressive Disorder or Substance Use Disorder assessed using the Structured Clinical Interview for DSM-5 Clinical Version (SCID-5-CV), which is considered the Gold Standard for Clinical Disorders.

Using regular medication didn't exclude BPD patients.

Problems that could interfere with the detection of eye movements were excluded for each participant.

2.2 Questionnaires

All the participants were asked to complete some Questionnaires:

- socio-demographical form: it includes anamnestic information about age, sex, education level, marital status and occupational status.
- Global Assessment of Functioning Scale (GAF/VGF): it is a numeric scale based on clinical judgement used to rate social, occupational and psychosocial functioning of adults (APA, 2000)[146]
- Symptom Checklist-90-Revised (SCL-90-R): it is a 90-item self-report symptom inventory developed to measure psychological symptoms and psychological distress. It is designed to be appropriate for use with individuals from the community, as well as individuals with either medical or psychiatric conditions. The SCL-90-R assesses psychological distress in terms of nine primary symptom dimensions and three

summary scores termed global scores. The principal symptom dimensions are labeled Somatization (SOM), Obsessive-Compulsive (OBS), Interpersonal Sensitivity (INT), Depression (DEP), Anxiety (ANX), Hostility (HOS), Phobic Anxiety (PHOB), Paranoid Ideation (PAR), and Psychoticism (PSY). The global measures are referred to as the Global Severity Index (GSI), the Positive Symptom Distress Index (PSDI), and the Positive Symptom Total (PST) (Derogatis. 1994)[147]

- Interpersonal Reactivity Index (IRI): it is a 28-items, multidimensional self-reported measure of empathy assessing the related but dissociable cognitive and affective components of empathic skills across four subscales: perspective taking, fantasy, empathic concern and personal distress (Davis, 1980)[43].
- Adult Rejection Sensitivity Questionnaire (ARSQ): operationalizes rejection sensitivity as generalized expectation and anxiety about whether significant others will meet one's need for acceptance or will be rejecting. The questionnaire presents respondents with 9 situations in which they must make a request to a significant other. They are asked whether they would be concerned or anxious about the response to their request (on a 6-point Likert scale, ranging from "very unconcerned" to "very concerned") and whether they would expect the other person to honor or reject the request (on a 6-point Likert scale ranging from "very unlikely" to "very likely") (Downey et al., 2006)[148].
- 19-item Effortful Control Scale (ECS) of the Adult Temperament Questionnaire (ATQ): it is a self-report questionnaire designed to assess temperament in adults >18 years. We only assessed the subscales which refer to Effortful Control, one of the ATQ Factors (EC, Extraversion, Negative Affect, Orienting Sensitivity), which may be calculated by computing the mean of the means of the subscales:
    - Attention Control;
    - Inhibitory Control;
    - Activation Control.

The ATQ uses a 5-point likert-type scale : 5= very true; 4= mostly true; 3= neither true nor false; 2= mostly false; 1= very false (Evans and Rothbart, 2007)[21].

2.3 Stimuli

Following Calbi et al. 2020, stimuli were emotional body postures taken from Bochum Emotional Stimulus Set (BESST; Thoma et al. 2013) and from Bodily Expressive Action Stimulus Test (BEAST; de Gelder & Van den Stock, 2011).

Stimuli represented negative (Anger), positive (Happiness), ambiguous (Surprised) and Neutral postures as control condition.

More specifically, among the whole sample of emotional body postures, they selected frontal bodies correctly recognized above 75% and whose expression was evaluated as natural (i.e. a score > 2.5 on a five-point Likert-type rating of the perceived naturalness. See Thoma et al. 2013).

Each selected stimulus was digitally manipulated to remove the head, as well as elements that could attract subjects' attention (e.g. watches, jewelry) and it was superimposed on a gray background (RGB: 128; 128; 128). Each stimulus had the same dimension of 827 x 827 pixelsand they were equiluminant without differences across the categories.

The final sample was composed by 40 gray-scaled stimuli, belonging to four different categories: 10 Angry (negative valence), 10 Happy (positive valence), 10 Surprised (ambiguous valence) and 10 Neutrals ("emotional" control).

2.4 Eye-tracking apparatus

Following Calbi et al. 2020, it was used a remote screen-based Tobii Pro System X3-120 eye-tracker to record eye movements at a sampling frequency of 120 Hz (Tobii 2016). Imageswere shown by means of Tobii Studio (3.4.5) on a 4K Ultra HD color LCD screen (28''; 39.3 cm x

65.7 cm) with a resolution downgraded to 1920 x 1080 pixels. The distance of 60 cm between the observer and the computer screen was the same for all trials, set using a chinrest. This distance was used to retain a constant depth of field, to reduce head movements and to ensure a fixed orientation (Duchowski 2007).

After the classification of raw data as fixations by means of the I-VT Filter implemented in Tobii Studio, several ocular parameters of interest were extracted by means of homemade scripts (R Core Team 2019).

In previous eye tracking studies, it clearly emerged that, although the stimuli were headless bodies, for Happy body postures the density of fixations was higher around the head's putative region (Head), whereas for both Neutral and Angry body postures it was higher around the Hands. Consequently, we drew three AOIs (i.e. Areas Of Interest: Head, Left Hand, and Right-Hand) of identical dimensions. In order to further explore the modulation of participant's visual exploration patterns by the four different experimental conditions, we evaluated the AOIs

Areas of Interest were defined through a kernel density estimation: the kernel bandwidth was set at 100 pixels, applied to each image across participants to create a density visual scale. In such a way we considered the variability of the actors' bodily postures.

Since the heatmaps provide a powerful visualization of an averaged spatial scan-path, but entirely lack any information regarding the time, we divided the fixations density of each AOI into 20 time slices (i.e., 100ms) to plot the fixations' frequency in each AOI over time.

In particular, latency and duration of first fixation were measured as an index of initial shift of attention towards salient regions of the stimulus during the detection task; proportional number/duration of fixations in each region of interest were measured as an index of higher-level visual processing related to the valence-estimation task.

