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Impulsivity in patients with borderline personality disorder: a comprehensive profile compared with healthy people and patients with ADHD

Pavla Linhartová[1], Adéla Látalová[1], Richard Barteček[1], Jan Širůček[2], Pavel Theiner[1], Anastasia Ejova[3], Pavlína Hlavatá[1,4], Barbora Kóša[1], Barbora Jeřábková[1], Martin Bareš[5,6] and Tomáš Kašpárek[1]

[1]Department of Psychiatry, University Hospital Brno and Faculty of Medicine, Masaryk University, Brno, Czech Republic; [2]Faculty of Social Studies, Institute for Research on Children, Youth and Family, Masaryk University, Brno, Czech Republic; [3]Faculty of Science, School of Psychology, University of Auckland, Auckland, New Zealand; [4]Behavioral and Social Neuroscience Research Group, CEITEC – Central European Institute of Technology, Masaryk University, Brno, Czech Republic; [5]First Department of Neurology, St. Anne's Hospital and Faculty of Medicine, Masaryk University, Brno, Czech Republic and [6]Department of Neurology, Faculty of Medicine, University of Minnesota, Minneapolis, MN, USA

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Author for correspondence:
Pavla Linhartová, E-mail: pavla.linhartova@med.muni.cz

Abstract

Background. Impulsivity is a core symptom of borderline personality disorder (BPD). Impulsivity is a heterogeneous concept, and a comprehensive evaluation of impulsivity dimensions is lacking in the literature. Moreover, it is unclear whether BPD patients manifest impaired cognitive functioning that might be associated with impulsivity in another patient group, such as ADHD, a frequent comorbidity of BPD.

Methods. We tested 39 patients with BPD without major psychiatric comorbidities and ADHD, 25 patients with ADHD, and 55 healthy controls (HC) using a test battery consisting of a self-report measure of impulsivity (UPPS-P questionnaire), behavioral measures of impulsivity – impulsive action (Go/NoGo task, stop signal task) and impulsive choice (delay discounting task, Iowa gambling task), and standardized measures of attention (d2 test), working memory (digit span), and executive functioning (Tower of London).

Results. Patients with BPD and ADHD, as compared with HC, manifested increased self-reported impulsivity except sensation seeking and increased impulsive choice; patients with ADHD but not BPD showed increased impulsive action and deficits in cognitive functioning. Negative urgency was increased in BPD as compared to both HC and ADHD groups and correlated with BPD severity.

Conclusions. Patients with BPD without ADHD comorbidity had increased self-reported impulsivity and impulsive choice, but intact impulsive action and cognitive functioning. Controlling for ADHD comorbidity in BPD samples is necessary. Negative urgency is the most diagnostically specific impulsivity dimension in BPD.

Introduction

Borderline personality disorder (BPD) is a pervasive mental disorder characterized by disturbed identity, impaired emotion regulation, and marked impulsivity (American Psychiatric Association, 2013). Impulsivity in BPD patients manifests in a range of dangerous and (self-) destructive behaviors such as drug abuse, self-harm, and suicidal behavior and, as such, can lead to serious consequences. However, impulsivity is a heterogeneous concept with several different subtypes associated with different measures that are rarely examined in a complex manner. Comprehensive analysis of impulsivity dimensions can lead to the specification of self-control impairment in a given patient group and, consequently, to tailoring individually suitable forms of psychotherapeutic (Stoffers-Winterling *et al*., 2012) or biological treatment (Lieb *et al*., 2010; Svěrák *et al*., 2018).

Impulsivity is considered either a consequence of some personality traits or a dysfunction of a neurobiological or cognitive function (Linhartová *et al*., 2019). The most up-to-date complex personality model of impulsivity is the UPPS-P questionnaire (Whiteside and Lynam, 2001; Cyders and Smith, 2007). BPD patients have been found to have increased impulsivity in all UPPS-P dimensions except sensation seeking, i.e. in lack of premeditation, lack of perseverance, negative urgency, and positive urgency (Bøen *et al*., 2015; Paret *et al*., 2016). Two broad subtypes of behavioral dimensions of impulsivity were defined in the literature: impulsive action and impulsive choice (Winstanley *et al*., 2006). Impulsive action can be further

divided into waiting impulsivity (difficulties inhibiting premature actions) and stopping impulsivity (difficulties interrupting ongoing actions) (Robinson *et al.*, 2009). In most previous studies, BPD patients have been found to have increased impulsive choice, but intact waiting and stopping impulsivity (Robinson *et al.*, 2009; Jacob *et al.*, 2010; Hagenhoff *et al.*, 2013; Legris *et al.*, 2014; Barker *et al.*, 2015; van Eijk *et al.*, 2015; Berenson *et al.*, 2016; Paret *et al.*, 2017).

