Emotion recognition at different intensities in borderline personality disorder patients compared to healthy controls

Thesis Neuropsychology

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Abstract

Borderline personality disorder is characterized by emotional dysregulation and underlying deficiencies in emotion recognition. This study investigated whether patients are more accurate in recognizing emotions that signify a social threat at low intensities of expression and whether they are less accurate in the recognition of these emotions at high intensities, compared to healthy controls. It was also investigated whether patients have a normalized recognition of these emotions after treatment for emotional dysregulation. 17 patients completed the emotion recognition task and the already existing data of 31 healthy controls were used. Two 2 x 2 x 2 ANOVAs were conducted to test the hypotheses. Contrary to the hypothesis, results indicated that patients were not more accurate in the recognition at low intensities and not less accurate at high intensities in comparison with the controls. An interaction effect suggests that patients, compared to controls, would rather be less accurate at low intensities and more accurate at high intensities. After treatment, patients did show improvements at low intensities, but they were evenly accurate at high intensities, compared to before. After treatment, patients have a more normalized recognition of anger and fear. These outcomes have an important implication for the treatment of BPD, because they provide tools to understand the underlying mechanisms in the pathology and treatment. Further research is needed to better understand the effects of BPD and BPD treatment on the emotion recognition.

Keywords: borderline, emotional dysregulation, arousal, emotion recognition task, treatment

Borderline personality disorder (BPD) is a common mental disorder with a prevalence between 1.6% and 5.9% in the general population. Characteristics of the disorder are instabilities in affect, interpersonal relationships, self-image and high impulsivity (American Psychiatric Association, 2013). The instability in affect, also referred to as emotional dysregulation (Conklin, Bradley & Westen, 2006), can be considered as the core component of BPD. Emotional dysregulation is defined as the inability to control one's emotions. In BPD, this is reflected by a higher sensitivity to emotional cues, a higher intensity in the experience of emotions and a slower return to the emotional baseline when an emotion is experienced (Linehan, 1993 in Conklin et al., 2006). It appears that the emotional dysregulation is caused by a combination of biological vulnerability and an invalidating rearing environment. The latter factor is also responsible for not learning adequate strategies that can regulate the intense emotional reactions patients experience. As a consequence, patients tend to make use of impulsive short-term strategies to regulate their unpleasant intense emotions. Often, and most worrisome, it is self-injury that patients apply to reduce their experienced emotional arousal (Chapman, Specht & Cellucci, 2005). At present, there is little consensus about the mechanisms of the emotional dysregulation in BPD. In order to being able to offer the best help to patients, this needs to be better understood.

Elaborating on the underlying process of emotional dysregulation, Carpenter and Trull (2013) discussed a model based on Linehan's (1993 in Conklin et al., 2006) biosocial theory. Their model states that emotional dysregulation consists of a process of four components resulting from each other. The first component in the model is a high emotional sensitivity, which means that one is more sensitive to emotional information. This directly causes the second component, which is heightened and labile negative affect when one is experiencing a negative emotional expression of another person. That is, when confronted with a negative emotion, one will experience more negative and more unstable affect. This results in the third component,

consisting of both a difficulty in learning to adequately use appropriate regulation strategies and an increase in the use of maladaptive regulation strategies. In other words, one is less capable of using the right emotion regulation strategy and, at the same time, uses more strategies that are dysfunctional to regulate affect. These processes also affect each other and lead to the last component, which is emotional dysregulation itself. This in turn results in a higher emotional sensitivity, causing a vicious circle.

A cognitive process related to the component of high emotional sensitivity, is emotion recognition (Carpenter & Trull, 2013). Although there is some lack of consensus, most research indicates that BPD patients are less accurate in recognizing facial expressions of emotion compared to healthy controls. These deficits appear to be present in identifying both negative and positive facial emotions (Daros, Zakzanis & Ruocco, 2013; Levine, Marziali & Hood, 1997; Preißler, Dziobek, Ritter, Heekeren & Roepke, 2010). In addition, it has been suggested more than once that patients tend to interpret neutral facial expressions as being emotional. Even though Domes, et al. (2008) found no deficiencies in the recognition of emotions in BPD patients, their results indicated that patients tended to interpret ambiguous expressions as angry. Reviewing studies on this topic, Domes, Schulze and Herpertz (2009) indeed found such a tendency in BPD patients, but it remained unclear whether they interpreted neutral expressions as specifically angry emotions or as negative emotions in general. It was in another study (Dyck, et al., 2009) that patients showed the tendency to ascribe negative emotions in general to neutral expressions. However, this was only the case when time was restricted. When there was no time restriction, neither deficits nor wrong interpretations of neutral expressions were found. A later study did also confirm the presence of the tendency in BPD patients to interpret neutral expressions as being emotional (Daros, Uliaszek & Ruocco, 2014). However, there was no specific direction of that tendency. That is, the valence of the ascribed emotion was not specifically positive or negative. It has to be noted that the emotions relevant for BPD patients,

namely anger and fear, were not included in the experiment. Therefore, the results have to be interpreted with caution. All taken together, apart from the exact way it is expressed, there is some certainty that BPD patients tend to ascribe an emotion to a neutral facial expression.

