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Associations of emotional arousal, dissociation and symptom severity with operant conditioning in borderline personality disorder

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ABSTRACT

Those with borderline personality disorder (BPD) display altered evaluations regarding reward and punishment compared to others. The processing of rewards is basal for operant conditioning. However, studies addressing operant conditioning in BPD patients are rare. In the current study, an operant conditioning task combining learning acquisition and reversal was used. BPD patients and matched healthy controls (HCs) were exposed to aversive and neutral stimuli to assess the influence of emotion on learning. Picture content, dissociation, aversive tension and symptom severity were rated. Error rates were measured. Results showed no group interactions between aversive versus neutral scenes. The higher emotional arousal, dissociation and tension, the worse the acquisition, but not reversal, scores were for BPD patients. Scores from the Borderline Symptom List were associated with more errors in the reversal, but not the acquisition phase. The results are preliminary evidence for impaired acquisition learning due to increased emotional arousal, dissociation and tension in BPD patients. A failure to process punishment in the reversal phase was associated with symptom severity and may be related to neuropsychological dysfunctioning involving the ventromedial prefrontal cortex. Conclusions are limited due to the correlational study design and the small sample size.

1. Introduction

Increased emotional reactivity (Ebner-Priemer et al., 2007, 2005; Kuo and Linehan, 2009; Reitz et al., 2012) and deficits in emotion and behavior regulation (Schmahl et al., 2014) are core features of borderline personality disorder (BPD). BPD is a disabling condition involving frequent self-injurious and suicidal behavior, with prevalence rates around 3% (Tomko et al., 2014) and results in large costs for health care systems. Psychotherapy may be improved by better understanding of learning mechanisms underlying behavioral adaptation and regulation in BPD.

By reversing stimulus-outcome associations in operant conditioning, one's malleable response to reward and punishment can be assessed. In reversal learning tasks, participants are presented with two stimuli, one of which is rewarded upon selection while the other is punished. Learning acquisition of the stimulus-outcome associations is followed by their reversal, and the stimulus which was earlier associated with a reward is now punished when selected. Impairments when processing rewards and punishments were repeatedly shown in several neuropsychological tasks with BPD patients (e.g. (Andreou et al., 2015; Barker et al., 2015; LeGris et al., 2014; Schuermann et al., 2011; Vega et al., 2013)). However, studies addressing reversal learning in BPD patients and healthy controls (HCs) have not shown group differences (Barker et al., 2014; Berlin et al., 2005; Dinn et al., 2004). It is surprising that despite consistent evidence of a deficit in reward processing, previous studies did not reveal affected reversal learning in BPD, although the support for this is sparse.

Learning can be affected by dissociative symptoms (Winter et al., 2014), which are often reported by BPD patients (Stiglmayr et al., 2001; Zanarini et al., 2000). Dissociation can impair classical conditioning processes in BPD patients (Ebner-Priemer et al., 2009) and is a predictor for unfavorable treatment outcomes in BPD (Arntz et al., 2015; Kleindienst et al., 2011). Krause-Utz et al. (2012) showed that dissociation increases in experimental settings when emotional stimuli are involved. This emphasizes the importance of better understanding the influence of dissociation on

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learning mechanisms. Besides dissociation, symptom severity (Völker et al., 2009) and impulsivity (Berlin et al., 2005; Dowson et al., 2004; Lawrence et al., 2010) affect reward processing in BPD and, hence, may affect operant conditioning. Taken together, increased dissociation and high BPD symptom severity may impair operant conditioning. Unfortunately, previous studies investigating operant conditioning did not report dissociation ratings. Thus, the main question we addressed was whether the presence of emotional stimuli had detrimental effects on operant conditioning in BPD patients. First, we hypothesized that the presentation of task-irrelevant aversive (versus neutral) stimuli would impair the instrumental learning of stimulus-outcome associations in BPD patients. We further explored associations of emotional intensity ratings and learning to assess whether group differences in emotional intensity might indirectly affect learning. Thirdly, we expected that higher states of dissociation would be associated with worse acquisition learning. Fourth, we wanted to further explore the influence of borderline symptom severity and impulsivity on learning.

