Slow processing in borderline personality disorder: the emotional Stroop paradigm

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Background. Emotional instability has been extensively considered the main core of the borderline personality disorder (BPD) that is characterised by an important bias towards emotional information. The aim of this study was to determine the emotional bias in patients with BPD by means of an emotional Stroop paradigm.

Sampling and Methods. Sixty-one women (38 Borderline Personality Disorder outpatients and 23 healthy matched control subjects) were included. All of them underwent a computerised version of an emotional Stroop which included four valences: borderline-related negative, negative, positive and neutral.

Results. The results showed that BPD patients were slower in spotting the ink of the words [F(1.59)=4.33; p=0.04], and this effect was mainly for borderline-related and neutral words. Likewise, the more severe the BPD the slower the subjects [F(2.57)=4.81; p=0.012], indicating difficulties in processing information.

Conclusions. The findings suggest that the emotional dysregulation may account for selective processing with emotional stimulus, which in turn triggers emotional responses in BPD patients, rather than to reflect a more general hypervigilance and an attentional bias for any kind of stimulus.

Key words:
Borderline personality disorder (BPD), Emotional dysregulation, Emotional Stroop, Processing information, Attention

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Lentificación del procesamiento de la información en el trastorno límite de la personalidad: el paradigma de Stroop emocional

Introducción. La inestabilidad emocional se considera la disfunción principal en el trastorno límite de la personalidad (TLP), que se caracteriza por un importante sesgo hacia la información emocional. El objetivo de este estudio fue determinar el sesgo emocional en pacientes con TLP mediante un paradigma de Stroop emocional.

Muestra y Método. Se incluyeron en el estudio 61 mujeres (38 pacientes ambulatorias con TLP y 23 controles sanos apareados). Todos los sujetos realizaron una versión informatizada de un Stroop emocional que incluía palabras con cuatro valencias: palabras negativas relacionadas con el TLP, palabras negativas, palabras positivas y palabras neutras.

Resultados. Los resultados indicaron que los pacientes con TLP era más lentos acertando el color de las palabras [F(1,59)=4,33; p=0,04], y este efecto se observaba principalmente en el caso de las palabras relacionadas con el TLP y de las palabras neutras. Además, los pacientes con mayor gravedad del trastorno eran más lentos [F(2,57)=4,81; p=0,012], lo que indica dificultades en el procesamiento de la información.

Conclusiones. Los resultados obtenidos indican que la desregulación emocional podría explicarse por un procesamiento selectivo ante estímulos emocionales, lo que desencadenaría respuestas emocionales en los pacientes con TLP, mejor que por una hipervigilancia generalizada o por un sesgo atencional ante cualquier tipo de estímulo.

Palabras clave:
Trastorno límite de la personalidad (TLP), Disregulación emocional, Stroop emocional, Procesamiento de la información, Atención

INTRODUCTION

Borderline personality disorder (BPD) patients are characterised by persistent problems in four areas of psychopathological symptoms: affective disturbance,

impulsivity, disturbed cognition, and intense unstable relationships. Emotional instability has been extensively considered the main core of the disorder that is characterised by an important bias towards emotional information. Such emotional instability has played a crucial role in the aetiology of BPD for different theoretical orientations.[1-4] It is believed that the failure to adequately process information about experienced emotions is associated with significant problems in managing their emotions, especially anxiety and anger that could lead to propensity for impulsive self-destructive behaviour.[1, 5] The difficulty of BPD patients with their emotions has been considered as emotional vulnerability, which refers to a biologically mediated predisposition for affective instability involving heightened sensitivity and reactivity to emotional stimuli, and a slow return to baseline level of emotional arousal.[6] Several neuroimaging studies have reported brain abnormalities that would reflect the biological vulnerability to emotional instability and impaired emotional processing.[7, 8] In this regard, a model of BPD that recently has gained prominence is Linehan's biosocial theory[1] which suggests that BPD emotional dysregulation results from the reciprocal transaction among two primary factors: the biologically emotion vulnerability transacting with an invalidating environment, consisting of caregivers who punish, ignore, dismiss or trivialize the child's emotional expression. One type of emotion regulation that has been shown consistently to be problematic is emotional avoidance or inhibition, e.g. suppression of unwanted emotional thoughts. In addition, negative affect intensity is considered within this model to be a central feature of emotional vulnerability in BPD.[6, 9, 10] This failure in processing appropriately experienced emotions leads to difficulties in interpersonal relationship.