2.5 Experimental procedure

The experiment was performed in a quiet room: the participant was invited to sit in front of the computer and to put the chin on the chinrest, trying to find a position as comfortable as possible. The correct eye position was checked using the eye-tracking apparatus.

After explaining the task, the light was turned off to permit the eye tracking apparatus to work. Before each task, the eye-tracking apparatus needed a calibration phase: the subject was invited to look at a red ball moving in 9 positions of the screen.

In addition to verbal instructions, before each task participants could read written instructions on the screen, too; moreover, short training test was given to better understand requests of the task.

A short break was allowed between the two experimental blocks.

2.5.1 Detection task

This task evaluates the ability of participants to detect emotional body postures (Anger, Happiness, Surprise) as compared to control (Neutral) ones.

At the beginning of this task, participant was instructed to press the two mouse buttons, one for each label (the right one for “non emotional” and the left one for “emotional” response). At the beginning of each trial, a black fixation cross on a gray background was displayed for200 milliseconds. The fixation cross was randomly presented on the right or left side of the screen, to avoid a location-related bias of the first fixation (Tatler, 2007[118]; Guo & Shaw, 2015[119]).

After the fixation cross one experimental stimulus was shown until a response or at least for two seconds. **(Fig.3)**

For each stimulus, participants were requested to indicate, as quickly and accurately as possible, if the body posture represents an emotion or not.

Each stimulus was randomly presented twice, for a total of 80 trials; this block lasted about 10 minutes.

Responses (emotional/non-emotional), reaction time and visual movements were recorded.

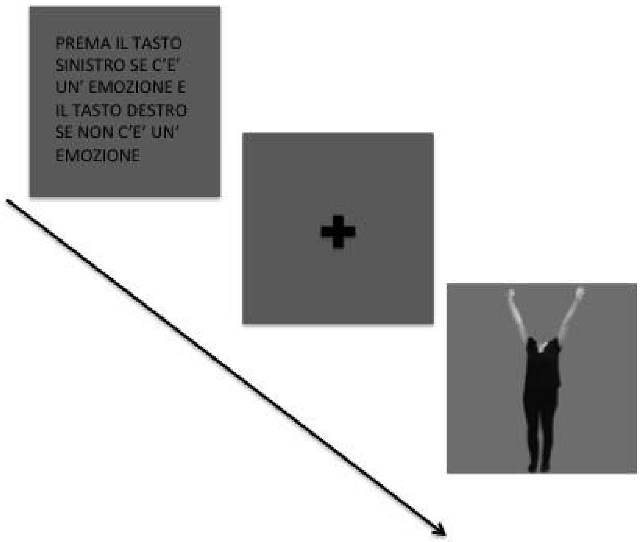

Figure 3: *Detection Task*

2.5.2 Valence estimation task

This task clarified the accuracy of recognition of valence of emotions, evaluating positive (Happiness), negative (Anger), ambiguous (Surprise) and Neutral body postures.

Before starting, participant was explained to visually explore the stimulus to rate the emotional valence of each posture on a scale ranging from -50 to 50.

At first, a black fixation cross on a gray background was displayed for 200 milliseconds. The fixation cross was randomly presented on the right or left side of the screen, to avoid a location-related bias of the first fixation (Tatler, 2007; Guo & Shaw, 2015).

After the fixation cross, one experimental stimulus was displayed for two seconds, and participant was asked to freely visually explore the image and then answer the question “How would you judge the emotional valence of the body expression?” on a Visual Analogue Scale ranging from -50 to 50, using negative numbers for negative emotions and positive numbers for positive emotions, each number of the scale could be used including 0 for neutral postures. Participants were asked to answer as accurately as quickly as possible within 5 seconds.

(Fig.4)

Each stimulus was randomly presented twice, for a total of 80 trials; this part of the experiment lasted about 10 minutes.

Ratings of emotional estimation and visual movements will be recorded.

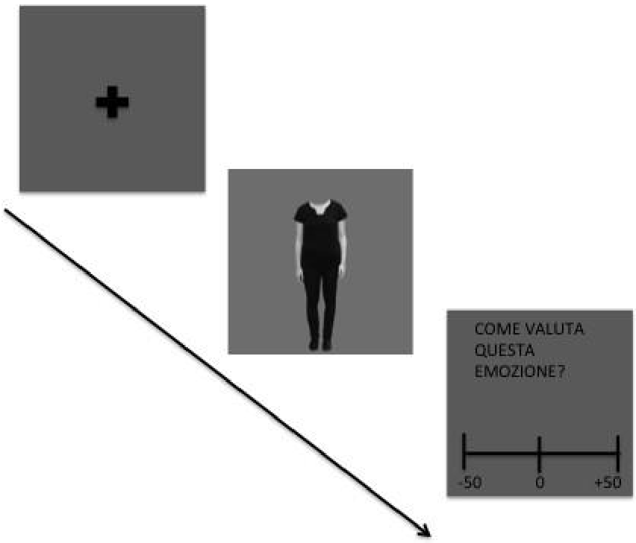

Figure 4: *Valence Estimation Task*

2.6 Statistical Analysis

2.6.1 The sample

Descriptive statistics were performed to detail the socio-demographic and clinical characteristics of the sample. HC and BPD groups were compared by means of Pearson's Chi-square tests relating to gender, marital status and occupational status; Student t tests between-groups were used to compare them in terms of age and years of education. Student t tests were planned to explore the groups' differences in psychometric assessment scores (VGF, SCL-90-R, IRI, ARSQ, Short form ATQ).

In order to better evaluate BPD patients visual exploration of the stimuli, we divided BPD Group into High traits and Low traits, using median value of SCID-5-PD dimensional scores (dimensional score < 13: Low BPD traits; dimensional score >13: High BPD traits).