Impulsivity manifested in behavioral tests, alongside increased impulsivity itself, may be associated with impaired cognitive functions necessary for task performance such as attention, working memory, and executive functioning (Bazanis *et al.*, 2002; Lampe *et al.*, 2007; Nigg, 2017). Research on cognitive functions in BPD patients has generally produced mixed results (e.g. Feliu-Soler *et al.*, 2013; Hagenhoff *et al.*, 2013). According to a recent meta-analysis, most studies found worse performance in some cognitive domains, but they do not indicate a specific cognitive function in which BPD patients fail consistently (Mcclure *et al.*, 2016).

The diverse results of studies on cognitive functioning in BPD could be related to comorbidities in BPD samples. Some comorbidities, such as major depression, bipolar disorder, and psychotic disorders, are usually excluded from research samples. However, attention-deficit/hyperactivity disorder (ADHD) in BPD patients is often neglected. ADHD is associated with substantial deficits in cognitive functioning. Results of existing meta-analyses suggest that patients with ADHD, in comparison to healthy controls, have worse performance in attention, working memory, planning, and organization (Alderson *et al.*, 2013; Mowinckel *et al.*, 2015; Pievsky and McGrath, 2018). Hence, not controlling for ADHD comorbidity in BPD samples could lead to biased results in tests of cognitive functioning. BPD patients with comorbid ADHD were found to have worse cognitive performance than healthy people and worse than BPD patients without ADHD comorbidity (Lampe *et al.*, 2007). Studies that excluded ADHD comorbidity suggest that BPD patients show deficits in working memory (Stevens *et al.*, 2004; Hagenhoff *et al.*, 2013).

ADHD comorbidity in BPD patients could also lead to distorted impulsivity test results. ADHD patients, as opposed to BPD patients, have been found to have increased waiting and stopping impulsivity (Lampe *et al.*, 2007; Pani *et al.*, 2013). Patients with ADHD and patients with BPD have been found to have increased impulsive choice and UPPS-P dimensions, with the exception of sensation seeking (Toplak *et al.*, 2005; Lopez *et al.*, 2015; Patros *et al.*, 2016; Pedersen *et al.*, 2016), with one study showing higher lack of premeditation and higher lack of perseverance in ADHD patients as compared to BPD patients (Krause-Utz *et al.*, 2016).

Aims and hypotheses

The current study provides a comprehensive evaluation of essential self-reported and behavioral impulsivity dimensions as well as cognitive functions in a sample of patients with BPD who are not affected by ADHD, major depression, bipolar disorder, psychotic disorder, or addiction. The impulsivity profile is compared with a sample of healthy controls and patients with ADHD (without BPD comorbidity). Based on previous research described in the Introduction, we hypothesize that BPD patients, as well as ADHD patients, show increased impulsivity in all UPPS-P subscales except sensation seeking and increased impulsive choice as compared to healthy controls. Further, we hypothesize that BPD patients, unlike ADHD patients, have intact impulsive action as compared to healthy controls. No specific hypotheses were made about cognitive function domains in BPD due to conflicting literature, but we test the hypothesis that only ADHD patients, but not BPD patients, have worse cognitive performance than healthy controls.

Methods

The study was reviewed and approved by the Ethics Committee of University Hospital Brno. Before the research procedure was carried out, the study was explained thoroughly to the subjects who then signed informed consent forms. The research was carried out in accordance with APA ethical standards.

Participants

The study included 39 patients with borderline personality disorder (BPD), 25 patients with attention-deficit/hyperactivity disorder (ADHD), and 55 healthy controls (HC). The HC group was a pooled sample of healthy controls matched to BPD and ADHD patients by age, sex, and education level. HC were recruited through internet advertisement. The Mini international neuropsychiatric interview (MINI; Sheehan *et al.*, 1998) was conducted with the HC to confirm the absence of any mental disorder. The BPD and ADHD patients were recruited at the Department of Psychiatry of the University Hospital Brno and through outpatient psychiatrists in the Czech Republic. The data included available patient documentation, patient charts, mental status examinations, and comprehensive interviews similar in structure to the comprehensive assessment of symptoms and history (Andreasen, Flaum, and Arndt, 1992) focused on patient history, pharmacological history, past symptoms, and the course of the disorder.

The BPD diagnosis was confirmed by two board-certified psychiatrists according to DSM-5 criteria and by a trained psychologist using the Diagnostic Interview for Borderlines – Revised (DIB-R; Zanarini *et al.*, 1989). According to DIB-R, a patient is assessed with BPD if they score at least 8 out of 10 points, with higher scores indicating more severe BPD. In the present sample, 12 patients (31%) scored in DIB-R 8 points, 9 patients (23%) scored 9 points, and 18 patients (46%) scored 10 points. If comorbid ADHD was suspected in the BPD patients, the Diagnostic Interview for ADHD in Adults 2.0 (DIVA 2.0; Kooij and Francken, 2010) was performed to exclude the ADHD comorbidity. For the ADHD sample, the ADHD diagnosis was confirmed by two board-certified psychiatrists according to DIVA 2.0 (Kooij and Francken, 2010). If comorbid BPD was suspected in ADHD patients, the DIB-R (Zanarini *et al.*, 1989) was conducted by a clinical psychologist to assess the comorbidity.