Interestingly, some studies indicate that BPD patients in addition to the tendency to ascribe emotions to neutral facial expressions, also, accurately, ascribe emotions to emotional facial expressions in earlier stages of the expression than healthy controls. In other words, compared to healthy controls, patients are better able to identify emotions at lower intensities of emotion expression. In one study (Lynch, et al., 2006), BPD patients were more sensitive and therefore faster in accurately recognizing facial emotions, regardless of the valence. That is, they had a lower threshold for the correct recognition of facial expressions morphing from neutral to fully emotional. Domes, Schulze and Herpertz (2009) state in their review that BPD patients indeed are more sensitive in the emotion recognition. However, this was only the case when emotions were negatively valenced. In addition, a meta-analysis (Daros, Zakzanis & Ruocco, 2013) proposed a model which states that BPD patients are more aroused than healthy controls when confronted with emotional information that signifies a social threat, that is the expression of anger and fear (Green & Phillips, 2004). This would serve to enhance the emotion recognition at lower intensities of these emotions, which was also implied by the faster responses of patients in earlier studies (Domes, et al., 2009; Lynch, et al., 2006). However, when patients are confronted with high intensities of these emotions, they would experience hyperarousal, which could lead to depletion of the cognitive functions needed in the emotion recognition. As a result, they would be less accurate in recognizing anger and fear at high intensities. In other words, compared to healthy controls, BPD patients would be more accurate in recognizing these emotions at lower intensities, but less accurate at higher intensities. The latter has already been confirmed for angry facial expressions (Daros, et al., 2013). In addition, Meehan, et al. (2017) found that having more BPD symptoms predicted a more accurate

recognition of anger and fear at lower intensities. However, undergraduates were recruited to participate in the study, rather than patients with a BPD diagnosis. Therefore, the conclusions should be drawn carefully and further evidence for the model of Daros, et al. (2013) has yet to be found.

Considering what is known about the abnormalities in emotion regulation in BPD patients and that it can cause a lower quality of life with self-injury in particular, it is necessary to focus on reducing these abnormalities. According to Fonagy and Bateman (2006), there is evidence for the effectiveness of multiple approaches in treating BPD symptoms. These include dialectical behaviour therapy (DBT) and psychodynamic oriented therapy (POT). In DBT, patients learn to develop their emotion regulation skills, interpersonal effectiveness, distress tolerance and self-management skills (Linehan, 1993). The therapy involves a combination of a cognitive-behavioral approach and approaches of mindfulness and acceptance. The procedure consists of individual psychotherapy, therapist consultations and skills training in group sessions (Gratz, 2007). On the contrary, POT focuses on the evolving relationship between the patient and the therapist (Clarkin, Foelsch, Levy, Hull, Delaney & Kernberg, 2001). In addition, this therapy addresses emotional themes (Clarkin, Levy, Lenzenweger & Kernberg, 2007). Techniques that are used are clarification, confrontation and interpretation (Clarkin, et al., 2001). These techniques should reduce the pathologic characteristics of BPD and therefore change the personality in a structural way (Giesen-Bloo, et al., 2006). Although DBT and POT appear to be effective in reducing symptoms of BPD (Fonagy & Bateman), the effects on the emotion recognition in BPD are not investigated yet.

In summary, for BPD patients there are indications for deficiencies in emotion recognition. Patients appear to have a tendency to interpret neutral or ambiguous facial expressions as negative emotions. Furthermore, it has been suggested that patients are more accurate in identifying anger and fear at lower intensities and less accurate in identifying these

emotions at higher intensities, compared to healthy controls. However, little is known about this topic and there is a lack of consensus. The aim of this study is to investigate whether BPD patients show differences in recognizing anger and fear at lower and higher intensities, compared to healthy controls. It is expected that patients are more accurate in recognizing anger and fear at lower intensities and less accurate in recognizing these emotions at higher intensities (Hypothesis 1). In addition, this study will investigate whether treatment influences this recognition in patients. The expectation is that this could be corrected to normal by having a psychological therapy focused on reducing emotion dysregulation in BPD (Hypothesis 2).