2.6.2 Detection Task

2.6.2.1. Behavioral analysis

In this task the participants were asked to evaluate two types of stimuli (Emotional or Non-emotional postures), with two possible subjective responses ("There is an emotion" or "There isn't an emotion"). The different responses to emotional/non emotional stimuli in each Group (HC, BPD) were analyzed by means of Pearson's Chi-squared test, obtaining a Stimulus X Response contingency table.

The different combinations stimulus-response shaped four possible outcomes: "Hit", which refers to an emotional posture correctly detected as emotional; "HitMiss", an emotional posture which has not been detected and mistakenly perceived as non-emotional; "CorrectRejection", a non-emotional posture recognized as neutral; "FalseAlarm", a non-emotional posture wrongly detected as emotional.

For each parameter, the model was obtained by means of a hierarchical approach.

Between-group differences in the ability to detect emotions were examined using a linear mixed effects analysis entering the Count of outcomes ("Hit", "HitMiss", "CorrectRejection", "FalseAlarm") as dependent variable and Group (HC vs. BPD) as between-subjects factor. Tukey's test was used for post-hoc comparisons among means.

Moreover, a linear mixed effects analysis was used entering Reaction times as dependent variable, the different combinations stimulus-response (Outcomes - 4 levels: "Hit", "HitMiss", "CorrectRejection", "FalseAlarm") as independent variable and Group (HC, BPD) as between-subjects factor. We entered by participants intercept for the effect of Outcome as random effect. Tukey's test was used for post-hoc comparisons among means.

2.6.2.1 Eye data analysis

The latency of the first fixation, as well as the first fixation duration, directed at each AOI, were analyzed by means of a linear mixed effects analysis. For each parameter, the model was obtained by means of a hierarchical approach. We started with a simple model and added parameters if their inclusion improved model fit.

In order to investigate any temporal difference among conditions, using a linear mixed effects analysis, we entered the Latency of first fixations in each AOI as dependent variable, AOI (3 levels: Head, Left-Hand and Right Hand) and Condition (2 levels: Emotion, Neutral) as independent variables, and Group (HC vs. BPD) as between-subjects factor. We entered by participants intercept for both the effect of AOI, Condition and Group as random effects.

t-test was used for post-hoc comparisons among means.

Then we entered visual parameter First fixation duration in each AOI as dependent variable, considering AOI (3 levels: Head, Left Hand, Right Hand) and Condition (2 levels: Emotion, Neutral) as independent fixed variables; Group (HC vs. BPD) was considered as between subjects factor. We entered by participants intercept for the effect of AOI, Condition and Group as random effects. t-test was used for post-hoc comparisons among means.

2.6.3 Valence-estimation Task

2.6.3.1 Behavioural analysis

For this task we performed a linear mixed effects analysis entering valence estimation scores (from -50 to +50) as dependent variable, to examine how the perceived estimation of an emotion as negative or positive was influenced by the experimental condition (Conditions: Anger, Happiness, Neutral, Surprise) and by the diagnosis (Group: HC vs BPD). For each parameter, the model was obtained by means of a hierarchical approach. t test was used for post-hoc comparisons among means.

2.6.3.2 Eye data analysis

The number of fixations directed at each AOI was analyzed by means of a linear mixed effects analysis. We entered the number of fixations at each AOI as dependent variable, and AOI (Head, Right Hand, Left Hand) and Condition (Happiness, Anger, Surprise, Neutral) as independent fixed variables; Group (HC vs. BPD) was included as between-subjects factor. T test was used for post-hoc comparisons among means.

All the analyses were carried out using R (R Core Team 2019) and lme4 (Bates et al. 2014[152]), ez (Lawrence 2013) and lsmeans (Lenth 2016). For data visualization we used ggplot2 (Wickham 2016).

3. RESULTS

3.1 Sample

The sample includes 52 participants, 26 patients with Bordeline Personality Disorder (BPD) and 26 Healthy Controls (HC), homogeneous by age and gender.

This thesis should be considered as an interim analysis of an ongoing study, in which the final sample will be homogeneous by age and gender.

Socio-demographic characteristics of the reduced sample are shown in the **Table 1**; clinical characteristics are shown in the **Table 2**.

	BPD (N. 26)	**HC (N. 26)**		
AGE	31,8 ± 13,2	31,5 ± 10,1	t = ,11	p = 0,916
YEARS OF EDUCATION	13,5 ± 3,5	16,3 ± 2,1	t = 3,47	p = 0,001
SEX				
F	24 (92,3%)	24 (92,3%)		
M	2 (7,7%)	2 (7,7%)		
			$\chi^2_{(1)}$= ,000	p = 1
FAMILY STATUS				
SINGLE	16 (61,5%)	19 (73%)		
DIVORCED	5 (19,2%)	0 (0,0%)		
MARRIED/COHABITING	5 (19,2%)	7 (27%)		
			$\chi^2_{(2)}$= 5,59	p = 0,061
OCCUPATION				
STUDENT	9 (34,6%)	10 (38,5%)		
FULL TIME	7 (26,9%)	15 (57,7%)		
PART TIME	5 (19,2%)	1 (3,8%)		
UNEMPLOYED	4 (15,4%)	0 (0,0%)		
PENSIONER	1 (3,8%)	0 (0,0%)		
			$\chi^2_{(4)}$ = 10,6	p = 0,031

Table 1. *Socio-demographic characteristics of the sample*

	BPD (N.26)	*HC (N.26)*	*T*	*Sign.*
VGF	63,58 ± 14,7	100,00 ± 0	12,6	*P=0,00*
RSanxexp	11 ± 5	9 ± 3,1	-1,7	*p* = ,088
RSangryexp	7,3 ± 4,6	5,6 ± 2,2	-1,7	*p* =,089
Ec_total	3,9 ± 1,1	4,6 ± 0,6	2,9	*p* =,005
SCL_total	25,1 ±9,9	15,4 ± 6	-4,1	*p* =,000
IRIPT	22,8 ± 5,5	26,2 ± 4,7	2,4	*p* = ,002
IRIFS	23 ± 5,7	22,7 ± 4,5	-0,2	*p* = ,851
IRIEC	26,2 ± 3,2	27,7 ± 3,1	1,7	*p* = ,098
IRIPD	20,8 ± 6,6	18 ± 4,2	-1,8	*p* = ,081

