Psychiatry Research 215 (2014) 733–739

Contents lists available at ScienceDirect

Psychiatry Research

journal homepage: www.elsevier.com/locate/psychres

Do cognitive measures of response inhibition differentiate between attention deficit/hyperactivity disorder and borderline personality disorder?

Fiona van Dijk [a,*], Arnt Schellekens [a], Pieter van den Broek [a], Cornelis Kan [a], Robbert-Jan Verkes [a,b], Jan Buitelaar [b,c]

[a] Radboud University Nijmegen Medical Centre, Department of Psychiatry (961), P.O.Box 9101, 6500 HB, Nijmegen, The Netherlands
[b] Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Nijmegen, The Netherlands
[c] Radboud University Nijmegen Medical Centre, Departments of Cognitive Neuroscience, Nijmegen, The Netherlands

ARTICLE INFO

Article history:
Received 29 January 2013
Received in revised form
29 October 2013
Accepted 18 December 2013
Available online 28 December 2013

Keywords:
Adults
Inhibition
AX-CPT

ABSTRACT

This study examined whether cognitive measures of response inhibition derived from the AX-CPT are able to differentiate between adult attention deficit/hyperactivity disorder (ADHD), borderline personality disorder (BPD), and healthy controls (HC). Current DSM-IV-TR symptoms of ADHD and BPD were assessed by structured diagnostic interviews, and parent developmental interviews were used to assess childhood ADHD symptoms. Patients (14 ADHD, 12 BPD, 7 ADHD and BPD, and 37 HC) performed the AX-CPT. Seventy percent of AX-CPT trials were target (AX) trials, creating a bias to respond with a target response to X probes in the nontarget (AY, BX, BY) trials. On BX trials, context, i.e. the non-'*A*' letter, must be used to inhibit this prepotent response tendency. On AY trials context actually causes individuals to false alarm. The effects of ADHD and BPD on AX-CPT outcome were tested using two-way ANOVA. BPD was associated with higher percentage of errors across the task and more errors and slower responses on BX trials, whereas ADHD was associated with slower responses on AY trials. The findings suggest response inhibition problems to be present in both ADHD and BPD, and patients with BPD to be particularly impaired due to poor context processing.

1. Introduction

Previous research has shown significant co-occurrence of DSM-IV-TR defined borderline personality disorder (BPD) and attention deficit hyperactivity disorder (ADHD) in adults with the use of self-report questionnaires or structured psychiatric interviews. Up to 60% of BPD patients met criteria for ADHD in childhood and up to 38% of BPD patients showed a co-occurring adult ADHD diagnosis. Impulsivity symptoms and traits are important overlapping features (Andrulonis et al., 1981, 1982; Rey et al., 1995; Fossati et al., 2002; Dowson et al., 2004a; Philipsen et al., 2008; Ferrer et al., 2010; van Dijk et al., 2011, 2012). This behavioral overlap influences diagnostic outcome and indications for treatment. It is therefore important to clarify whether the shared symptoms are pointing to the same underlying cognitive processes or whether BPD and ADHD can be differentiated at the level of cognitive processes.

It is suggested that impulsive behavior, broadly defined as the tendency to act prematurely without foresight, is not a unitary construct, but rather consists of several independent dimensions involving various forms of impaired cognitive control. Impulsivity could incorporate behavior that has not adequately sampled sensory evidence ("reflection impulsivity"), a failure of motor or response inhibition ("impulsive action"), a tendency to accept small immediate or likely rewards versus large delayed or unlikely ones ("impulsive choice") and risky behavior, in the context of decision making (Evenden, 1999).

Reviews (Woods et al., 2002; Hervey et al., 2004; Seidman et al., 2004; Boonstra et al., 2005; Schoechlin and Engel, 2005) and several more recent single studies (Fischer et al., 2005; Nigg et al., 2005b; Faraone et al., 2006; Biederman et al., 2007; Stavro et al., 2007; Boonstra et al., 2010) are clear in showing that adults with ADHD have deficits in executive functioning in general and response inhibition (i.e. the behavioral phenomena of "impulsive action") in particular. In fact, inhibitory dysfunction is regarded as underpinning one of a number of dissociable and different pathways to ADHD (Nigg et al., 2005c; Sonuga-Barke et al., 2010). However, it remains unclear if inhibition deficiencies are specific for ADHD, especially with regard to BPD. Non-ADHD clinical

* Corresponding author.
E-mail addresses: fevandijk@gmail.com, f.vandijk@acsw.ru.nl (F. van Dijk).

0165-1781/$ - see front matter © 2013 Elsevier Ireland Ltd. All rights reserved.
http://dx.doi.org/10.1016/j.psychres.2013.12.034

control groups with mood and anxiety disorders appeared to perform better on response inhibition tasks than adults with ADHD (Barkley et al., 2001; Epstein et al., 2001; Murphy et al., 2001), but patients with schizophrenia perform equally worse as patients with ADHD (Ross et al., 2000).

The results of neuropsychological studies of patients with BPD are mixed but mostly indicate that individuals with BPD also exhibit inhibitory dysfunction. Problems with an impulsive response style with difficulty delaying, a preference for immediate gratification, and impairments that reflect the inhibition of ongoing responses are frequently found in mostly female patients with BPD when compared to healthy controls (Leyton et al., 2001; Bazanis et al., 2002; Dinn et al., 2004; Nigg et al., 2005a; de Bruijn et al., 2006; Grootens et al., 2008b; Rentrop et al., 2008; McCloskey et al., 2009; Volker et al., 2009; Lawrence et al., 2010).

Deficient inhibitory control in its broadest sense may thus underlie both ADHD and BPD. However, it is currently unclear to what extent BPD is associated with response inhibition problems independently of the frequently co-occurring ADHD. To date, we found four studies comparing patients with ADHD and BPD in terms of neuropsychological overlap and differences.