Method

Participants

This study was conducted as part of a larger research into emotional dysregulation at GGz Centraal. For patients, an inclusion criterion was that they had a diagnosis of BPD, a diagnosis of features of BPD or that there were indications of those diagnoses, based on a clinical interview. Other criteria were that they had to be at the beginning of a treatment for problems in emotion regulation, had a normal or corrected to normal vision and had no history of neurological treatment. 17 patients met these criteria and were included. Among them were three men and 14 women (see Table 1 for their mean age and treatment duration). Participation took place at GGz Centraal. Those who completed the study were rewarded with a €10 gift voucher, which was funded by the larger research.

In addition to BPD patients, the already existing data of healthy controls from the larger study at GGz Centraal were used to be able to compare the patients to a healthy control group. Inclusion criteria were similar to the criteria for patients, except that the presence of indications for a personality disorder or features of a personality disorder were a reason to exclude that participant from analysis. Eventually, 31 controls were included. Among them were six men

and 25 women (see Table 1 for mean age). The groups did not differ in mean age, t (46) = 0.91, p = .369, two-tailed.

Table 1

Mean age per group and average treatment duration of BPD patients

Group	*M* age[a] *(SD)*	*M* treatment duration[b] *(SD)*
BPD patients	28.35 (9.87)	8.93 (3.22)
Healthy controls	25.74 (9.35)	

[a]In years
[b]In months

Materials

First, a questionnaire was used to collect information about age and sex of all participants. In addition, some questions were orally asked to ascertain a good vision, no color blindness and no history of neurological treatment. Secondly, participants performed a computerized emotion recognition task (ERT) in which they were presented by six different facial expressions of two male and two female actors (Terburg, et al., 2012). The task involved five blocks of 24 randomized trials. In each trial, the expression fluently morphed from a neutral expression to an emotional expression. The intensities of the emotions in the final images of the stimuli increased per block from 20 to 100%. The duration of the morphing process ranged between 0.3 s in the first block and 1.7 s in the final block. Each stimulus was presented within an angle of 10° and remained visible 0.5 s. Participants then were asked to choose the emotion that best described the presented facial expression, from six options: anger, disgust, fear, happiness, sadness and surprise. Responses could be given using the mouse to click on the chosen emotion button.

To check for the BPD diagnosis in patients, their treatment reports were read. When the diagnosis of BPD or characteristics thereof was missing, the Dutch version of the Structured

Clinical Interview for DSM-IV Axis II disorders (SCID-II) was used. This interview can be seen as the golden standard for the assessment of personality disorders (Lobbestael, Leurgans & Arntz, 2011). The SCID-II contains 134 questions, categorized by the 10 specific personality disorders of the DSM-IV. An example of a question for BPD is "Do your relationships with people you really care about have a lot of ups and downs?". Answers are scored by the interviewer with 1 (*trait is absent*), 2 (*presence of the trait is doubtful*) or 3 (*trait is present*). The reliability of the SCID-II is excellent (Lobbestael, et al, 2011) and the validity is acceptable (Smith, Klein & Benjamin, 2003).

For controls, the Assessment of DSM-IV Personality Disorders questionnaire (ADP-IV) was used to be able to exclude participants with indications for a personality disorder in the controls. This questionnaire consists of 94 items. One of them is "I always assume that others will exploit, hurt or deceive me". The participant has to judge to what extent the items are characteristic for his personality, on a scale ranging from 1 *(totally disagree*) to 7 *(totally agree*). When an item has been scored between 5 and 7, which indicates the presence of that trait, the participant has to judge whether that trait causes distress in the participant or his environment. This should be done on a scale ranging from 1 (*not at all*) to 3 (*definitely*). The ADP-IV has a good reliability and a good validity (Schotte & Doncker, 2000).

Procedure

Patients were informed about confidentiality and anonymity and they were told that participation was on voluntary basis, where after they signed a consent form. Then, some questions were asked to ascertain the presence of a good vision and the absence of color blindness and a neurological treatment in history. Subsequently, patients performed the ERT. They were left alone when they understood the procedure and everything was working properly. The researcher kept an eye on when the task had been completed. When finished, patients were instructed how to fill out the questionnaire. Then again, they were left alone. That way, there

was minimal distraction and participants could think calmly. After completing the questionnaire, it was screened for omissions by the researcher and any missed items were still answered. Finally, the SCID-II was conducted when patients had not had a personality assessment which included this interview.