Table 2. *Clinical characteristics of the sample*

3.2 Behavioral results

3.2.1 Detection Task

We found a significant effect of the condition (*Condition*: F=52.9, p<0.01) indicating that all the participants gave a greater number of correct for both emotional and neutral stimuli responses (Hit= 15.41 ± 1.05; Correct Rejection= 17.96 ± 1.03) as compared to wrong responses (Miss= 5.03 ± 1.07; False alarm= 5.10±1.65) (p_s <.001). Both HC and BPD group did not revealed differences in the accuracy of distinguish emotional body postures (which included Happiness, Anger and Surprise stimuli) to non-emotional ones (Neutral stimuli) (*Group*: F=3.30, p=.07 ns; *Group by Condition* interaction F = 1.41, *p*=.24 ns).

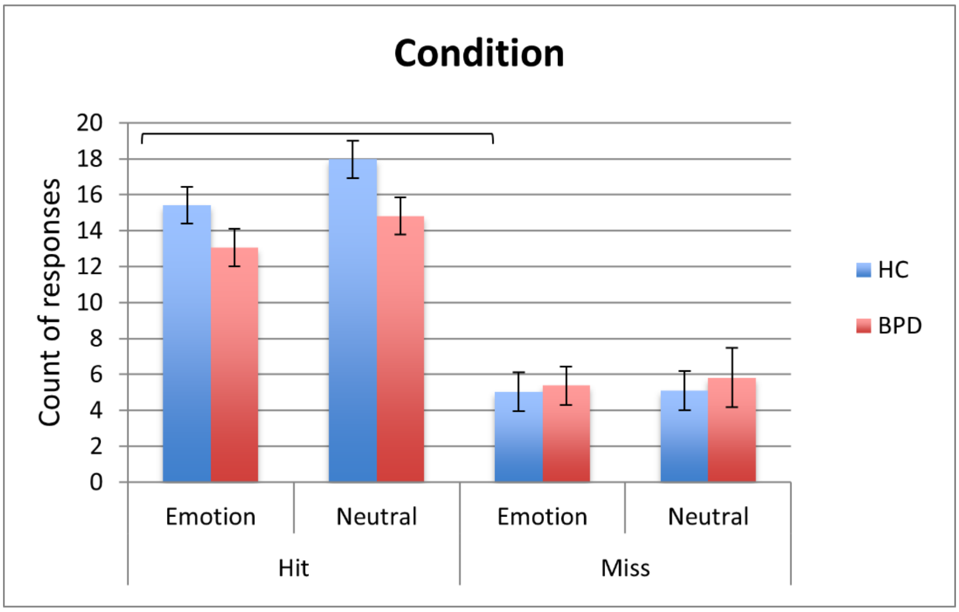

Figure 5*: Detection task: Accuracy*

Considering the Reaction Times (RT) we observed a significant *Group by Condition* interaction (*F* = 36.79, *p*<.001), showing that HC were faster than BPD patients when they correctly identified emotional stimuli as emotional (Hit condition: HC= 981 ±81.9 msec, BPD=1109±32.1 msec; p=.004).

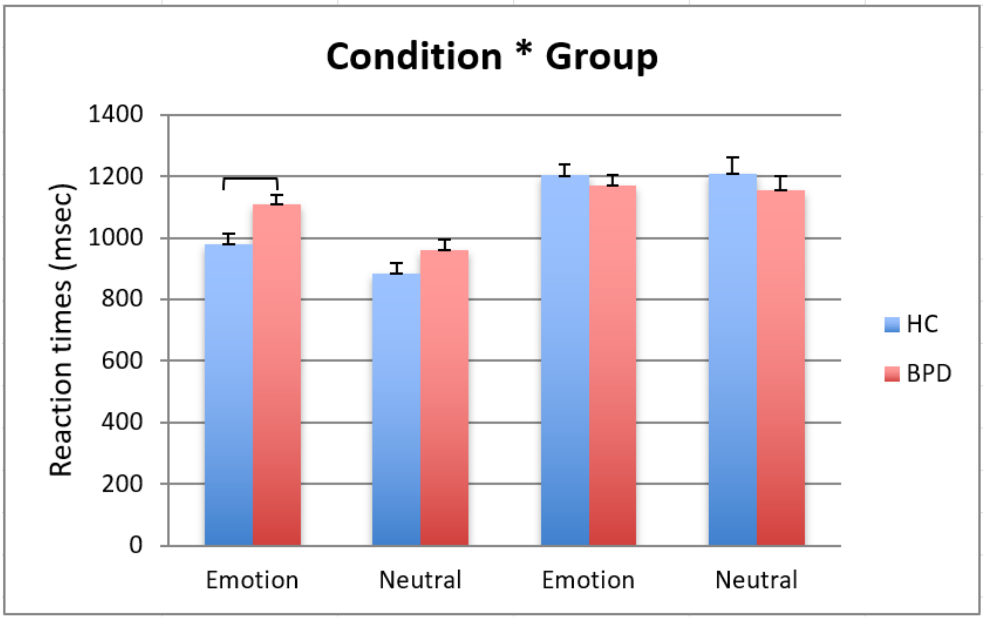

Figure 8*: Detection task: Reaction times*

3.2.2 Valence-Estimation Task

The model revealed a main effect of Condition ($F(3)=1830.98$, $p<.0001$).

In addition, in the Valence task the significant Condition by Group interaction revealed that HC and BPD answered with different valence ratings to different types of stimuli ($F(3)=74.32$; $p<.0001$).