Cluster B Personality Disorders, although this category is pending of a reformulation in next DSM-V,[11] are characterized by hypervigiliance and attentional biases for any emotional negative stimulus.[12] These kind of information-processing biases are associated with several -possibly related- forms of psychopathology such as depressive disorder, posttraumatic stress disorder and BPD.[13] Cognitive theories assume that such attentional biases are not a simple product of the mood disorder, but a key role in causing and maintaining these biases, leading to a vicious cycle, which in turn precipitate a state of heightened anxiety that appears out of control and endless.[14] Besides, the link between selective attention and borderline personality disorder has been demonstrated in several studies,[14-16] which indicate a common context between borderline pathology, affective disorders, anxiety disorders, attention deficit hyperactivity disorder (ADHD) and also give evidence to neuropsychological deficits in patients with BPD.[16]

One of the more used tests to evaluate emotional processing is the emotional Stroop. Several studies[12, 17, 18] have used a modified version of the Stroop paradigm to examine cognitive processes in anxiety involving emotional information. A robust finding based on the emotional Stroop effect is that individuals suffering from an emotional disorder exhibit selective processing of stimuli that are idiosyncratic to their disorder.[18] It has been repeatedly demonstrated that pathological anxiety is related to longer response latencies of naming the colours of words that are related to pathological fears, compared with neutral and non-specific emotional words.[19, 20] On the basis of an extensive review of the literature on emotional Stroop and psychopathology, these authors concluded that individuals with emotional disturbance show disproportionate colour-naming interference for negative stimuli and for stimuli related to personally relevant themes. It seems likely that the interference of negative materials in clinical populations is due to mood-congruence effects. Regarding BPD, Arntz et al.[12] chose an emotional Stroop task given the hypervigilance for danger signals observed in BPD patients. However, they did not find evidence that such hypervigilance was restricted to BPD patients only.

The aim of this study was to determine the emotional bias in BPD by means of an emotional Stroop paradigm. We sought to asses whether there were differences in processing emotionally valenced words (neutral, positive, negative and BPD-related), by measuring the latency to respond.

METHODS

Participants

The sample included 61 women (38 BPD outpatients and 23 healthy control subjects). All patients were recruited at the Department of Psychiatry of Hospital de la Santa Creu i Sant Pau, Barcelona. Control subjects were recruited from the same geographic area with advertisements and from non-medical hospital staff.

Inclusion criteria for patients with BPD consisted of: 1) meeting the DSM-IV diagnostic criteria for BPD as assessed by using two semi-structured diagnostic interviews: the Structured Clinical Interview for DSM-IV Axis II Disorders (SCID-II)[21] and Revised Diagnostic Interview for Borderlines (DIB-R)[22]; 2) patients aged between 18 and 45 years; 3) no comorbidity with schizophrenia, drug-induced psychosis, organic brain syndrome, alcohol or other toxic dependence, bipolar disorder, mental retardation, or major depressive episode in course; 4) Clinical Global Impression of Severity (CGI-S)[23] scores $\geq$ 4. As the majority of patients with BPD normally take pharmacological treatment, in our study, patients could continue pharmacological treatment if they had been initiated at least two months before their participation in the study. The healthy controls had to report satisfaction with present life conditions and without past o current DSM-IV Axis I disorder, Personality Disorder, or any BPD criterion. Exclusion criteria for all participants were

Table 1 List of the words in Spanish for each category. English translation in brachets

