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Testing the reinforcement sensitivity theory in borderline personality disorder compared with major depression and healthy controls

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ABSTRACT

Links between the reinforcement sensitivity theory (RST) proposed by Gray and several mental disorders have been established in a number of studies. However, specifically in the field of personality disorders, there is a lack of evidence regarding clinical samples. The aim of the present study was to test the RST in subjects with borderline personality disorder (BPD, $n = 100$), compared to subjects with major depression disorder (MDD, $n = 45$) and healthy controls (HCs, $n = 100$). Behavioral approach system (BAS) and behavioral inhibition system (BIS) were assessed using the sensitivity to punishment and sensitivity to reward questionnaire; in addition all participants completed the beck depression inventory. Individuals with BPD showed higher scores on BIS and BAS compared with both control groups. An interaction between BIS and BAS was not observed, suggesting that the joint subsystems hypothesis (JSH) is not applicable in the case of BPD. A logistic regression analysis indicated that scores in sensitivity to punishment and sensitivity to reward were able to predict almost an 80% of BPD cases. Findings suggest that BIS and BAS reactivity is related to BPD main psychopathology.

1. Introduction

In the original formulation the reinforcement sensitivity theory (o-RST) proposed by Gray (1987) suggests the existence of two major motivational systems: the behavioral inhibition system (BIS) and the behavioral approach system (BAS). The BIS is sensitive to signs of punishment and unconditioned fear stimuli. BIS activation has been related with neuroticism personality trait and a tendency to experience negative affect. To the contrary, BAS organized behavior in response to appetitive stimuli related with signs of unconditioned reward and non-punishment. BAS activity has been related with the impulsivity trait of personality and a tendency to experience positive affect (Bijttebier, Beck, Claes, & Vandereycken, 2009).

The o-RST has undergone a major reformulation over the past years (Gray & McNaughton, 2000). In the revised version (r-RST), BAS is conceptualized in most aspects as in the o-RST; BIS is related to resolving conflicts, especially the approach–avoidance type but not to reactions to punishment as in the original model; finally, a third construct named Fight-Flight-Freeze System (FFFS), that in many aspects is similar to the original BIS, is responsible for reactivity to all types of punishment. The o-RST adopted a separable subsystems hypothesis (SSH) assuming that BIS and BAS were separable subsystems that operate independently of one another. In contrast to this assumption, Corr (2001) presented the joint subsystems hypothesis (JSH), which postulates that BIS and BAS could have interdependent or joint effects. Whereas the JSH is expected to be valid under certain human experimental conditions, it is believed that the SSH is more suitable in extreme personality groups or in cases where sensitivity to punishment and sensitivity to reward are both high (Bijttebier et al., 2009; Corr, 2001, 2004).

BIS and BAS activity, as defined in the o-RST, have been studied in relation to a broad range of Axis I disorders, showing that extreme levels of BIS and BAS activation are related with several disorders (e.g., depression, anxiety or drug abuse; Bijttebier et al.,

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2009). Recently, RST study has expanded to personality disorders (Caseras, Torrubia, & Farré, 2001). Borderline personality disorder (BPD) is a severe psychiatric condition that is very prevalent in clinical populations (Leichsenring, Leibing, Kruse, New, & Leweke, 2011). Current theories of BPD agree to consider that emotional dysregulation and impulsivity are two major features of the disorder (Crowell, Beauchaine, & Linehan, 2009; Gunderson, 2010). Recently, the DSM-5 incorporates an alternative model for personality disorders (DSM-5, section III; APA, American Psychiatric Association, 2013), based on maladaptive personality traits. According to this new proposal (American Psychiatric Association, 2013), BPD is characterized by pathological personality traits in the negative affectivity (NA), disinhibition and antagonism domains. The NA domain – the pathological pole of neuroticism-include among others, emotional lability, anxiousness and depressivity. While, impulsivity and risk taking are part of the disinhibition domain – the pathological pole of conscientiousness – (Miller, Morse, Nolf, Stepp, & Pilkonis, 2012; Skodol, 2012). In studies regarding non-clinical samples, BIS activation has been related with NA, whereas BAS activation has been related with the impulsivity trait (Smits & Boeck, 2006; Taylor, Reeves, James, & Bobadilla, 2006; Zelenski & Larsen, 1999).