To be able to investigate whether the emotion recognition was corrected to normal by having a treatment, patients were invited once again after completing their psychological therapy. They performed the ERT again, under the same conditions as the first moment of measurement. After completing the task for the second time, patients received the gift voucher.

Design and data analysis

This study involved an explorative design. For the hypothesis that BPD patients were more accurate in recognizing anger and fear at low intensities and less accurate in recognizing these emotions at high intensities, a 2 (patients, controls) x 2 (anger, fear) x 2 (low intensities, high intensities) analysis of variance (ANOVA) was conducted. For the second hypothesis that BPD patients, after having a treatment, had a normalized accuracy in the recognition of negative emotions, another 2 (pretreatment, posttreatment) x 2 (anger, fear) x 2 (low intensities, high intensities) ANOVA was used.

For the analysis, the displayed intensities of emotion were split up in three levels, resulting in a low intensity level, a medium intensity level and a high intensity level. The low intensity level consisted of the data of the blocks with 20% and 40% intensities. In the medium intensity level, the data of the block with 60% intensity were included. Finally, the high intensity level consisted of the data of the 80% and 100% intensity blocks. Only data of the low intensity level and high intensity level were analyzed in order to test the hypotheses.

Although there are ceiling and floor effects of the task due to the fact that it is not possible to be more accurate than 100% and less accurate than chance level, only parametric tests were

reported unless non-parametric tests indicated other outcomes. In the cases that the assumption of sphericity was violated, the degrees of freedom were adjusted by the Huynh-Feldt Epsilon.

Results

General task effects

First, a one-way repeated measures ANOVA revealed that there was an effect of intensity on the accuracy of both groups, F (4, 64) = 46.19, $p < .001$, partial $\eta^2 = .74$ (patients); F (4, 120) = 78.42, $p < .001$, partial $\eta^2 = .72$ (controls). In addition, there was an effect of emotion on the accuracy, F (3.28, 52.51) = 17.97, $p < .001$, partial $\eta^2 = .53$ (patients); F (3.71, 111.35) = 29.60, $p < .001$, partial $\eta^2 = .50$ (controls).

As can be seen in Figure 1, happiness was best recognized by both groups. There was no effect of intensity on this recognition in patients (see Table 2). This could be explained by the fact that patients were almost perfectly accurate in recognizing this emotion at the lowest intensities, making it nearly impossible to improve their accuracy at higher intensities. In contrast, controls did show an intensity effect *(*see Table 3). Anger was second best recognized by both groups, with an intensity effect showing that participants were more accurate as the intensity level increased (see Table 2 and Table 3). As can be seen in Table 2, in patients, this was followed by surprise which did not display an effect of intensity, and disgust, sadness and fear, which all had an intensity effect. In controls, anger was followed by sadness, which also had an effect of intensity, surprise, again without such an effect, and disgust and fear, both displaying an effect of intensity.

Although happiness in patients and surprise in both groups did not show an intensity effect, these data suggest that the task was successful in overall measuring accuracy at different intensities. Because anger and fear are the emotions of interest in the current study, outcomes could be interpreted without any concern about the validity of the task.

Table 2

Mean, standard deviation and intensity effect per emotion in BPD patients

Emotion	*M* (*SD*)	*df*	*F*	*p*	partial η^2
Anger	0.76 (0.13)	3.05, 48.76	18.62	< .001	.54
Disgust	0.72 (0.14)	2.66, 42.55	19.64	< .001	.55
Fear	0.61 (0.16)	4, 64	27.64	< .001	.63
Happiness	1.00 (0.01)	1, 16	1.00	.332	
Sadness	0.66 (0.15)	4, 64	11.93	< .001	.43
Surprise	0.73 (0.18)	4, 64	0.81	.526	

Table 3

Mean, standard deviation and intensity effect per emotion in healthy controls

Emotion	*M* (*SD*)	*df*	*F*	*p*	partial η^2
Anger	0.74 (0.14)	3.15, 94.46	16.55	< .001	.36
Disgust	0.67 (0.16)	3.36, 100.76	28.81	< .001	.49
Fear	0.63 (0.18)	4, 120	35.05	< .001	.54
Happiness	1.00 (0.02)	1.49, 44.66	3.61	.047	.11
Sadness	0.73 (0.11)	4, 120	21.97	< .001	.42
Surprise	0.71 (0.17)	3.41, 102.23	1.94	.120	