Particularly, the post-hoc tests showed that HC evaluated Anger body postures with more negative ratings than BPD (HC: M=-20.91±1.73; BPD: M=-11.38±1.73; $t = -9.52$, $p<.001$). By contrasts, patients with BPD judged Neutral stimuli with more negative ratings than HC at the tendency level of statistical significance (HC:M=0.34±1.73; BPD: M=-3.95±1.73; $t =4.29$, $p=.07$). **(Fig.6)**

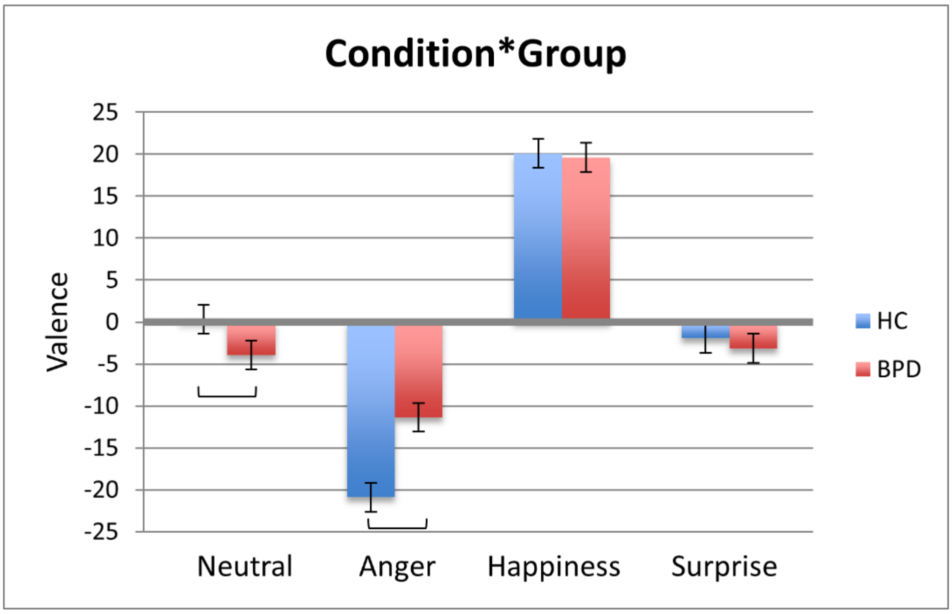

Figure 6: *Valence-estimation task: BPD vs HCs*

3.3 Eye-tracking Results

3.3.1 Detection Task

3.3.1.1 Latency of first fixation

Considering the Latency of First fixation of the AOIs (Head, Right Hand, Left Hand) during the evaluation of the different stimuli (Emotional, Neutral) in Detection task, the model revealed a main effect of *AOI* ($F(2) = 238.94$, $p < .0001$), a significant *AOI by Condition* interaction ($F(2) = 142.86$, $p < .0001$), a significant *AOI by Group* interaction ($F(2) = 8.63$, $p = .05$) and a significant interaction *AOI by Condition by Group* ($F(2) = 7.89$; $p=.05$).

Specifically, we found that in the neutral Condition HC (620±27.5 *CIs = [566, 674])* showed a lower latency of first fixation to the Left Hand AOI than BPD patients (749 msec *CIs* = [689, 809]), indicating that they had a faster gaze at the Left Hand in response to Neutral body postures ($t=-129.3$, $p<.01$).

These results could suggest that HC correctly concentrated on the main attentional cue, which is Left Hand, therefore they could rapidly discriminate Neutral stimuli, as demonstrated by higher speed in First Fixation at Detection task. This can be considered as greater accuracy related to the implicit part of attention, as opposite to BPD patients, who showed slower exploration of Neutral body postures. **(Fig.7)**

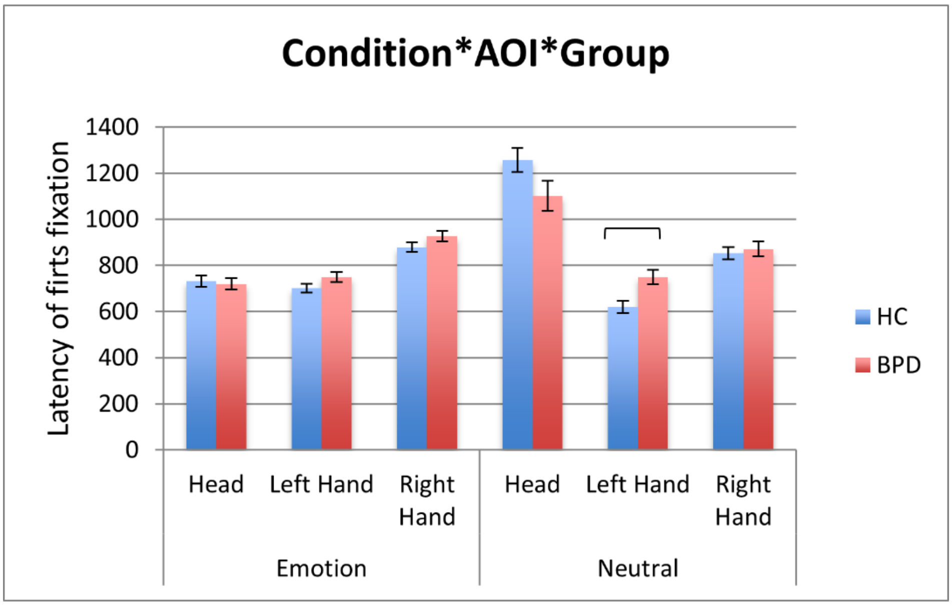

Figure 7: *Eye-tracking results: latency of the first fixation BPD vs HCs*

3.3.1.2 Duration of first fixation

Evaluating the duration of first fixation we found a significant Condition by Group effect (F(1) = 3.40; p=0.05), without a Condition*Group*AOI interaction (F=0.46, p=0.79 ns).