2. Methods

2.1. Sample

Out of 22 female BPD patients who participated in the study, one was excluded from the analysis due to a technical error in the experimental procedure. This reduced the final sample to $n=21$ (age: 27 ± 6.7 [mean $\pm$ standard deviation]). Patients were recruited via advertisements in print media or websites. Eligible patients were invited for diagnostic interviews conducted with the International Personality Disorder Examination (IPDE; (Loranger, 1999)) and the Structured Clinical Interview for DSM-IV (SCID; (First et al., 1997)) by trained interviewers. Patients were included if they met 5 or more DSM-criteria for BPD and if they were free of psychotropic medication for at least two weeks prior to participation. They were excluded from participation if they met criteria for lifetime bipolar-I, lifetime schizophrenia, current substance use disorder, current major depressive episode, or if they reported any lifetime or current neurological conditions. Comorbidities found in the sample were posttraumatic stress disorder (current=4, lifetime=6), major depression (lifetime=17), dysthymia (current=1), social phobia (current=3), specific phobia (current=1), panic disorder (current=4), bulimia nervosa (current=2). All participants were tested negative for drug ingestion using a urine test before participation. HCs ($n=15$, age: 25.1 ± 3.7) were all female and were included if they did not report any current or lifetime DSM-IV diagnosis. They fulfilled none of the DSM BPD criteria. Both groups did not differ in age ($t(34)=0.99$, $p=0.33$). The study was conducted according to the declaration of Helsinki and approved by the Ethics Committee of the Medical Faculty Mannheim of the University of Heidelberg. All subjects provided written informed consent before participation and were financially compensated for participation.

2.2. Procedure

2.2.1. Ratings and psychometric measures

Before the experiment, participants completed the Borderline Symptom List (BSL-23 (Wolf et al., 2009), Cronbach's $\alpha=0.83$, n=19; we report Cronbach's alpha of scales for the BPD group), the Barratt Impulsiveness Scale (BIS-11; (Patton et al., 1995; Preuss et al., 2008), Cronbach's a=0.46–0.58, n=19) and the UPPS Impulsive Behavior Scale (Cronbach's $\alpha=0.76$–0.84, n=21, (Schmidt, 2008; Whiteside and Lynam, 2001)). The items of the dissociation tension scale short version (DSS-4, (Stiglmayr et al., 2009), Cronbach's $\alpha=0.91$–0.96, n=21) were presented on the computer screen after each experimental run. The DSS-4 is a four item self-assessment scale asking for the level of current psychological and somatoform dissociative experiences. Additionally, it includes a fifth item to assess aversive tension. Ratings were assessed on a 10 point Likert type scale (0=not at all to 9=extremely high).

After the experiment, each picture was presented again and was rated for emotional arousal and valence on the Self-Assessment Manikin (SAM) scale (5 levels, 1=relaxed/very positive to 5=highly arousing/very negative).

2.2.2. Instruction and set-up

Participants were instructed to choose one of two pictures presented on a 17″ computer screen by pressing the left or right button on a computer keyboard. If the response was correct, they received 100 credits, otherwise 100 credits were taken off their account. They were instructed to choose the picture that was most often rewarded. Reversals would randomly occur, in which the opposing picture would be associated with a reward. Additionally, participants were told that they would receive one cent per 100 credits earned, in addition to the compensation for participating in the experiment. Stimuli were presented with Presentation software (Neurobehavioral Systems, Berkeley, CA).

2.2.3. Experimental design

The stimuli in the experimental runs either consisted of images depicting aversive scenes involving human beings (aversive condition) or images of animals (neutral condition). The pictures were selected from the IAPS (Lang et al., 2008) and EmoPics (Wessa et al., 2010) picture sets.

To test our hypotheses, an operant conditioning task was developed implementing both acquisition and reversal conditions, while controlling for aversive versus neutral stimulus content. Four experimental runs were administered, either starting with the aversive condition or the neutral condition; the conditions alternated in the remaining runs. Each trial started with the presentation of a fixation cross on a black screen (550 ± 300 ms), followed by the presentation of the picture pair (2000 ± 300 ms), then a black screen (800 ± 300 ms) and then finally a feedback presentation (1050 ± 300 ms) stating either "you win 100 credits" in green or "you lose 100 credits" in red letters in German language (Fig. 1a). Participants were advised to press a button every time a picture pair was presented before it disappeared. There were 100 trials per run, resulting in a total of 200 runs per condition. At the end of the run, participants received a message stating the number of credits they had won during the run.

We assessed the performance in three separate phases: an early phase ('acquisition') and two late phases ('reversal' and 'retention'). Trials of a picture pair were presented repeatedly until the pair passed the 'acquisition' phase and entered one of the late phases. During the 'acquisition' phase, one of the paired images was rewarded (the 'rewarded stimulus') when selected (i.e., in case of a 'hit' response). The other stimulus (the 'non-rewarded stimulus') was always punished when selected (i.e., in case of an 'error' response, Fig. 1b). As soon as the rewarded stimulus was selected in a certain number of subsequent trials (probabilistic learning criterion: 6–9 hits), stimulus-outcome associations in half of the pairs swapped and the pair entered the 'reversal' phase. For the other half of the pairs, stimulus-outcome associations stayed the same, i.e., the participants needed to produce the correct responses from memory (the 'retention' phase, Fig. 1c). Again, after 6 subsequent hits, the learning criterion was passed and the picture pair was replaced by a new pair of images, starting with the acquisition phase. To aid in ones learning stability, 90% hits were rewarded with congruent feedback and 10% of hits were punished with incongruent feedback. Congruent feedback was always given