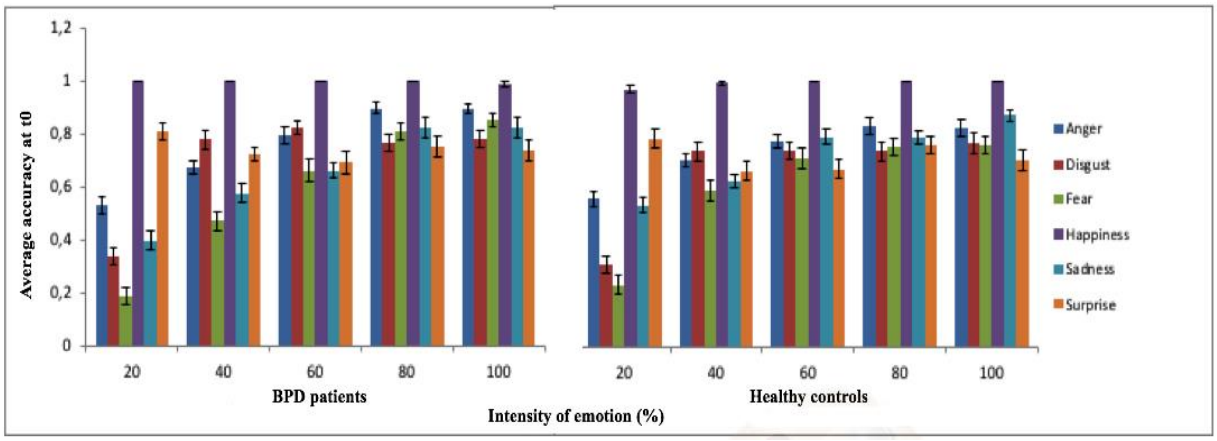

Figure 1. Average accuracy per intensity level of expressed emotion of BPD patients and healthy controls at the first moment of measurement. The error bars represent the standard errors of the mean.

Hypothesis 1

The first hypothesis states that BPD patients are more accurate in recognizing anger and fear at low intensities and less accurate in recognizing these emotions at high intensities. Results

of the 2 x 2 x 2 ANOVA indicated that there was a main effect of intensity, F (2, 46) = 192.72, $p < .001$, partial $\eta^2 = .81$ with participants being more accurate at high intensities ($M = 0.83$, $SD = 0.15$) than at low intensities ($M = 0.50$, $SD = 0.13$). A main effect of group was not found, F (1, 46) = 0.101, $p = .752$. An interaction between intensity and group was obtained, F (1, 46) = 6.97, $p = .011$, partial $\eta^2 = .13$ (see Figure 3). However, independent samples t-tests revealed that BPD patients did not differ in accuracy at both low and high intensities of expressed anger and fear (see Table 4). Furthermore, although the expectation was that patients would be more accurate in the recognition of anger and fear at low intensities and less accurate in the recognition of these emotions at high intensities, the interaction suggests that when there would be an effect of group on the different intensity levels, patients would be actually less accurate at low intensities and more accurate at high intensities. These findings reject the hypothesis.

Table 4

Mean and standard deviation for BPD patients and healthy controls in the accuracy of recognition of expressed anger and fear

Emotion and intensity level of expression	*M (SD)* patients	*M (SD)* controls	*t* (46)	*p*
Anger, low intensity	0.60 (0.14)	0.63 (0.16)	-.56	.576
Anger, high intensity	0.90 (0.13)	0.83 (0.20)	1.30	.202
Fear, low intensity	0.33 (0.18)	0.41 (0.23)	-1.23	.225
Fear, high intensity	0.83 (0.17)	0.75 (0.19)	1.40	.167