The first one, although not focusing on response inhibition in particular, compared adults with ADHD, BPD and healthy controls (each group $N=19$). No significant group differences were found for spatial working memory and spatial recognition memory, but the mean deliberation time for the decision-making task was significantly longer in the BPD than in the other groups, and with a significant difference between the BPD and ADHD group. The authors concluded that subjects with ADHD and BPD may have dissociable patterns of neuropsychological impairments (Dowson et al., 2004b).

Another study did focus on response inhibition in particular and measured stop signal reaction times in 105 adults with ADHD (of whom 20% with co-occurring BPD) and 90 controls (Nigg et al., 2005a). The results provided evidence that problems in response inhibition are specific to BPD symptoms even when symptoms of other personality disorders, lifetime depression, anxiety, and posttraumatic symptoms are controlled for. However, this effect could still be due to the overlap of BPD and ADHD symptoms. When ADHD symptoms were entered as a predictor, response inhibition ceased to be significantly associated with BPD symptoms, probably due to the high correlation of ADHD and BPD in the sample. The authors emphasize the importance of clarifying whether BPD per se is related to problems of response inhibition.

A third study compared four groups of participants (22 ADHD, 21 BPD, 20 ADHD with BPD and 20 Healthy Controls) on various inhibitory functions. ADHD patients performed significantly worse on tasks that measure the ability to interrupt an already ongoing response, but showed no significant deficits in the capacity to suppress prepotent responses as tested with the error rate of a go/no go test. In all inhibitory tasks, ADHD subjects showed generally longer RTs than controls. Patients with ADHD+BPD did not differ significantly from those with pure ADHD on any cognitive task and the BPD group achieved better results than the ADHD group in most tasks. The authors conclude that impaired inhibition is a core feature in adults with ADHD, but not in adults with BPD, and that ADHD and BPD have no common attention or inhibitory deficits (Lampe et al., 2007).

The most recent study explored the role of stress in different components of impulsivity, including response inhibition, in four groups of participants (15 BPD, 15 BPD with ADHD, 15 ADHD and 15 healthy controls) (Krause-Utz et al., 2013). The results showed impaired response inhibition as measured with the Immediate and Delayed Memory Task (IMT/DMT) in patients with both BPD and ADHD, but not in those with BPD but without ADHD.

In summary, these studies seem to contradict the probable shared response inhibition problems between ADHD and BPD as well as the previous findings of inhibitory dysfunction in BPD. Given these inconsistencies might be explained in part by heterogeneity in the inclusion and exclusion criteria, the issue of response inhibition in BPD and ADHD needs further investigation.

Continuous performance tasks (CPT′s) are among the most used tasks to assess impulsive action. CPT′s are based on the paradigm that a global prepotency of response is created that must occasionally be overridden by voluntary control (Rosvold and Delgado, 1956). Research on this paradigm has been relatively voluminous, in both the experimental and the clinical literature (Riccio and Reynolds, 2001; Riccio et al., 2002). Several studies have associated ADHD with impaired CPT performance but comparison with clinical samples is scarce (Woods et al., 2002; Hervey et al., 2004). We found four studies reporting specifically on CPT performance in BPD of which the results are ambiguous. One study showed slightly but not significantly more errors in female BPD patients compared to healthy controls but not to individuals with depression (Volker et al., 2009). Yet two other studies found significantly more errors and more inattentiveness on the CPT indices in patients with BPD compared with non-psychiatric controls (Rubio et al., 2007; Ruocco et al., 2012). The most recent study investigated response inhibition and working memory together with elementary cognitive processes in BPD and healthy controls (Hagenhoff et al., 2013). As in other tasks, they found no impairments of response inhibition in the AX-CPT results. Moreover they found faster responses along with comparable accuracy, suggesting a superiority of faster cognitive processing in BPD. Correctly, the authors mention that it has to be investigated whether this alteration might shift into a disadvantage when task characteristics favor impulsive responding. Also, faster motor reactions may be an indication of response inhibition deficit (Conners, 2000).

In the present study we aim to examine whether cognitive measures of response inhibition derived from an Expectancy AX version of the Continuous Performance Task (AX-CPT) are able to differentiate between ADHD, BPD, and healthy controls. An advantage of using the AX-CPT is that it takes into account that response inhibition also depends on context processing, i.e. the representation, maintenance and updating of context in prefrontal networks (Braver et al., 2009). From this perspective, inhibition is the processing of task-relevant information to provide the top down support needed to allow secondary responses to compete effectively with distracting information. In the AX-CPT task, contextual information, conceptualized as any task relevant information that is internally represented, is required to drive or inhibit responses to a target stimulus (Braver and Barch, 2002). In the Expectancy AX-CPT, AX trials comprise a large portion (70%) of the overall task which creates a strong expectancy and tendency toward responding with the target button. Participants′ ability to inhibit this prepotent tendency is particularly evident on the small portion (10%) of the remaining trials in which the cue letter A is followed by a probe letter other than X (i.e. an AY trial). Errors occur if participants respond when they are required to inhibit their response and high error rate points to difficulties with response inhibition.

On another portion (10%) of the non-target trials, a cue letter other than A is followed by the probe letter X (i.e. a BX trial). Note that on BX trials, the internal representation of context should improve performance, by inhibiting an inappropriate response bias. However, on AY trials, representation of context should impair performance, by creating an inappropriate expectancy bias.

Thus, if context representations are intact, AY performance should be worse than BX performance (both in errors and or RT). Conversely, if context representations are impaired, BX performance should be worse than AY performance. Performance on AX target trials should also be poorer if context processing is