Emotional and Non-emotional Facets of Impulsivity in Eating Disorders: From Anorexia Nervosa to Bulimic Spectrum Disorders

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Abstract

Objective: Impulsivity and difficulties in regulating emotions are considered to be transdiagnostic characteristics of patients with eating disorders (EDs). The study aimed to investigate trait impulsivity and inhibitory components of impulsivity, related or unrelated to emotions in patients with EDs.

Method: 17 patients with anorexia nervosa (AN), 16 patients with bulimic-spectrum EDs (BSD) and 20 healthy control participants (HC) completed an impulsivity scale (UPPS-P) before performing an emotional inhibitory control task during electroencephalography (EEG) acquisition.

Results: Higher trait impulsivity in EDs than HC (with higher scores among BSD patients) was observed. However, no differences in behavioural measures or neural indexes (event-related potential - ERP) of emotional and non-emotional inhibitory control were observed between patients and HC.

Conclusion: The present results highlighted negative urgency, an impulsive personality trait related to emotions, as a common feature of AN and BSD. Lack of perseverance, a trait which is less related to emotions, specifically characterizes patients with BSD. On the other hand, behavioural and ERP data did not show altered inhibitory control in EDs, for either general or emotional-related response inhibition.

Keywords: eating disorders, event-related potentials, inhibitory control, negative urgency, trait impulsivity.

Introduction

Impulsivity and difficulties in regulating emotions are considered to be transdiagnostic characteristics of patients with eating disorders (EDs) (Mallorquí-Bagué et al., 2018; Wolz et al., 2015). At a clinical level impulsive behaviours are typically related to the bulimic-spectrum of EDs, encompassing bulimia nervosa (BN), binge eating disorder (BED) and anorexia nervosa bingeing/purging subtype (AN-BP) (Atiye, Miettunen, & Raevuori-Helkamaa, 2015; Lavender et al., 2015; Waxman, 2009; Wolz et al., 2015); although impulsive behaviours have also been found in the restrictive subtype of anorexia nervosa (AN-R) (Favaro & Santonastaso, 2000). Similarly, patients with EDs show difficulties in recognizing and regulating emotions (Harrison, Sullivan, Tchanturia, & Treasure, 2009). It has been suggested that patients with EDs engage in dysregulated eating behaviours (e.g. bingeing, purging, and even restricting) in a maladaptive attempt to regulate negative emotions (Brockmeyer et al., 2014; Corstorphine, 2006; Harrison et al., 2009; Lavender et al., 2014). Moreover, an intense emotional state (both negative and positive) often precedes binge episodes in patients with BN or BED (Bongers, Jansen, Houben, & Roefs, 2013; Gianini, White, & Masheb, 2013; Leehr et al., 2015; Nicholls, Devonport, & Blake, 2016). These patterns of emotion dysregulation and some forms of impulsivity seem to be strongly interrelated in patients with EDs. Impulsivity, defined as the tendency to act quickly without enough consideration of the action consequences, is a multifaceted construct comprising personality traits, and behavioural and cognitive factors. Emotions seem to have a central role in the characterization of certain domains of impulsivity, thus a distinction between emotional and non-emotional components of impulsivity has been suggested (Barratt, 2004; Perales, Verdejo-Garcia, Moya, Lozano, & Perez-Garcia, 2009).

With regards to impulsive personality traits, the UPPS model has emerged as a successful factorial account (Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010a) and has shown to be useful to identify impulsive behaviours associated with different psychopathologies, including the EDs spectrum (Claes, Vandereycken, & Vertommen, 2005). The UPPS-P (Whiteside & Lynam, 2001) includes five main dimensions: positive urgency (i.e. the tendency to act impulsively when undergoing positive affect), negative urgency (i.e. the propensity to act impulsively when experiencing negative affect), sensation seeking (i.e. the disposition to seek exciting experiences), lack of perseverance (i.e. the tendency to not persist in an activity that can be arduous or boring) and lack of premeditation (i.e. the tendency to act without considering the consequences of an action). Of these five dimensions, sensation seeking as well as negative and positive urgency are the ones mostly linked to emotional factors (Torres et al., 2013). Current studies conducted with EDs draw special attention to emotional

impulsive traits and especially to negative urgency, which is strongly suggested as a key component of binging and purging behaviours whereas the association of binging with other impulsivity dimensions shows small effect sizes (Cyders & Smith, 2008; Fischer, Smith, & Anderson, 2003; Kenny, Singleton, & Carter, 2019). However, some studies report the link of non-emotional impulsive traits with these eating behaviours. For instance, patients with binge purging behaviours consistently showed less premeditation and perseverance than patients with AN together with more negative urgency and sensation seeking (Claes et al., 2005).