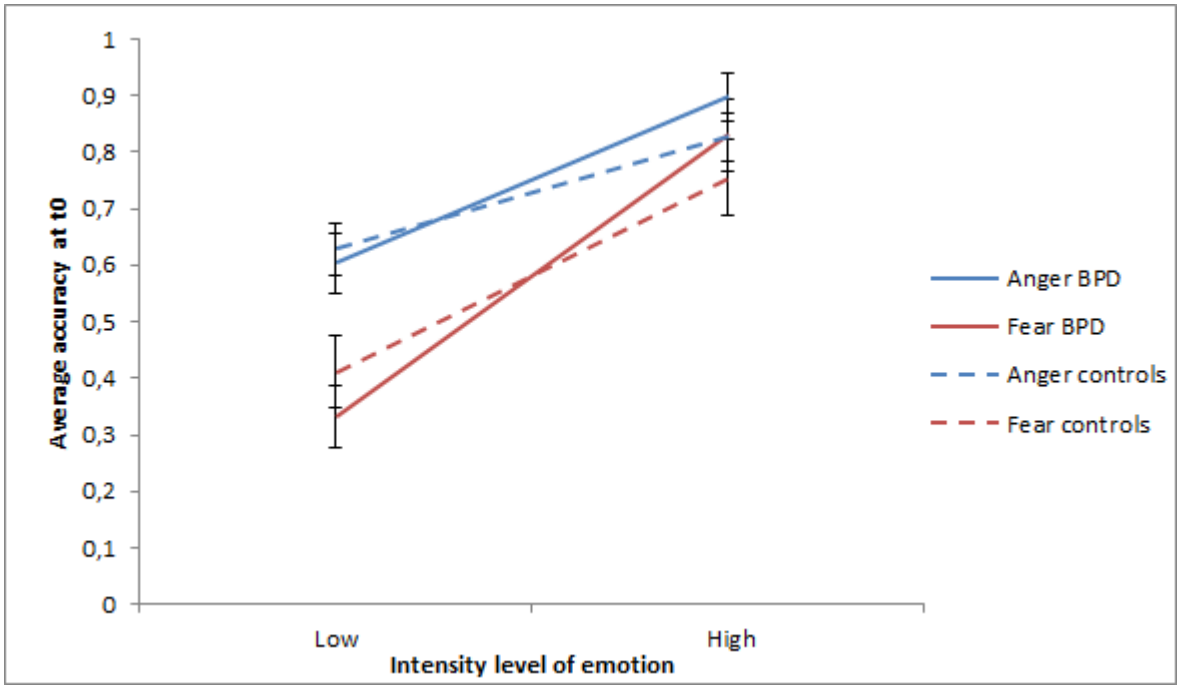

Figure 2. Average accuracy of anger and fear per intensity level of expressed emotion in BPD patients and healthy controls at the first moment of measurement. The error bars represent the standard errors of the mean.

Hypothesis 2

The second hypothesis states that BPD patients have a normalized recognition of emotions that signify a social threat after treatment. Although a main effect for moment of measurement was not obtained, a trend effect was found, F (1, 16) = 4.22, p = .057. This suggested that patients were more accurate in the recognition of anger and fear after treatment (M = 0.67, SD = 0.08), compared to before (M = 0.71, SD = 0.12). A main effect for intensity level of expressed emotion was found, F (1, 16) = 152.10, p < .001, partial η^2 = .91 with patients being more accurate at high intensities *(*M = 0.84, SD = 0.12) than at low intensities *(*M = 0.53, SD = 0.09). There was an interaction between moment of measurement and intensity level of expressed emotion, F (1, 16) = 19.47, p < .001, partial η^2 = .55. Patients were more accurate at low intensities after treatment than before treatment, however, this was considered only a trend effect for the recognition of fear (see Table 5 and Figure 3). At high intensities, patients were after treatment equally accurate in the recognition of anger compared to before. For fear, there

was only a trend indicating that patients were less accurate after treatment in comparison with before. Except for the recognition of anger at high intensities, this finding is consistent with the hypothesis that patients have a normalized accuracy after following a treatment for their borderline personality disorder.

Table 5

Mean and standard deviation for BPD patients and healthy controls in the accuracy of recognition of expressed anger and fear

Emotion and intensity level of expression	*M (SD)* at t0[a]	*M (SD)* at t1[b]	*t* (16)
Anger, low intensity	0.60 (0.14)	0.74 (0.14)	-3.27*
Anger, high intensity	0.90 (0.13)	0.90 (0.13)	0.00
Fear, low intensity	0.33 (0.18)	0.44 (0.22)	-2.11#
Fear, high intensity	0.83 (0.17)	0.75 (0.23)	1.89#

Note. t0 = before treatment; t1 = after treatment.
*$p < .05$. #$05 < p < .1$.