Borderline-Negative	Negative	Neutral	Positive
Depresión (Depressive)	Enemigo (Enemy)	Automóvil (Vehicle)	Paz (Peace)
Suicidio (Suicide)	Catástrofe (Catastrophe)	Árbol (Tree)	Entusiasmo (Entusiasm)
Angustia (Anxiety)	Epidemia (Epidemia)	Mueble (Furniture)	Honestidad (Honesty)
Abandono (Abandonment)	Ruina (Ruin)	Colección (Collection)	Salud (Health)
Ira (Rage)	Desgracia (Misfortune)	Librería (Library)	Armonía (Harmony)
Inestable (Instable)	Herida (Wound)	Comedor (Dinning-room)	Sinceridad (Sincerity)
Descontrol (Uncontrolled)	Funeral (Funeral)	Sillón (Armchair)	Tranquilo (Quiet)
Soledad (Loneliness)	Terrorismo (Terrorism)	Actividad (Activity)	Diversión (Fun)
Impulsivo (Impulsive)	Cáncer (Cancer)	Pensamiento (Thought)	Felicidad (Happiness)
Vacío (Emptiness)	Accidente (Crash)	Vestido (Dress)	Éxito (Success)
Autolesión (Self-injury)	Enfermedad (Illness)	Objetivo (Aim)	Confianza (Confidence)
Rechazo (Rejection)	Tumor (Tumor)	Lapicero (Pencil-case)	Amistad (Friendship)

alcohol or drug use during testing, IQ below 80 (estimated by means of Block design and Vocabulary tests of Wechsler Adult Intelligence Scale, WAIS-III), and possible visual problems with the Stroop task. The study was approved by the Clinical Research Ethics Review Board of the Hospital of Sant Pau and by the Spanish Drug Agency. After giving a full description of the study, written informed consent was obtained from all participating patients.

Procedures

Demographic and clinical variables were obtained from all participants. Data about pharmacological treatment was also obtained. For the purpose of this study, a computerised version of the emotional Stroop test was implemented. The classic paradigm involves presenting a subject with colour words written in different coloured inks [13]. The subject's task is to identify the colour of the ink whilst ignoring the semantic content of the word. The modified paradigm involves the presentation of emotional and non-emotional words in different coloured inks, and the task of the subject is to identify their colour. The words were divided in four different valences: borderline-related negative valence, negative valence, neutral valence and positive valence (see Table 1). Subjects had to press the appropriate colour button (blue, yellow, red or green), in accordance with the ink of the word. Latency times were analyzed for those items when the colour was correctly spotted.

Data analyses

Demographic and clinical variables were compared in the two groups by means of one-way ANOVAs. Non-parametric tests were used for categorical variables.

A repeated measures ANOVA was performed for emotional Stroop task, with group as between-subjects factor and valence as within-subjects factor (borderline-related, negative, positive and neutral valence). One-way ANOVA was also carried out for number of hits in the Stroop task. A Huynh-Feldt correction was used where the assumption of sphericity was violated (uncorrected *df* reported). Significant interactions were further analysed by using simple main effect analyses.

Another repeated measures ANOVA was carried out by defining three groups, in terms of DIB-R scores to ascertain the role of BPD severity. The group of outpatients was divided in two groups: severe BPD patients (DIB-R>8) and moderate scorers (DIB-R range 6-8). Severity assessment by means of DIB-R had already been used in a previous study.[24]

In order to asses the effect of the pharmacological treatment a sub-analysis was performed in the patients group, by considering whether patients took medication or not, and whether taking benzodiazepines was related to increased latency times.

RESULTS

Demographic and clinical results

Table 2 shows the demographic and clinical variables of the sample. There were no differences in age between BPD patients and healthy controls (t=1.756, p=0.09). None of the other variables showed differences between groups (p>0.1). The percentage of patients with a DIB-R score higher than 8 was of 71%. Other clinical variables were obtained: 81.6% of the patients had attempted suicide, and they also had had to be

Table 2 Demographic and clinical variables of the sample

		BPD patients	CONTROL subjects
N (females)		38	23
Mean age (SD)		27.42 (5.8)	25.56 (2.3)
Marital Status			
Single		47.4%	65.2%
Married		26.3%	21.7%
Divorced		21.1%	13.1%
Level of Education			
Primary School		26.3%	17.4%
Secondary School		39.4%	30.4%
University		28.9%	52.2%
Work Status			
Active		28.9%	43.5%
Inactive		31.6%	47.8%
Retired/Disabled		34.2%	8.7%
DIB-R Score	6-8	16	NP
	>8	21	NP
Duration of illness (years)		5.05 (3.9)	NP
Previously hospitalized		50%	NP
Pharmacological Treatment			
Antidepressants		65.8%	NP
Mood stabilizers		23.7%	NP
Benzodiazepines		81.1%	NP