From a behavioural perspective, one of the main components of impulsivity is inhibitory control which refers to the ability to suppress, interrupt or delay an activated behaviour or cognitive course of action (Bartholdy, Dalton, O'Daly, Campbell, & Schmidt, 2016). The underlying mechanisms of Inhibitory control and its related brain network seems mostly non-emotional (Rubia et al., 2001), yet the evidence indicates that the brain regions involved in the network changes as a function of the response to be inhibited. Thus, when emotional responses are implicated, brain networks related to emotional salience (e.g. limbic system, amygdala, insula) are involved (Banich et al., 2009; Compton et al., 2003; García-García et al., 2016). Response inhibition tasks (e.g. go/no-go; stop signal) have been most commonly used to investigate motor components of inhibitory control. Affective version of these tasks (e.g. emotional go/no-go) can be adopted to study emotional modulation of response inhibition (Drevets & Raichle, 1998; Schulz et al., 2007).

Time-locked electroencephalography (EEG) or event-related potential (ERP) helps capture neural activity related to both sensory and cognitive processes. Given its excellent temporal resolution, ERP technique is well suited to study neurophysiological correlates of inhibitory control and emotional modulation of this process. ERP components which have been consistently associated with inhibitory control mechanisms are: the no-go N2, which is a negative deflection occurring 200-350 ms following the no-go stimuli (Bruin, Wijers, & van Staveren, 2001; Kiefer, Marzinzik, Weisbrod, Scherg, & Spitzer, 1998; Pfefferbaum, Ford, Weller, & Kopell, 1985) linked to effortful attention, detection of response conflict, and action monitoring (Donkers & van Boxtel, 2004; Nieuwenhuis, Yeung, van den Wildenberg, & Ridderinkhof, 2003; Yeung, Botvinick, & Cohen, 2004); and the no-go P3, a positive deflection occurring at 300-600 ms following no-go stimuli, which has been primarily related to the inhibitory process itself (Bruin et al., 2001; Smith, Johnstone, & Barry, 2008). A few ERP studies investigated inhibitory control in presence of emotional stimuli in healthy population, with some showing emotional modulation of the no-go P3 component (Albert, López-Martín, & Carretié, 2010; Chiu, Holmes, & Pizzagalli, 2008). Interestingly, larger no-go P3 has been reported for emotional than

neutral stimuli in individuals with higher trait impulsivity (Messerotti Benvenuti, Sarlo, Buodo, Mento, & Palomba, 2015), whereas larger no-go N2 in an emotional go/no-go task has been reported in individuals with higher emotional intelligence (Megías, Gutiérrez-Cobo, Gómez-Leal, Cabello, & Fernández-Berrocal, 2017).

In patients with EDs, altered inhibitory control appears to be implicated in the development and maintenance of the disorder. Specifically, poor inhibitory control contributes to the inability to control the urges to binge or to purge, whereas excessive inhibitory control is reported in AN (Brooks, Rask-Andersen, Benedict, & Schiöth, 2012). A meta-analysis of studies on response inhibition tasks in patients with EDs reported general deficits in bulimic-type eating disorders, although with small effect size (Wu, Hartmann, Skunde, Herzog, & Friederich, 2013). Overall, current literature presents divergent findings with some studies suggesting lower general response inhibition in patients with AN (Galimberti, Martoni, Cavallini, Erzegovesi, & Bellodi, 2012), BN (Wu, Giel, et al., 2013) and BED (Svaldi, Tuschen-Caffier, Trentowska, Caffier, & Naumann, 2014), while other studies do not report evidence for reduced response inhibition in EDs (see for a review: Bartholdy et al., 2016). Nonetheless, more consistent findings in patients with BN showed deficits when response inhibition is specifically measured for disorder-relevant stimuli (e.g., food; body-shape) (Wu, Hartmann, et al., 2013). This may suggest that difficulties in response inhibition among EDs may be particularly affected in relation to specific stimuli rather than general stimuli. Given the alteration in emotional processing and regulation suggested in EDs, it could be expected that the emotional context would differently modulate inhibitory control in patients with EDs compared to the general population. However, there is a lack of studies assessing emotion-related inhibitory control in patients with EDs.