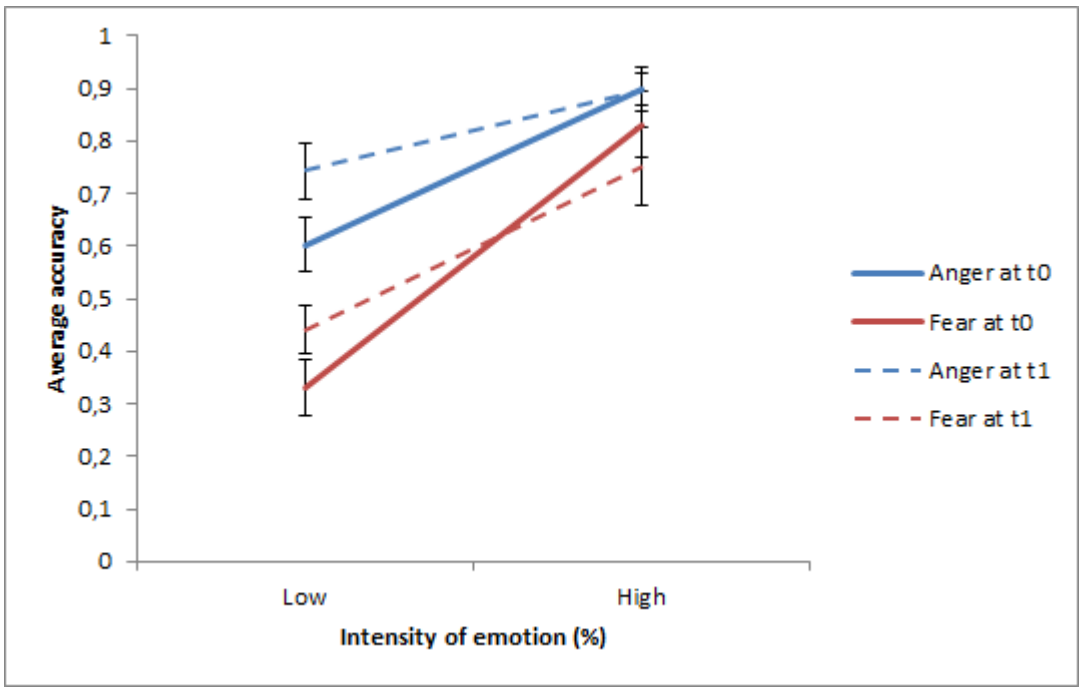

Figure 3. Average accuracy per intensity level of expressed emotion before (t0) and after treatment (t1) of BPD patients in the recognition of anger and fear. The error bars represent the standard errors of the mean.

Discussion

Previous studies indicated that BPD patients are more sensitive for expressed emotions at low intensities, which causes them to recognize those emotions earlier than healthy controls (Lynch, et al., 2006; Domes, Schulze & Herpertz, 2009). More specifically, the model proposed by Daros, Zakzanis and Ruocco (2013) suggested that patients are more accurate in recognizing low intensity expressions of anger and fear due to the experience of more arousal and that they are less accurate in recognizing high intensity expressions of these emotions due to the experience of hyperarousal. The current study investigated the emotion recognition as proposed by this model. In addition, it was investigated whether patients got a normalized accuracy in the recognition of anger and fear at both intensities of expressed emotion after following a treatment for their emotion dysregulation. Results indicated that patients were not more accurate in recognizing anger and fear at low intensities and not less accurate in recognizing these emotions at high intensities. Furthermore, a significant interaction revealed that when there would be any difference, the opposite would be rather the case. In addition, although patients were not more or less accurate at different intensities in comparison with healthy controls, this interaction effect indicated that patients were more accurate in recognizing anger and fear at high intensities in comparison with their recognition of these emotions at low intensities. These findings all suggest that patients are rather less accurate at low intensities and more accurate at high intensities in the recognition of anger and fear. Therefore, the first hypothesis was completely rejected. Interestingly, after treatment, patients were more accurate at recognizing anger at low intensities than before. For the recognition of fear at low intensities, there was a trend in the same direction. At high intensities, patients were equally accurate at recognizing anger after treatment, compared to before. There was a trend for fear indicating that patients were less accurate at high intensities after treatment. These findings partly confirm the second hypothesis

and suggest that patients show a more normalized accuracy in the recognition of anger and fear after treatment.

One possible explanation for the fact that evidence for the proposed model of Daros, Zakzanis and Ruocco (2013) has not been found in the current study, is that patients simply did not experience more arousal than healthy controls when confronted with low intensity anger and fear and that patients were not hyper aroused when confronted with high intensities of these emotions. Therefore, the cognitive functions needed in emotion recognition would not be enhanced at lower intensities of emotion expression and would not be depleted at higher intensities (Daros et al., 2013). This suggests that the model is not valid. It is plausible that patients do experience less arousal than controls when confronted with low intensity expressions of anger and fear and that they experience more arousal, but no hyperarousal, when confronted with high intensity expressions of these emotions. This could have resulted in the findings that are in contradiction with the first hypothesis. It has to be noted, however, that the current study design involved no social interactions in which the expressed emotions had to be recognized. It is possible that patients do experience more arousal than healthy controls at low intensities of expression and that they experience hyperarousal at high intensities when they are in interaction with others. In other words, although the model appeared not to be valid in a test environment, it could be valid in real life. Furthermore, Daros et al. based their model on reactive emotional tasks such as a dot-probe task. In contrast to the task that was used in the current study, it is possible that patients experience more hyperarousal during this kind of tasks because participants have to give responses to a trial which are preceded by seeing emotional faces that are not involved in the solution of the task (Fani et al, 2012). In the current study, participants were involved in a static task, in which they only had to see an emotional face and decide which emotion was expressed on that face. The experienced arousal described in the model of Daros et al., could be limited to reactive emotional tasks and therefore not be of influence in the current