(NA = not applicable)

hospitalized at some point along the disorder (see Table 2). In this regard, the majority of patients undertook pharmacological treatment (81.6%), among them only 10 out of 38 took only one drug, 8 out of 38 took two different drugs and 13 out of 38 needed three or more different drugs. As can be observed in Table 2, benzodiazepines (such as diazepam, clonazepam or alprazolam) were the most frequent. Regarding antidepressants, 44.7% of patients took selective serotonin reuptake inhibitors (SSRIs), 7.9% tricycle antidepressants (ADT), and 13.2% selective noradrenaline reuptake inhibitors (SNRIs).

Emotional Stroop task results

There was no effect on accuracy of colour categorisation, with both groups scoring very accurately [>96%; F(1.59)=3.27, p=0.08]. Interaction of group by valence did not reach statistical significance [F(3.177)=0.63, p=0.6]. There was a significant group effect on latency times [F(1.59)=4.33; p=0.04], showing that BPD patients were slower in spotting the appropriate colour of the words. Post hoc analyses displayed group differences in borderline-related words [F(1.59)=5.05; p=0.03] and in neutral words [F(1.59)=4.66; p=0.04] where the group of patients had higher latency responses (see Figure 1), although positive and negative words showed a tendency towards the same effect (p<0.07).

The repeated measures ANOVA of the three groups (i.e. severe group –DIB-R > 8–, moderate group –DIB-R ≤ 8–, and healthy group) showed no interaction of group by valence [F(6,171)=1.68, p=0.13]. As observed in the previous ANOVA,

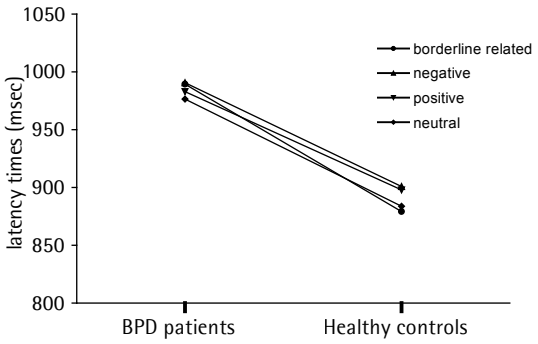

Figure 1 Reaction times of the two groups (BPD patients vs. healthy controls) in spotting the colour valenced words in the Emotional Stroop Task. Mean values are represented for each valence and group

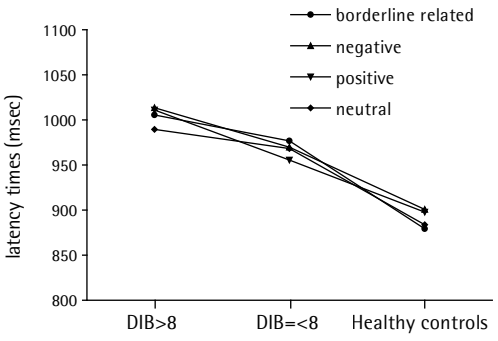

Figure 2 Reaction times in spotting the colour valenced words in the Emotional Stroop Task. Patients group is divided in moderate and severe BPD. Mean values are represented for each valence and group

there was a group effect on latency times [F(2.57)=4.81, p=0.012], being the severe BPD patients the slower (see Figure 2). Post hoc analyses showed that such differences, after a Bonferroni correction, were between the severe BPD patients and healthy controls for borderline-related [F(2.59)=5.12, p=0.009] and positive words [F(2.59)=5.14, p=0.009].

Regarding the pharmacological variables, the results of the ANOVA showed that undertaking medication or benzodiazepines had no effect on latency or on accuracy in the patients group ($p > 0.2$).