In the present study, we aimed to investigate different components of emotional and non-emotional impulsivity in patients with AN and bulimic-spectrum EDs (BSD; i.e.: including BN and BED) as compared to HC. More specifically, we explored: a) trait impulsivity, assessed according to the UPPS-P model; b) inhibitory control, assessed through an emotional go/no-go task and neurophysiological correlates of response inhibition. We hypothesized higher trait impulsivity in ED patients compared to HC, with higher impulsivity in BSD than AN. Based in previous literature we specifically expected negative urgency to be the trait more highly linked to ED patients in general but even more in patients from the bulimic-spectrum. We also expected to observe a tendency to higher sensation seeking scores together with lower perseverance and premeditation scores in BSD patients. As for response inhibition, we expected to detect lower accuracy in no-go trials compared to go trials, which would be reflected at a neurophysiological level by larger N2 and P3 amplitudes in no-go trials. In particular, we expected to

detect differences in behavioural and ERP indices of response inhibition in patients with EDs compared to controls, possibly expecting reduced ability to withhold inappropriate motor responses in BSD and higher control ability in AN compared to HC. Emotional images (positive and negative) are expected to interfere with inhibitory control mechanisms, at least in HC. This is the first study investigating emotional-inhibitory control in ED patients, thus a priori hypothesis was not present. However, based on emotional difficulties described in EDs, emotional stimuli may lead to reduced response inhibition in BSD, while lower interference of emotional stimuli on response inhibition may be expected in patients with AN.

Methods

Participants

In the present study, the sample was comprised of two clinical groups and a HC group: 1) patients with AN 2) patients with BSD (including BN and BED) and 3) a HC group. The clinical groups were comprised of 20 female treatment seeking patients diagnosed with AN according to DSM-5 criteria (American Psychiatric Association, 2013) and 20 female treatment seeking patients diagnosed with any BSD (70% BED and 30% BN, according DSM-5) who attended to the ED Unit within the Department of Psychiatry at Bellvitge University Hospital- a public health hospital certified as a tertiary care centre with a highly specialised unit for the treatment of ED in Barcelona (Spain). The HC group consisted of 21 female participants who had no history of an ED. Participant groups were matched by education level. All participants were recruited between June-2016 and July-2018.

Data from eight participants (one HC, three AN and four BSD) had to be excluded due to poor EEG data quality. The final sample size consisted of 53 participants, of whom 17 were patients with AN (mean age = 22.7 years, SD = 6.51, age range 18 to 43, mean BMI = 16.63 kg/m^2, SD = 1.0), 16 were patients with a BSD (mean age = 40.18 years, SD = 9.93, age range 22 to 56, mean BMI = 37.81 kg/m^2, SD = 7.2) and 20 were HC (mean age = 20.81 years, SD = 4.84, age range 18 to 39; mean BMI= 20.8 kg/m^2, SD = 1.61). Exclusion criterion for all participants were: (a) being male, (b) younger than 18 years, (c) current or life-time history of chronic illness or neurological condition (abnormal EEG activity), which could influence electrophysiology and/or the neuropsychological assessment, (d) lifetime diagnosis of a severe mental health condition, (e) current substance dependence or any other mental disorder that could interfere with cortical activity or the assessment. Additionally, in the HC group, an exclusion criterion was a lifetime diagnosis of any ED, assessed by means of the Mini

International Neuropsychiatric Interview (MINI, (Sheehan et al., 1998), or being obese (Body Mass Index (BMI) ≥ 30) or underweight (BMI < 18.5).

All participants gave written informed consent for being part of the study and the study protocol and procedures were approved by the Ethics Committee of University Hospital of Bellvitge in accordance with the Helsinki Declaration of 1975 as revised in 1983. Participants received no compensation for taking part in the study.

Procedure

Patients who sought treatment for AN, BED or BN as their primary health concern were assessed by an experienced clinical psychologist as part of the ED unit protocol, which is based on DSM-5 (American Psychiatric Association, 2013) criteria and includes height and weight measurements. All patients consecutively diagnosed with AN, BED or BN were screened for the inclusion criteria of the study and gave informed consent for voluntarily accepting to be part of the study. HC participants were recruited within a university campus and if they were interested in taking part in the study, an eligibility screening was conducted prior to the initial face-to-face assessment session.