Considering the previous literature, it can be expected that BPD subjects were characterized by a high activation of both BIS and BAS, as they were postulated in the original model. However, empirical testing of the RST framework in large BPD samples is still needed. To further clarify this matter, the present study has the following aims: (1) to investigate BIS and BAS sensitivities as defined in the o-RST in BPD subjects by contrasting 3 groups: individuals with BPD, individuals with major depressive disorder (MDD), and healthy controls (HCs), (2) to investigate the joint subsystems hypothesis (JSH) in regard to the three groups (BPD, MDD and HC), and (3) to clarify if o-RST framework could be useful for discriminating between BPD and MDD subjects.

2. Methods

2.1. Participants and procedure

A total of 245 subjects were recruited: 100 diagnosed with BPD, 45 diagnosed with MDD and 100 HCs. HCs were recruited directly by the authors through appeals at the hospital and university, while clinical participants were outpatients recruited during a 1 year period at two Departments of Psychiatry in Spanish Hospitals. Inclusion criteria for HCs were as follows: (a) no current or past psychiatric diagnosis; (b) absence of history of psychotropic medication; (c) absence of depressive symptoms according to BDI scores (BDI >13) and (d) absence of BPD diagnosis according to a screening instrument for subjects with BPD.

Diagnosis of both clinical groups was assessed by means of structured interviews. Exclusion criteria for MDD and BPD groups consisted of: presence of psychotic disorder, current substance dependence or eating disorders according to DSM-IV-TR criteria, or severe physical conditions. Patients were allowed to be under pharmacological treatment.

The study was approved by the Clinical Research Ethics Committee of the Hospital de la Santa Creu i Sant Pau and followed the principles outlined in the Declaration of Helsinki. Participants did not receive any remuneration and an informed consent to participate in the study was acquired.

2.2. Measures

The Structured Clinical Interview for DSM-IV-TR Axis I and II (SCID-I and SCID-II) were used to make BPD and MDD diagnosis. In addition, BPD was confirmed by the Revised Diagnostic Interview for Borderlines (*DIB-R*; Barrachina et al., 2004). To dismiss BPD criteria in HCs and MDD samples, the *McLean Screening Instrument for Borderline Personality Disorder* (*MSI-BPD*; Zanarini et al., 2003) was used. The original version reports adequate psychometric properties (Zanarini et al., 2003). In our study, internal consistency as measured by Cronbach's alpha was .89. Depressive symptoms were assessed by the *beck depression inventory* (BDI-II; Sanz, García-Vera, Espinosa, Fortún, & Vázquez, 2005). To examine BIS and BAS activation we used the *Sensitivity to Punishment and Sensitivity to Reward Questionnaire* (SPSRQ; Torrubia, Ávila, Moltó, & Caseras, 2001), which consists of 48 yes/no items and it is divided into two independent scales. The sensitivity to punishment scale (SP) evaluates individual differences regarding BIS activity. The sensitivity to reward scale (SR) measures individual differences regarding BAS activity. The original version of the SPSRQ has shown good psychometric properties regarding internal consistency and test–retest reliability and both scales have been related with other BIS and BAS scales (Caseras, Ávila, & Torrubia, 2003; Torrubia et al., 2001).

2.3. Statistical analysis

To compare sociodemographic variables and clinical data among groups Chi square and ANOVA Tests were performed. Differences between groups were tested by means of ANOVAs using post hoc tests (Bonferroni). In the venue of significant differences among groups in other variables, ANCOVAs were to be carried out instead, together with comparisons between groups by means of pairwise ANCOVA.

To test the effect of SR and SP and their interaction on BDI scores, 3 regression analyses were conducted (one for each group: BPD, MDD and HCs). BDI scores were entered as dependent variable and SP and SR scores (mean-centred) were entered as factors in the first step. A two way cross product (SP × SR (mean-centred)) was entered as factor in the second step.

A backward stepwise logistic regression analysis was performed in order to explore the ability of SP, SR and BDI scores to predict whether participants belonged to the BPD group. Data analysis was performed using SPSS version 18.0 for Windows with level of significance at $p < .05$.

3. Results

No significant differences were found for sex distribution [percentage of women: BPD (94.0%), MDD (93.3%) and HCs (93%)]. Statistical differences were found for age [$F(2, 238) = 35.33$, $p < .001$; BPD, 33.6 (9.7), MDD 44.9 (12.3), HC 29.8 (9.3)] and level of education ($\chi^2(2) = 16.15$, $p < .001$; percentage of high school/university studies: BPD, 83%, MDD, 73.5%, HC, 98.6%). Sample size for BDI comprised only 222 participants (BDP $n = 100$, MDD $n = 45$, HCs $n = 77$), due to incomplete data of the HCs sample. Scores on BDI differed significantly among groups [$F(2, 219) = 148.996$, $p < .001$), BPD 29.2 (13.4), MDD 23.4 (10.2), HC, 2.9 (2.3)].