In particular, at tendency level of statistical significance (p=.09) BPD patients directed their gaze at Neutral stimuli (M=348 msec, CIs=[309, 388]) for a longer time than Emotional ones (M=292 msec, CIs=[260, 324]), irrespective of the AOIs, as compared to HC. Possibly, these results could be connected with the impaired Neutral stimuli recognition in BPD, that involves a longer phaseof exploration of these body postures, as compared to emotional ones. **(Fig.11)**

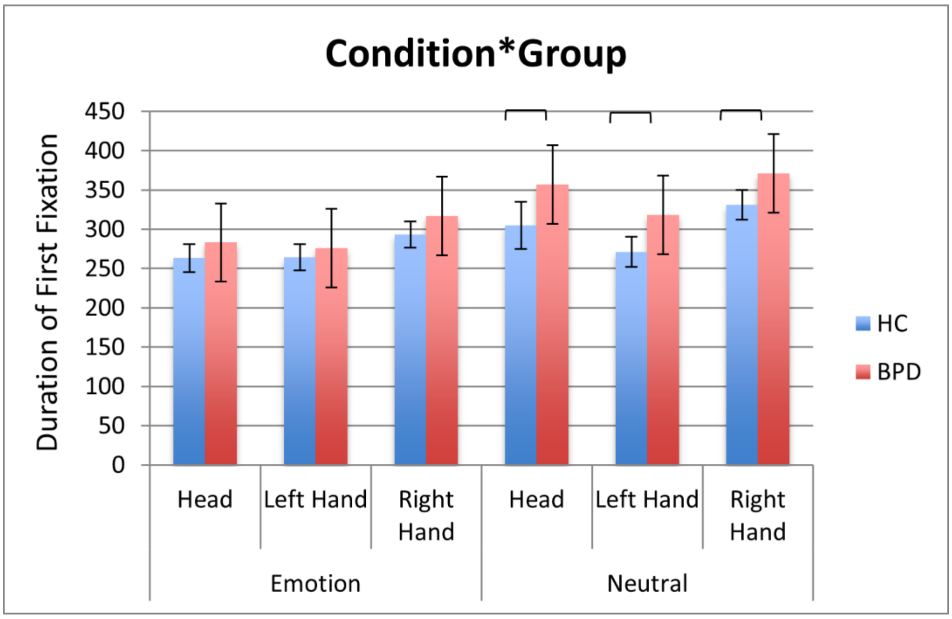

Figure 8: *Eye-tracking results: duration of the first fixation BPD vs HCs*

3.3.2 Eye-tracking Results

3.3.2.1 Number of fixations

The significant AOI by Group interaction revealed that HC and BPD patients directed a different number of fixations to the different AOIs ($F(2)=25.26$, $p<0.01$). The pattern of visual exploration depends on the valence of the postures, with greater number of fixations to the head in Happy posture and greater fixation to the Hands in angry, ambiguous and neutral posture. The hands and specifically the left hand received the greater number of fixations in anger conditions. **(Fig.9)**

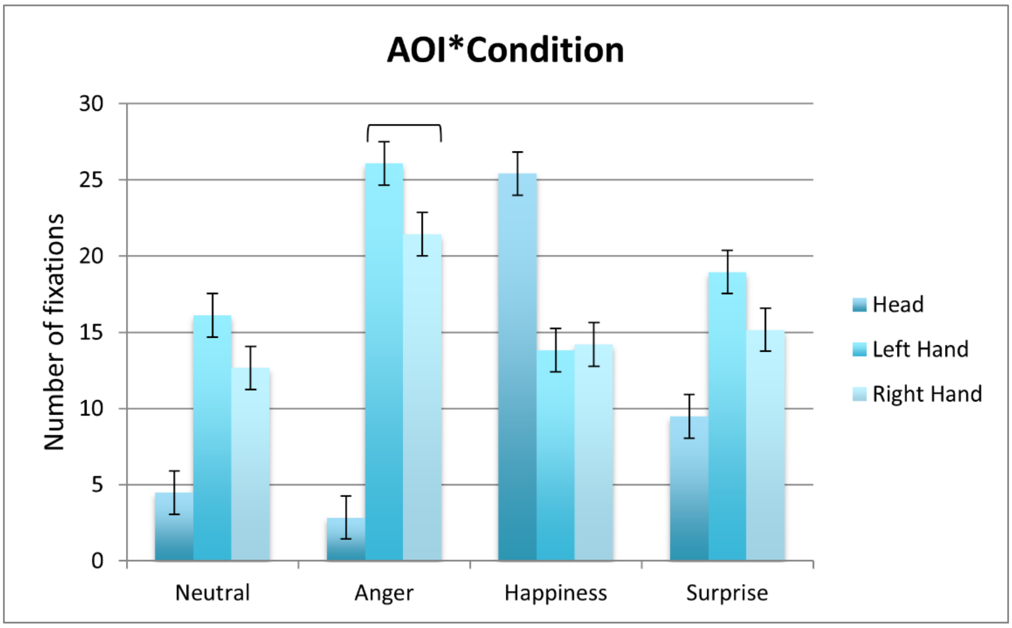

Figure 9: *Eye-tracking results: number of the fixation BPD vs HCs*

Considering the group differences, we found that patients with BPD displayed a significant avoidance of exploration of the hands We know that hands play a crucial role in conveying emotional information, and BDP patients are less accurate in seeking emotional information by paying less attention to them.

Specifically, HC directed their gaze more frequently to the Right Hand AOI (HC: M=19.9, CIs= [17.38, 22.3]; BPD: M=11.9, CIs=[9.38, 14.3]; t=8, p <.0001), as compared to BPD patients, with a tendency also for the Left Hand AOI (HC: M=21.7, CIs= [19.24, 24.2]; BPD: M=15.7, CIs=[13.26, 18.2]; t=5.98, p=.001). **(Fig.10)**