The variables explored in the present study were evaluated as part of a bigger assessment which took part in two separate sessions of approximately 90 minutes each. Firstly, participants were evaluated with the MINI (Sheehan et al., 1998) to exclude those patients with any severe psychiatric condition. Afterwards, they completed a battery of self-reported questionnaires (including UPPS-P). Next, participants performed the experimental tasks (emotion go/no-go task and two extra tasks which are reported in a separate manuscript Mallorquí-Bagué, et al., 2020) during EEG acquisition. Participants were instructed to have a 'normal' meal 90 minutes before the session and then to refrain from eating or drinking coffee. Additional information was collected on the day of the experimental session, in order to control for a set of variables (i.e. food consumed the day of the session, menstrual cycle, and alcohol or drugs consumption in the last 24h). In a second session, participants completed a different set of experimental neurophysiological tests (data will be reported in a separate manuscript).

Measures

Clinical and self-reported measures

The Mini-International Neuropsychiatric Interview (MINI; Sheehan et al., 1998) is a short structured diagnostic interview for the major psychiatric disorders in the DSM-IV (American

Psychiatric Association, 1994) which has shown good reliability and validity properties. With an administration time of approximately 15 minutes, it was designed to meet the need for a short but accurate structured psychiatric interview for multicentre clinical trials and epidemiology studies and to be used as a first step in outcome tracking in non-research clinical settings. The standard MINI assesses the 17 most common disorders in mental health. The disorders investigated are the most important to identify in clinical and research settings. The disorders were selected based on current prevalence rates of 0.5% or higher in the general population in epidemiology studies.

The UPPS-P Impulsivity Scale (Whiteside, Lynam, Miller, & Reynolds, 2005) is a 59-item questionnaire to assess five different features of impulsive behaviour: lack of premeditation, lack of perseverance, sensation seeking, negative urgency and positive urgency. The UPPS-P has satisfactory psychometric properties in terms of both convergent and discriminative validity and its Spanish adaptation also shows adequate psychometric properties (Verdejo-García, Lozano, Moya, Alcázar, & Pérez-García, 2010). The α values for the different UPPS-P scales in our sample are: lack of premeditation (0.842), lack of perseverance (0.872), sensation seeking (0.879), positive urgency (0.924) and negative urgency (0.884).

Emotional go/no-go task:

Participants completed an emotional go/no-go task which consisted of the visual presentation of affective pictures as go (i.e. blue framed affective pictures) and no-go stimuli (i.e. yellow framed affective pictures). The task was compiled and run using E-PrimeTM software (Psychology Software Tools, Inc., Pittsburgh, PA; Schneider, Eschman, & Zuccolotto, 2002) and the images were selected from the International Affective Picture System (IAPS; Lang, 2005) on the basis of their standardized ratings of affective arousal and valence ratings. Images were divided into three emotional valence categories: 200 pleasant, 200 neutral and 200 unpleasant. The mean (SD) normative valence ratings and the mean (SD) normative arousal ratings respectively were 7.58 (0.31) for pleasant images; 5.17 (0.27) and 3.25 (0.61) for neutral images; 2.08 (0.37) and 5.96 (0.73) for unpleasant images.

The task required participants to monitor 600 stimuli presented individually in the centre of a computer screen and respond as rapidly as possible (while trying not to make errors) by pressing a mouse button to target stimuli (go cues) and withholding responses to non-target stimuli (no-go cues). The emotional and non-emotional go/no-go task consisted of three blocks. Each block contained 200 images, of which 75% were go cues (“press the left side of the mouse as fast as you can when you see a

blue frame") and 25% were no-go cues ("do not press the left side of the mouse when you see a yellow frame"), resulting in a total of 600 images (450 go cues and 150 no-go cues). Trial order of the presentation of the images in the task was counterbalanced within each block and blocks' order presentation was also randomized. Images were presented in the centre of the screen (w= 75%; h=75%; the remaining 25% corresponds to y/b frame) for 200 ms each. The interstimulus interval (ISI) was pseudorandomized from 1500 to 1700 ms to discourage anticipatory responses; a fixation cross was displayed in the centre of the screen during the ISI. Instructions were presented on the computer screen before each block started and participants pressed a mouse button when ready to begin. In order to ensure that participants processed each picture's content; they were required to keep the eyes fixed on the centre of the screen. Before the beginning of the task, participants underwent a practice block of 8 trials (75% go and 25% no-go), to ensure they understood task instructions.