Separate ANCOVAs were conducted for each scale (SR and SP) as dependent variables, groups (BPD, MDD and HCs) as between-subjects factor, controlling for the effect of age and BDI. As the main effect of group was significant for SP [$F(2, 214) = 10.61$, $p < .0001$] pairwise comparisons were performed. BPD participants showed significant higher scores than MDD [$F(1, 142) = 8.01$, $p < .005$] and HCs [$F(1, 174) = 16.57$, $p < .0001$]. Analysis with SR showed a group main effect [$F(2, 214) = 15.43$, $p = .000001$]; pairwise comparisons showed that BPD participants displayed significantly higher scores than both MDD [$F(1, 142) = 26.41$, $p = .000001$] and HC [$F(1, 174) = 23.08$, $p = .00003$]. Difference between MDD and

Table 1
Differences in sensitivity to punishment and sensitivity to reward questionnaire scores between groups.

	BPD $n = 100$ Mean (SD)	MDD $n = 45$ Mean (SD)	HC $n = 100$ Mean (SD)	Pairwise comparisons
SPSRQ				
SP	16.06 (5.5)	12.6 (5.3)	7.9 (4.9)	BPD > MDD > HC
SR	12.02 (4.9)	7.2 (4.8)	6.6 (4.2)	BPD > MDD, HC

BPD = Borderline personality disorder, MDD = major depressive disorder. HC = healthy controls, SPSRQ = sensitivity to punishment and sensitivity to reward questionnaire. SP = Sensitivity to punishment, SR = sensitivity to reward.
Differences between groups are indicated with <or> symbols.

HC was not significant [$F(1, 119) = 0.03$, $p = .87$]. Results are summarized in Table 1.

As shown in Table 2, SP × SR (mean-centred) beta coefficients of the hierarchical regression analysis were not statistically significant for BPD and HCs groups. A significant effect of SP × SR (mean centred) introducing SP × SR(mean centred) as predictor in a second step was associated with higher R^2 only in the MDD group ($R^2 = .312$, $F(1, 41) = 6.202$, $p = .001$) with a significant SP × SR(mean-centred) interaction ($\beta = -.500$, $p = .001$). To prove this an interaction test of simple slopes was performed in the MDD group, finding a steep and significant slope for SP predicting BDI scores only at low levels of SR ($\beta = .652$, $p = .001$). A non-significant slope between SP and BDI scores at high levels of SR was found ($\beta = -.083$, $p = .7$). These results suggest that the level of depression in subjects with MDD is positively associated with SP, only in cases where SR is low.

The logistic regression analysis accounted for 30% of the variance (Nagelkerke pseudo $R^2 = .332$). SR (Exp [B] = 1.235, 95% CI = 1.125–1.356, $p < .001$) and SP (Exp [B] = 1.120, 95% CI = 1.042–1.202, $p = .002$) appeared to be significant as indicators of the BPD group and the model was able to predict a 79.3% of BPD cases.

4. Discussion

The present study aimed at testing BIS and BAS sensitivities in individuals with BPD in comparison with subjects with MDD and HCs. Three major findings are to be stressed: (1) the BPD group showed a hyper activation of both BIS and BAS when compared to MDD and HCs groups, (2) for the BPD group we did not find an interaction between BIS and BAS as postulated in the JSH and (3) logistic regression analysis shows that scores on SR and SP predicted BPD in almost 80% of the cases.

BPD participants showed a hyperactivity of BAS and BIS systems, being in concordance with other studies regarding clinical BPD samples (Vega et al., 2013) and non-clinical BPD profiles (Pastor et al., 2007; Taylor et al., 2006). Our findings fit well in the description of BPD subjects as patients with high impulsive behaviors who also present high affective symptomatology (Gomà-i-Freixanet, Soler, Valero, Pascual, & Pérez Sola, 2008) and is congruent with the BPD profile suggested in the alternative model proposed in DSM-5 (American Psychiatric Association, 2013). Given that NA is the pathological pole of the neuroticism dimension, the overlapping with SP scores seems reasonable (Torrubia et al., 2001). Most of the facets that are included in the NA domain, such as: emotional lability, anxiousness and depressivity, had already been related with BIS activation (Bijttebier et al., 2009). The effect of depressive symptoms in SP scores could be explained by the fact that BIS activation could be dependent on depressive state (Meyer, Johnson, & Winters, 2001). In regard to BAS activation it has been strongly related with impulsivity facet (Bijttebier et al., 2009), which is part of the disinhibition domain (DSM-5; American Psychiatric Association, 2013).