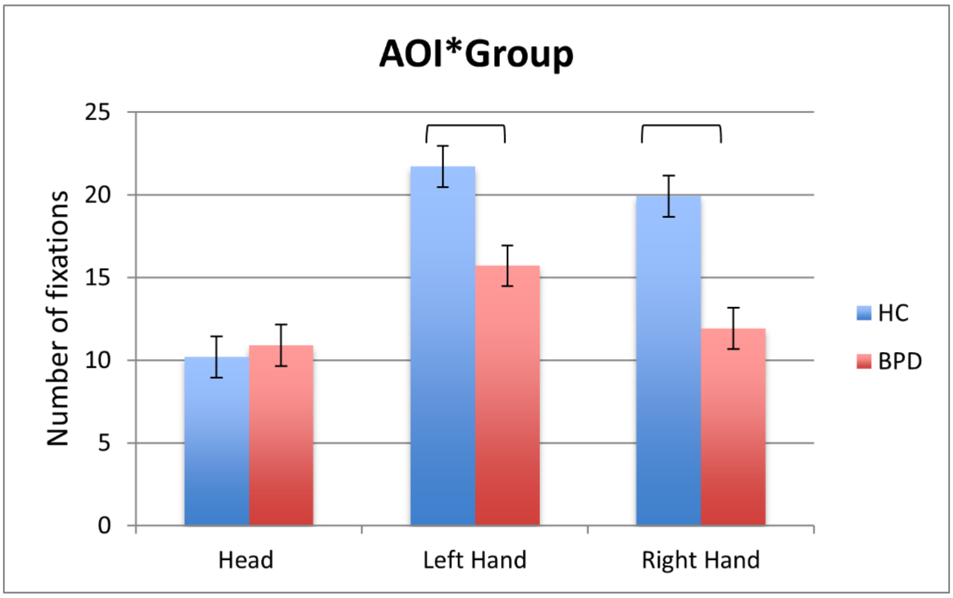

Figure 10: *Eye-tracking results: number of the fixation BPD vs HCs*

4. DISCUSSION

The present study aims to evaluate the ability to recognize emotions conveyed by body postures, considering that the human bodies are essential to correctly comprehend others' emotions and intentions; it investigates the characteristics of EBL visual perception, comparing a group of HCs with a group of patients diagnosed with BPD.
Specifically, we are interested in exploring the differences in the abilities of the participants in detecting and labelling the emotional and non-emotional stimuli and their gaze exploration patterns on EBL.

Until now, we have only acquired the data regarding the control group and part of the BPD group, which will be extended.

Three main findings emerged. First, BPD patients and HC did not differ in the accuracy of recognizing emotional or neutral stimuli, even though HC responded more quickly when they correctly identified both emotional and neutral postures as compared to BPD patients.
Second, in the Valence-estimation task, BPD patients subjectively rated the neutral postures as more negative and angry postures as less negative than HC.
Third, considering the eye-tracking results, BPD patients showed a different visual exploration pattern of body postures as compared with HC, suggesting potential difficulties in focusing attention to salient cues of the stimuli.

The behavioral results of the Detection Task showed that both patients and HC identified with greater accuracy Emotional stimuli compared with Neutral ones, without significant differences between the two groups, according to previous findings of a preserved accuracy in emotion recognition in BPD patients, especially as regards the detection phase (Franzen et al., 2011; Robin et al., 2012; Schilling et al., 2012).

Considering the Reaction Times, instead of a preserved accuracy, BPD patients are slower than HC either when they recognize emotional stimulus as emotional (i.e. Hit condition) and Neutral stimulus as non-emotional (i.e. Correct Rejection condition). It can be interpreted as a major BPD patients' effort when they are asked to correctly recognize if an emotion is expressed or not in all types of body postures, suggesting that they may require additional time to process any social information, whether emotional or not. This is consistent with the decreasing of detection accuracy as much as rapidly patients are asked to discriminate facial expressions (Dyck et al. 2009).

Detection represents a "reflexive" phase of emotion recognition that provides an automatic, fast response to social cues and it requires to be processed by amygdala and ventral striatum; it seems to be intact in BPD patients and they are equally sensitive when recognizing emotion (Domes et al., 2008; Hagenhoff et al.,2013). Hagenhoff et al. evidenced the difference between the face-in-the-crowd task, that requires an implicit appraisal, in which BPD patients were accurate as HC, while in emotion labeling task, that demands explicit processing, they showed a different performance from HC. In the task in which schematic faces were presented as in our detection task, no alterations in the processing of emotional faces were observed in BPD. When the faces were presented individually, emotion labeling was slower, indicating differences in the cognitive processes involved in both tasks, so further analysis of these differences might contribute to better understand emotion processing alterations in BPD patients.

As concerned to Valence ratings, BPD patients subjectively rated the neutral postures as more negative than HC, according to the Negativity Bias (Baer et al 2012; Wagner & Linehan, 1999; Arntz & Veen, 2001; Domes et al. 2008; Miano et al. 2013; Dyck et al. 2009; Merkl et al, 2010; Schulze et al, 2013; Veague and Hooley, 2014; Fenske et al. 2015;

Meehan et al., 2017). It highlights that the oversensitivity to negative stimulus, due to an orientation to focus attention on negative experiences and memories, makes them prone to misinterpret neutral signals in a negative way.

Several studies, in support of Negativity bias, demonstrated that BPD patients tend to over-attribute negative emotions to neutral stimuli (Daros et al., 2014; Fenske et al., 2015) and misinterpret such signals as untrustworthy and consequently avoiding them (Fertuck et al., 2013; Miano et al., 2013). Bortolla and collegues' data confirmed the presence of a negative bias in BPD patients' evaluation of social cues (Fenske et al., 2015; Scott, Levy, Adams, & Stevenson, 2011) in social-emotional contexts (Bortolla et al., 2019). This biasseems to relate to a cognitive style characterized by the propensity to anticipate rejection and threat in social situations (Domes et al., 2008; Miano, Fertuck, Arntz, & Stanley, 2013).

Furthermore, BPD patients evaluated Anger body postures with less negative ratings than HC; this may be due to the hostile growth environment and to the high intensity negative emotions and feelings of anger they have experienced that could have potentially raised their emotion intensity threshold, so that they perceive negative emotions as less intense, compared to HC. People diagnosed with BPD tendto experience intense emotional responses, easily triggered and a slower return to emotional baseline (Perez-Rodriguez et al., 2018).