Reaction times (RTs) in go trials and accuracy in go and no-go trials were calculated for each emotional category (i.e.: positive, negative and neutral). The RTs data for the go trials were calculated after the deletion of incorrect responses and outliers for each individual (i.e., RTs below 150 ms or above 1500 ms).

Electrophysiological (EEG) recording and data reduction

The electroencephalogram (EEG) was recorded continuously throughout the experimental task using PyCorder (BrainVision). Sixty active Ag/AgCI electrodes were placed into an EEG recording cap (EASYCAP GmbH), distributed according to the 10–20 system; additional three electrodes were adopted for recording vertical and horizontal electrooculogram (EOG) and Cz was used as online reference. Impedances were kept below 20 KOhm using the SuperVisc high-viscosity electrolyte gel for active electrodes. Signals from all channels were digitized with a sampling rate of 500 Hz and 24 bit/channel resolution and online filtered between 0.1 and 100 Hz.

Offline EEG analyses were performed with Brain Vision Analyser consisting in the following steps: high pass filtering 0.1 Hz, low pass filtering at 30 Hz (Butterworth zero phase filter; 24 dB/octave slope) and notch filter at 50 Hz; raw data inspection for manual detection of artifact and screening for bad channels, semi-automatic eye-blink correction using independent component analysis (ICA); artifact rejection of trials with an amplitude exciding ± 80 μV; EEG data were segmented into 1500 ms epochs from 500 ms before to 1000 ms after stimulus onset. Data were baseline corrected against the mean voltage during the – 200 ms pre-stimulus periods. Artifact free epochs were separately

averaged for each subject in each experimental condition (go, no-go) and stimulus type (positive, negative, neutral).

ERP analyses were based on visual inspection of the grand average waveforms and the existing literature. Peak amplitudes for the N2 and P3 components were computed in fronto-central cluster (FC1, FC2, Fz, C3, C4, Cz), in the time windows between 200-380 ms and 300-500 ms, respectively.

Statistical analysis

Statistical analysis was carried out with Stata16 for Windows. The impulsivity levels (UPPS-P scores) were compared between groups using analysis of variance, adjusted by the participants' age (ANCOVA). Effect size for pairwise comparisons was measured through Cohen's-*d* coefficient (low/poor effect size was considered for $|d|>0.2$, moderate for $|d|>0.5$ and large/high for $|d|>0.8$; (Kelley & Preacher, 2012).

Accuracy and ERP components (N2, P3) of the go/no-go task were compared through 2×3×3 mixed ANOVA, defining as within-subjects the factors "condition" (go *versus* no-go) and "type" (positive, negative and neutral) and as between-subjects factor the "group" (HC, AN, and BSD). Pairwise comparisons estimated main effects (for non-significant interaction parameters) and simple effects (for significant interaction parameters). In this analysis, eta-squared coefficient ($\eta 2$) was obtained to measure the effect size for the ANOVA (values of 0.01, 0.06, and 0.14 were interpreted as low-poor, moderate-medium, and large-high effect size) (Levine and Hullett, 2002).

Results

Self-report measures:

Table 1 contains the results of the ANCOVA (adjusted by age) measuring the mean differences in the UPPS-P scores between the groups. Lack of perseverance was higher in the BSD group compared to both AN (T = 3.07, p = 0.004, |d| = 1.52; $\eta 2$ = 0.164) and HC (T = 4.06, p=0.001, |d|=2.45; $\eta 2$ = 0.256). Sensation seeking scores were not significantly different between the groups, but a moderate effect size was obtained in the comparison between BSD and AN (higher mean in the BSD group: T = 1.21, p = .232, |d|=0.63; $\eta 2$ = 0.030). Regarding negative urgency, the group that presented higher mean scores was the BSD group, followed by the AN and the HC groups all pairwise comparisons achieved statistical significance and/or mild to large effect size; HC vs AN: T = 1.96, p = 0.056, |d| = 0.69, $\eta 2$ = 0.074; HC vs BSD: T = 2.83, p = .007, |d| = 1.48, $\eta 2$ = 0.143; AN vs BSD: T = 1.56, p = .126, |d| = 0.80, $\eta 2$ = 0.048).

Table S1 (supplementary) includes the results of assessing for potential differences between the AN subtypes [restrictive (AN-R) versus bulimic-purgative (AN-BP)] in the impulsivity profile. Statistical differences appeared in the negative urgency domain: higher mean score in the AN-BP compared to AN-R (35.3 versus 28.0, p=.041, $|d|$=1.24).