The lack of significant differences between MDD group and HCs on SR contradicts the hypothesis of a hypoactive BAS as a hallmark of MDD patients (Pinto-Meza et al., 2006), however, it has to be noted that our controls had lower scores than the expected for a general population (Torrubia et al.,2001).

We found an interdependent BIS and BAS effect only in the MDD group, meaning that the JSH was only applicable in this group. An interactive effect of SR and SP on depressive symptomatology was recently reported by Harnett, Loxton, and Jackson (2013), using the r-RST. In subjects with BPD, BIS and BAS appear to operate independently, according to the SSH framework. It has to be noted that the JSH already specifies that punishment and reward interdependences would not be found in all cases (Corr, 2001). The case of extreme personality individuals – such as subjects with BPD – was postulated within these exceptions (Bijttebier et al., 2009; Corr, 2001, 2004).

We found that scores on both SR and SP were good predictors of BPD diagnosis (in regard of depressive symptoms), suggesting that the RST framework is useful to discriminate between BPD and MDD groups. This later finding is especially interesting taking into account the existent interest in relation to dimensional models of

Table 2
Hierarchical regression with SP, SR scores and their interaction (SP × SR) as predictors of BDI scores.

Group	*B*	*B* se	β	Sig. β	*R*	R^2	ΔR^2	Df	ΔF	Sig. *F* change
BPD										
Step 1					.282	.060	.079	2,97	4.182	.018
SP	.683	.236	.281	.005						
SR	.030	.264	.011	n.s						
Step 2					.300	.062	.011	1,96	1.133	n.s.
SP × SR	−.056	.053	−.108	n.s						
MDD										
Step 1					.306	.050	.093	2,42	2.162	n.s.
SP	.534	.286	.279	.069						
SR	.386	.314	.183	n.s						
Step 2					.559	.262	.219	1,41	13.042	.001
SP × SR	−.195	.054	−.500	.001						
HC										
Step 1					.292	.060	.085	2,74	3.437	.037
SP	.143	.054	.302	.011						
SR	−.040	.062	−.073	n.s						
Step 2					.325	.069	.021	1,73	1.710	n.s.
SP × SR	−.015	.012	−.146	n.s						

BPD = Borderline personality disorder, MDD = major depressive disorder, HC = healthy controls, SP = sensitivity to punishment, SR = sensitivity to reward, n.s = not significant.

personality, suggesting that these two basic dimensions could characterize BPD. Moreover, despite the presence of depressive symptoms in both samples, the fact that BDI was not significant in the regression model, suggests the potential of RST framework to distinguish between psychiatric disorders, which shared similar clinical characteristics, pointed out by Bijttebier et al. (2009).

In this paper we have assumed the association between the SP scale and BIS functioning, as was originally defined in light of the original RST (Gray, 1987). However, if we take into account the redefinition of the model by Gray and McNaughton (2000) and lately by McNaughton and Corr (2004), SP could be considered as either an index of the FFFS or an index of the combined BIS/FFFS functioning, and in that case, the obtained results should be interpreted in accordance with this proposal. However, despite that in the recent years some attempts have been made in order to develop specific measures of the revised BIS and FFFS (Heym, Ferguson, & Lawrence, 2008), future work is still needed to count on an adequate assessment of this system. As regards to BAS activity, it can be assumed that SR scale is still a valid measure for the measurement of individual differences in this system.

The lack of a structured Axis II assessment in MDD patients has to be stress as a limitation of the study. Due to viability reasons we used the MSI-BPD to dismiss BPD diagnosis in the MDD sample, but still MDD patients could have BPD traits.

Findings of the present study could have interesting clinical implications regarding both aetiology and treatment of BPD patients. To the best of our knowledge this is the first study that examines BIS and BAS sensitivities in a large clinical BPD sample. Future studies should continue to investigate the utility of BIS and BAS dimensions to assess BPD from a dimensional perspective.

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