study. Moreover, with regard to the suggestion that the model is only valid in real life, social interactions are more similar to reactive emotional tasks than to static tasks: in real life, expressed emotions are part of the social interactions in which one has to react to the other, rather than that they are explicitly evaluated by category. Considering the problems in interpersonal relationships in BPD, the suggested model of Daros et al. could be still of great importance. To find out whether this is indeed the case, the relationship between the degree of arousal and the recognition of anger and fear at different intensities in BPD patients who are interacting with others should be further investigated.

The outcomes of the second part of the current study revealed that patients showed recognition improvement at the low intensities of the anger and fear expressions. When the expressions had a higher intensity, patients showed no differences or even less accuracy compared to before their treatment. This is in line with the expected normalization and suggests that treatment causes a more normal recognition of emotions that signify a social threat. Furthermore, it could be argued that low intensities are more similar to neutral and ambiguous expressions, which leads to the suggestion that the patients' tendency to wrongly interpret neutral and ambiguous expressions decreased. It has to be noted that the current study has not focused on neutral and ambiguous expressions and that this should be investigated in future research.

The present findings have an important implication for the treatment of BPD, because when the normalization is true, the vicious circle of emotion dysregulation (Linehan, 1993 in Conklin, et al., 2006) is broken. As proposed by the theory, emotion dysregulation is caused by a use of inappropriate regulation strategies, which is a result of heightened and labile negative affect that arises from a high emotional sensitivity. A possible explanation for the normalization after a psychological treatment is that treatment for emotion regulation problems is consistent with the regulation strategies component of the circle. In addition, it could be assumed that

treatment directly decreases the sensitivity for emotions in BPD patients. However, it is unlikely that the methods used in therapy will affect this sensitivity. Patients are taught to make more use of appropriate strategies to regulate emotions and to use less maladaptive strategies (Clarkin, Levy, Lenzenweger & Kernberg, 2007; Linehan, 1993). In this way, the vicious circle could be reversed, leading to less labile negative affect, and therefore also, indirectly, leading to less emotional sensitivity. A more normal emotion recognition may be the result. This mechanism should be further investigated, so that treatment can be better aligned to the underlying processes of emotion dysregulation in BPD patients.

Conclusions about the outcomes should be drawn with caution. First, a relatively small sample was used in this study, possibly leading to the finding of no significant differences between patients and healthy controls. Given the indications for an inverse effect relative to the hypothesis, more participants should be included in future research to investigate this effect. Secondly, participants in the current study followed different types of treatment, which made it difficult to determine the exact underlying mechanism of the normalization in emotion recognition. In order to understand the effects of the specific types of treatment, it is a logical step to investigate the outcomes per type of treatment in future research. Finally, the healthy controls of whom the data was used in the current study did not have a second moment of measurement. Therefore, it could not be excluded that a learning effect in patients accounted for the found differences that confirmed the second hypothesis. Such an effect is not very plausible, however, because the treatment duration, and similarly the time interval between the moments of measurement, were at least five months. To ascertain the absence of a learning effect, future research should also include the control group in the second moment of measurement, ideally after the same time interval as patients will have.

In summary, the results of the current study indicate that there are no differences between BPD patients and healthy controls in the recognition of emotions that signify a social threat. In

addition, contrary to the hypothesis, the found interaction effect suggested that when there would be differences, patients would be less accurate in the recognition of these emotions at low intensities of expression and more accurate in the recognition of these emotions at high intensities of expressions. After treatment for emotion dysregulation, the recognition of patients normalizes in the direction of the accuracy of healthy controls. These results have an important implication for treatment of BPD, because they provide tools to better understand the underlying mechanisms in both the pathology and the treatment. Further research is needed to better understand the effects of BPD and treatment of this disorder on the emotion recognition.

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