--- Table 1 ---

Table 2 shows the means and standard deviations of the reaction times (RTs) and accuracy in the go/no-go task, as well as the amplitudes (μV) for each ERP component (N2 and P3). Table S2 (supplementary) includes the complete results obtained in the mixed ANOVA.

Emotional go/no-go task:

RTs in go trials. The mixed design ANOVA yielded a quasi-significant main effect of group F = 2.84, df = 2/48, p = 0.068; η2 = 0.104, a non-significant main effect of the type (F=0.73, df=2/49, p=0.469, η2=0.015), and a non-significant group x type interaction (F=0.80, df=4/49, p=0.517, η2=0.031). Post-hoc pairwise comparisons revealed that the main effect of the group was related to the higher means in the reaction time registered in the HC compared to the AN (p=0.023).

Accuracy. The mixed design ANOVA yielded a significant main effect of condition (F=11.82, df=1/49, p<0.001; η2=0.194), a significant main effect of group (F=5.88, df=2/49, p=0.005, η2=0.193) and a non-significant effect of type (F=1.35, df=2/49, p=0.264, η2=0.027). No significant interaction parameters were obtained (group x condition: F=0.61, df=2/49, p=0.547, η2=0.024; group x type: F=0.38, df=4/49, p=0.817, η2=0.015; condition x type: F=0.89, df=2/49, p=0.415, η2=0.018; and group x condition x type: F=0.11, df=4/49, p=0.977, η2=0.005). Post-hoc pairwise comparisons revealed that the main effect of condition was due to higher means registered in the go trials compared to the no-go trials (p<.001), and that the main effect for the group was related to the lower means in the BSD compared to HC (p=.001) and AN (p=.013).

N2-amplitude. The mixed design ANOVA yielded a significant main effect of condition (F=4.92, df=1/49, p=0.031; η2=0.091), and a non-significant main effect of type (F=1.04, df=2/49, p=0.357, η2=0.021) and group (F=1.08, df=2/49, p=0.349, η2=0.042). No significant interaction parameters were obtained (group x condition: F=1.04, df=2/49, p=0.337, η2=0.043; group x type: F=0.95, df=4/49, p=0.438, η2=0.037; condition x type: F=0.44, df=2/49, p=0.611, η2=.009; and group x condition x type: F=1.77, df=4/49, p=0.152, η2=.067). Post-hoc pairwise comparisons revealed that the main effect of condition was due to more negative means (higher N2 negativity) registered in the go trials compared to the no-go trials (p<.001).

P3-amplitude. The mixed design ANOVA yielded a significant main effect of condition ($F=4.36$, $df=1/49$, $p=0.042$; $\eta2=0.082$), and a non-significant main effect of type ($F=0.60$, $df=2/49$, $p=0.547$, $\eta2=0.012$) and group ($F=0.01$, $df=2/49$, $p=0.989$, $\eta2=0.001$). No significant interaction parameters were obtained (group x condition: $F=0.68$, $df=2/49$, $p=0.597$, $\eta2=0.027$; group x type: $F=0.24$, $df=4/49$, $p=0.913$, $\eta2=0.010$; condition x type: $F=0.19$, $df=2/49$, $p=0.821$, $\eta2=0.004$; and group x condition x type: $F=0.82$, $df=4/49$, $p=0.510$, $\eta2=0.033$). Post-hoc pairwise comparisons revealed that the main effect of condition was due to more positive amplitude registered in the go trials compared to the no-go ($p<.001$).

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Discussion

The present study explored trait impulsivity and emotion-related inhibitory control in patients with BSD and AN, and compared them with a normal-weight group of HC. Trait impulsivity was assessed using the UPPS-P scale; an emotional go/no-go task during EEG recording was used to assess inhibitory control in presence of emotional (positive and negative) and neutral stimuli. Results demonstrated higher trait impulsivity in EDs than HC (with even higher scores among BSD patients) and lower response accuracy in the go/nogo task among BSD patients; however, no group differences were detected in neural or behavioural indices of inhibitory control, neither in presence of emotional or neutral stimuli.