DISCUSSION

The main result of this study is that BPD patients seem to display higher latency times to respond regardless the valence of the words, with no differences in accuracy. Likewise, the more severe the BPD the slower the subjects, indicating that such difficulties in processing information depend on the severity of the disorder. The latency times were affected by the emotional content of the borderline-related and positive words, and there was a tendency towards negative words to be processed the slowest. The medication could have account for such slowness given that some psychotropic drugs affect the speed processing, but the results do not suggest that those patients taking benzodiazepines or antidepressants were the slower. Our results are partly in agreement with Williams et al.,[19] although patient's interference for emotional stimuli was more moderate than disproportionate.

The higher latencies in BPD sample could be related with the severity of the disorder. With the Stroop paradigm, a relation between more severe psychopathology across the anxiety disorders and slower responses has already been suggested.[25] Our results show that BPD displays a similar relation with severity which might be explained in terms of the comorbidity of BPD with depression and general anxiety. In this regard, Arntz et al.[12] reported that BPD patients (but also Cluster C patients) were hypervigilant for danger signals, i.e. those patients displayed longer reaction times in the emotional Stroop paradigm.

The present study fails to replicate the hypothesis that moderate-severe BPD patients are hypervigilant for any emotional negative stimulus as observed by Arntz et al.[12] In fact, we observe interference responses on emotional borderline-related words for those patients with higher scores on DIB-R interview. The lack of stimulus specificity reported in Arntz's study[12] might either indicate that the small sample size may have missed other effects and interactions via type II errors, or that emotional content congruent interference is only detectable in severe BPD patients. Worth particular note is the fact that the diagnosis of BPD was established with DSM-IV criteria, and more importantly the severity of the disorder was also determined by means of the DIB-R which allows a more precise diagnose of BPD. The Spanish version of this semi-structured interview has showed good total internal consistency and high inter-rater reliability, and it also displays higher sensitivity and specificity than the SCID-II.

Taking into consideration the emotional specificity, the higher latencies for positive words were somehow unexpected. This result could account for the presence of hyperreactivity to emotional content (either positive or negative) rather than hypervigilance for danger signals more common in anxiety disorders. The selective processing could also be attributed to concern relevance.[18] Words such as *emptiness* are high in emotionality and are highly related to a BPD patient concern, but also *love* or *happiness* because of the emotional impact caused to these patients, because of a high sensitivity to emotional stimuli, as Linehan[1] has argued it. BPD patients show difficulties in regulating emotions, i.e., they have troubles in decreasing their emotionality after a personally relevant stimulus. During the Stroop task, the presence of borderline-related words might trigger negative experiences that are maintained, and there can be an overlap with next words, even if they are neutral or positive. In this regard, Levine et al.[14] found that BPD patients had more limited capacities for processing emotional information related to self and others.

Our finding does not suggest an impulsive pattern in the way the patients performed the emotional Stroop task (all patients were highly accurate throughout the task). Domes et al.[26] suggested that individuals with BPD have difficulties in actively suppressing irrelevant information when it is of an aversive nature. In our case, the BPD patients probably read the words, when it was not the objective of the task, and this made them slower in telling the colour of the ink. Inhibitory dysfunction appears to be closely related to state and trait variables of unstable affect, but not to self-reported impulsiveness.[26]

This study presents some limitations that have to be mentioned. The sample size may account for the lack of significant interactions of valence by group, which was the main hypothesis of this study. Also, considering only females to be entered in the study might have biased the results. It cannot be surely asserted that benzodiazepines had no effect on reaction time in the patients group, given that the majority of patients were taking such medication, and only six patients were benzodiazepine-free.

In summary, the Stroop task has been used in psychopathology research for a considerable period of time. Our results also suggest that the Stroop task is a valuable tool for examining cognitive processes in psychopathology. We have found that BPD subjects had longer response times than normal controls to emotionally valenced words. Interestingly, this finding was specific to words reflecting BPD topics, contrary to reflect a more general hypervigilance and an attentional bias for any kind of stimulus. Further studies should investigate the implication of biological variables in the selective attention of relevant/negative information, such as levels of cortisol while processing.

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