Other previous studies demonstrated that patients with BPD may be less accurate than HC in their recognition of negative facial emotions when displayed at full intensity, including anger, fear, disgust and sadness (Levine et al., 1997; Bland et al., 2004; Dyck et al., 2009; Unoka et al., 2011). The model proposed by Daros and colleagues (2013) accounted for the enhanced recognition of emotions in faces seen at lower levels of intensity, where higher arousal serves to enhance the recognition of emotions in faces for patients with BPD, in contrast to poorer recognition observed at higher levels of intensity (Lynch et al., 2006; Domes et al., 2008).

When viewing faces displaying high levels of emotional intensity, patients with BPD are thought to experience hyperarousal to the extent that the cognitive resources required to disengage attention from highly salient emotional stimuli are progressively depleted. This circumstance interferes with their perception of the emotion displayed in each given face, and therefore reduces accuracy in recognizing these emotions (Levine et al., 1997; Unoka et al., 2011). At higher levels of intensity, individuals with BPD may have difficulties disengaging their attention from these highly salient stimuli, whichmay interfere with the cognitive processes required to accurately identify this emotion.

Despite not reaching a full statystical significacy in our study, BPD patients's Duration of First fixation in neutral stimuli has shown a trend that's coherent to this model.

Considering the eye-tracking results, this preliminary study indicated that BPD patientsshowed a different visual exploration pattern of body postures as compared with HC.

Eye-tracking results of the Detection Task showed, for BPD patients, a general higher effortinvolved in interpreting Neutral stimuli.

The Latency of the First Fixation represents the time between the onset of the stimulus and the participants' First Fixation at the areas of interest, expressing how rapidly attention is caught. Comparing the Latency of the First Fixation between Neutral and Anger stimuli, it emerged that the visual exploration pattern was the same in the two Groups: Anger and Neutral stimulus were explored starting from the Left Hand, followed by the Right Hand andthen the Head's putative region. These results are consistent with the evidence that human body aren't explore casually but the emotion they express influences the gaze pattern. In particular, when the stimulus is negative, exploration starts from the Hands (Fridin et al,.

2009). Specifically, according to Calbi and collegues (2020), it starts from the Left Hand.The same pattern is reproduced in Neutral stimuli.

In particular, the attentional cue is represented by the Left Hand because of the combinationof two important theories. First is represented by the significance of Hands which are necessary to recognize particularly Negative emotions, such as fear and anger (Ross & Flack, 2020) and contain motor information which are essential to decode others' intentions (Gallese, 2003; Gallese et al., 2004; Montgomery et al., 2007); second, the presence ofa Left-Gaze Bias which is in the involuntary tendency to look first and longer at the left side of faces (Guo et al. 2009; Butler et al. 2005; Guo et al. 2012) and bodies (Calbi et al., 2020). This tendency may be explained by the presence of relevant stimuli (Leonards & Scott-Samuel, 2005), which in this case is represented by the dominant hand of the other (Marzoli et al., 2014).

In comparison with HC, BPD patients displayed a longer latency of first fixation to the Left Hand of Neutral body postures, indicating that they were slower than HC in directing reflexive eye movements to salient cues of neutral stimuli that could have a crucial role in the recognition of threat-based emotions, suggesting potential difficulties in focusing the involuntary attention on salient regions typically useful to discriminate threatening signals.

These results could suggest that HCs quickly concentrate their attention on the main attentional cue in order to discriminate any threatening stimuli, excluding the aggressive component of the stimulus first and then rapidly explore other areas, whereas BPD patients are slower in directing their gaze to salient regions to evaluate the presence or absence of emotion.

In support of these remarks, previous studies demonstrated a preferential way which allows to focus the attention on potentially dangerous stimuli because of the motivated attention theory (Lang et al. 1997; Bradley et al. 2003; Kret et al,. 2013b).

Moreover, in the detection task, in BPD patients the duration of the first fixation was longer for neutral stimuli, irrespective of the body's region, as compared with HC. Therefore, Neutral stimuli in general seem to be more attention-grabbing for BPD patients, suggesting that once the attention is directed to neutral stimuli the focus of attention is captured for longer time. These findings can be explained with a probable difficulty in shifting the attention to other cues of the stimuli, probably also because of the ambiguousness of neutral body postures.

In the Valence-estimation task, irrespective of the valence of the body postures, BPD patients displayed a lower number of fixations on hands as compared with HC, showing a low level of interest on hands of all the postures. Hands play a crucial role in conveying emotional information (Niimi 2020), and BDP patients are less accurate in seeking emotional information by paying less attention to them. In support of these results, previous studies affirmed that in the context oftheir emotional dysregulation, patients with BPD show deficits in attentional control, with an impact of oscillations from emotional baseline on attentional processes. Particularly, patients with BPD probably show problems in disengaging attention from salient stimuli because of their deficits in emotional regulation (Linehan MM, 1993; Ceumern-Lindenstjerna, 2009).

These results are limited because are partial analysis of an ongoing study. Probably, increasing the number of participants and comparing BPD patients with a clinical control group (i.e. C cluster Personality Disorder patients) we will add some information on these themes.

5. CONCLUSIONS

This preliminary study indicated that BPD patients showed a different visual exploration pattern of body postures as compared with HC.

Patients with BPD were slower than HC in directing reflexive eye movements to salient cues of neutral stimuli that could have a crucial role in the recognition of threat-based emotions, suggesting potential difficulties in focusing the involuntary attention on salient regions normally useful to discriminate threatening signals.

Moreover, in the detection task, neutral stimuli in general seem to be more attention-grabbing for BPD patients as compared to HC, suggesting that once the attention is directed to neutral stimuli the focus of attention is captured for longer time.

In addiction, in the valence estimation phase of the emotion recognition process, patients with BPD confirmed their tendency to misinterpret neutral cues as more negative (Negativity bias) and they showed a low level of interest (i.e. lower number of fixations) on hands of all the postures. This could lead to speculate that the biased later stages of emotional information processing in BPD patients might be related with difficulties in focusing visual attention on important source of emotional information, essential for understanding behaviors and intentions.

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