With regards to trait impulsivity, as hypothesised results displayed higher negative urgency in both ED groups compared to HC, with BSD showing higher negative urgency than AN. Patients with BSD also showed the highest score in lack of perseverance compared to both AN and HC, and a mean value for the sensation seeking domain higher than AN (with an effect size into the mild/moderate range). No significant differences were observed for the lack premeditation or positive urgency. Our results support those of previous studies reporting negative urgency as a key component of BSD (Fischer, Peterson, & McCarthy, 2013; Magel, 2019; Steward et al., 2017) and add some extra evidence on the role of lack of perseverance in this disorder. Therefore, in patients with BSD, it appears as remarkably relevant to specifically target and assess negative emotions during treatment as well as to target and assess low perseverance as it could be an indicator of bad prognosis and worse treatment outcome..

In the emotional go/no-go task, RTs in go trials were not modulated by positive or negative images, which may suggest a lack of emotional bias, at least over motor responses. As for accuracy, significantly lower accuracy was present in no-go trials compared to go trials, indicating that the task was effective in inducing a pre-potent tendency to respond. However, again, emotional images do not affect accuracy in no-go trials, in neither HC nor EDs subjects, suggesting that in our task incidental emotional stimuli with positive or negative valence do not interfere with response inhibition. Interestingly, BSD patients showed lower task accuracy, and this seems to be particularly evident in the no-go trials (see table 2). Unfortunately, the interaction between group and condition was not significant thus it did not support the hypothesis of lower inhibitory control in patients with BSD. Still these results may be due to reduced statistical power. As compared to previous literature, some of the behavioural studies of inhibitory control, did not show differences between patients with EDs (including AN, BED, BN and EDNOS) and HC (Claes, Nederkoorn, Vandereycken, Guerrieri, & Vertommen, 2006; Mole et al., 2015; Wu, Hartmann, et al., 2013) although contrasting findings are present (Bartholdy et al., 2016; Wierenga et al., 2014; Wu, Hartmann, et al., 2013). Overall, it has been suggested that specific elements of inhibitory control may be differently affected among ED subtypes. For instance, proactive component of inhibitory control (i.e. a form of inhibitory control related to the preparation or initiation of a response) is augmented in patients with AN (Bartholdy et al., 2017). By contrast, no differences in reactive inhibitory control (i.e. withhold a motor response in reaction to a cue) were detected in patients with BN, BED or AN compared to controls, suggesting that specific elements of inhibitory control may be differently affected in different EDs. Further investigating these differences with experimental paradigms may allow the development of specific inhibitory control trainings adapted for different EDs.

Concerning ERP measures, N2 and P3 amplitudes in no-go trials were larger than in go trials, in line with the typical go/no-go effect, also observed at behavioural level. However, and similarly to behavioural results, no differences were shown across groups in neural index of response inhibition (e.g. no-go N2 / P3 amplitudes). Neither patients nor controls showed differences in ERP between emotional and non-emotional trials of the task, further confirming the lack of emotional modulation of inhibitory control. In a previous study in HC, results showed emotional modulation of no-go P3 only in individuals with high traits impulsivity, measured by the BIS-11 scale (Messerotti Benvenuti et al., 2015). This suggests that, at least in healthy individuals, emotional context may interfere with inhibitory control as a function of trait impulsivity. Given this, the lack of differences in emotional or non-emotional inhibitory control between patients and HC may be partially explained by variability in

impulsivity traits observed in the HC group. Thus, impulsivity trait seems to be an important factor to assess in healthy population.

It is also worth noting that there are no previous ERP studies assessing emotional inhibitory control in EDs, which makes the present findings difficult to compare and contextualize. Only a recent ERP study in patients with BED measured food-related inhibitory control using an antisaccade paradigm with food stimuli (Leehr et al., 2018), after inducing negative mood. Despite of methodological differences (e.g. mood induction; task; sample of EDs; food-related stimuli), ERP results did not show reduced inhibitory control in BED, as showed by similar N2 amplitudes between patients and controls. By contrast, at behavioural level more errors were detected in BED, suggesting food-specific inhibitory control difficulties.

The current study should be considered under some limitations. First of all, the cross-sectional design of this study cannot imply causality. Additionally, the limited sample size may have an effect on the external validity of the study (and therefore in the capacity to infer conclusions to the original populations) as well as on the statistical power analyses (the capacity to identify relationships between the variables is limited). However, it must be maintained that the conclusions of the current study were not only based on the significance tests but also on the standardized measures used to calculate the effect sizes (Cohen's-*d* values, which are not affected by samples sizes). Likewise, it should be considered that the assessment conducted in this study is difficult to perform in clinical samples, and therefore researches in this area are scarce, include low sample sizes and perform extra caution for controlling potential biases in the statistical analyses. Given that the assessment of the present study mainly focuses on some aspects of the impulsivity, our results are not generalizable to all facets of impulsivity which should be explored in future studies. Finally, current findings should not be generalised to men with EDs, as only women were recruited in the current sample.

In conclusion, the present results highlighted negative urgency, an impulsive personality trait related to emotions, as a common feature of AN and BSD. Lack of perseverance, a trait which is less related to emotions d, specifically characterizes patients with BSD. On the other hand, behavioural and ERP data did not show altered inhibitory control in EDs, for neither general nor emotional-related response inhibition. Other facets of impulsivity and inhibitory control should be further investigated in future studies in larger clinical samples, to better elucidate cognitive profiles of EDs and developing specific treatments.

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

Table 1

Comparison of the clinical profile between groups: ANCOVA adjusted by age

	HC (*n=20)*		AN (*n=17)*		BSD (*n=16)*		HC vs AN		HC vs BSD		AN vs BSD	
	Mean	*SD*	*Mean*	*SD*	*Mean*	*SD*	*p*	|*d*|	*p*	|*d*|	*p*	|*d*|
UPPS-P Lack premeditation	21.1	5.3	21.2	5.8	21.6	5.8	.953	0.02	.861	0.09	.893	0.07
UPPS-P Lack perseverance	16.1	4.5	18.7	6.4	27.2	4.5	.146	0.46	**.001***	**2.45†**	**.004***	**1.52†**
UPPS-P Sensation seeking	28.5	8.4	24.7	7.1	29.5	8.1	.138	0.49	.791	0.13	.232	**0.63†**
UPPS-P Positive urgency	23.8	5.7	24.9	8.6	26.8	12.6	.745	0.14	.544	0.30	.694	0.18
UPPS-P Negative urgency	26.1	6.4	30.6	6.8	36.4	7.5	.056	**0.69†**	**.007***	**1.48†**	.126	**0.80†**

Note. SD: standard deviation. HC: healthy control. AN: anorexia. BSD: Bulimic spectrum disorder.

*Bold: significant parameter (.05 level). †Bold: effect size into the mild/moderate (|*d*|>0.50) to large/good range (|*d*|>0.80).

Table 2

Means and SD for behavioural and ERP measures during the go/no-go task

			HC		AN		BSD	
			n=20		*n*=17		*n*=16	
Measure	Condition	Type	*Mean*	*SD*	*Mean*	*SD*	*Mean*	*SD*
RTs	Go	Positive	389.9	57.3	349.8	46.2	369.7	66.2
		Negative	391.4	56.0	344.0	56.1	391.4	73.0
		Neutral	390.8	58.0	349.1	49.4	374.2	70.7
Accuracy	Go	Positive	0.99	0.03	0.99	0.04	0.94	0.07
		Negative	1.00	0.01	0.99	0.02	0.94	0.07
		Neutral	1.00	0.03	0.99	0.03	0.93	0.08
	No-go	Positive	0.86	0.11	0.83	0.12	0.75	0.12
		Negative	0.87	0.10	0.83	0.11	0.75	0.12
		Neutral	0.86	0.11	0.81	0.13	0.73	0.13
N2-amplitude	Go	Positive	-4.27	2.05	-4.46	2.38	-5.53	2.30
		Negative	-4.44	2.26	-5.32	2.30	-5.82	2.51
		Neutral	-4.59	2.04	-5.07	2.33	-5.49	2.10
	No-go	Positive	-3.49	2.37	-4.91	2.20	-6.18	2.99
		Negative	-5.16	2.56	-5.92	3.01	-6.75	2.51
		Neutral	-5.47	2.27	-6.14	2.40	-6.43	2.42
P3-amplitude	Go	Positive	1.14	2.02	1.24	1.86	1.45	1.49
		Negative	1.10	1.75	0.95	1.76	1.10	1.52
		Neutral	0.81	2.07	0.76	1.47	1.74	1.98
	No-go	Positive	3.34	2.60	3.25	2.04	3.11	1.69
		Negative	3.10	2.51	3.20	2.32	2.97	2.23
		Neutral	3.10	2.46	3.24	2.44	3.01	2.21

Note. SD: standard deviation; RTs (reaction times). Results adjusted by the participants' age.

Figure 1. ERP amplitudes (μV) and latencies (ms) for each group (AN, BSD, HC), condition (go, no-go) and type (positive, negative, neutral).