The following comorbidities were excluded from both BPD and ADHD groups according to DSM-5 criteria: major psychiatric disorders with possible influence on impulsive behavior and cognitive functioning, specifically bipolar disorder, major depression, psychotic disorder, addiction; any personality disorder other than BPD in the BPD group; and any personality disorder in ADHD group. The exclusion process was carried out by two board-certified psychiatrists and a clinical psychologist after the interviews and reviewing all aforementioned sources of information about patients.

Characteristics of the samples are presented in Table 1. Details on patient status and medications are presented in online

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Table 1. Descriptive statistics of the samples

	BPD	ADHD	HC	Group comparison
Sex				
Men	$N = 5$	$N = 19$	$N = 20$	BPD *v.* HC: $\chi^2(1) = 6.48$, $p = 0.011$ ADHD *v.* HC: $\chi^2(1) = 10.81$, $p = 0.001$ BPD *v.* ADHD: $\chi^2(1) = 25.95$, $p < 0.001$
Women	$N = 34$	$N = 6$	$N = 35$	
Age	$M = 23.39$	$M = 23.28$	$M = 23.42$	$F(2, 116) = 0.00$, $p = 0.996$
	S.D. = 4.82	S.D. = 8.56	S.D. = 6.34	
Education				
Primary	$N = 11$	$N = 11$	$N = 13$	BPD *v.* HC: Mann-Whitney $U = 1296.00$, $Z = 1.83$, $p = 0.07$ ADHD *v.* HC: Mann-Whitney $U = 808.50$, $Z = 1.69$, $p = 0.09$ BPD *v.* ADHD: Mann-Whitney $U = 435.50$, $Z = -0.49$, $p = 0.63$
Lower secondary	$N = 6$	$N = 1$	$N = 1$	
Higher secondary	$N = 17$	$N = 7$	$N = 26$	
College	$N = 5$	$N = 5$	$N = 15$	
Socio-economic status				
Insufficient	$N = 9$	$N = 0$	$N = 6$	BPD *v.* HC: Mann-Whitney $U = 1430.00$, $Z = 4.01$, $p < 0.001$ ADHD *v.* HC: Mann-Whitney $U = 717.50$, $Z = 0.33$, $p = 0.74$ BPD *v.* ADHD: Mann-Whitney $U = 664.50$, $Z = 3.59$, $p < 0.001$
Unsatisfactory	$N = 17$	$N = 8$	$N = 9$	
Satisfactory	$N = 6$	$N = 10$	$N = 21$	
Very satisfactory	$N = 3$	$N = 7$	$N = 19$	
Depression (MADRS)	$M = 17.69$	$M = 6.64$	$M = 0.82$	$F(2, 116) = 110.842$, $p < 0.001$, $\eta^2 = 0.656$ Bonferroni post-hoc tests: BPD *v.* HC: $t(116) = 14.858$, $p < 0.001$ ADHD *v.* HC: $t(116) = 4.449$, $p < 0.001$ BPD *v.* ADHD: $t(116) = 7.951$, $p < 0.001$
	S.D. = 8.41	S.D. = 4.98	S.D. = 1.57	
Anxiety (SAS)	$M = 49.21$	$M = 40.57$	$M = 28.23$	$F(2, 111) = 86.638$, $p < 0.001$, $\eta^2 = 0.610$ Bonferroni post-hoc tests: BPD *v.* HC: $t(111) = 13.008$, $p < 0.001$ ADHD *v.* HC: $t(111) = 6.511$, $p < 0.001$ BPD *v.* ADHD: $t(111) = 4.312$, $p < 0.001$
	S.D. = 9.44	S.D. = 7.82	S.D. = 5.80	

BPD, borderline personality disorder; ADHD, attention-deficit/hyperactivity disorder; HC, healthy controls; MADRS, Montgomery Åsberg Depression Rating Scale; SAS, Zung self-report anxiety scale.

Supplementary Material. The groups did not differ in age or level of education. BPD and ADHD groups differed in sex, and both groups also differed in sex in comparison with HC as a result of pooling HC matched to BPD patients and HC matched to ADHD patient into one control sample. BPD patients had lower socioeconomic status than both HC and ADHD patients with no difference between the latter two groups. Large differences between the groups were observed in anxiety and depression symptoms, with BPD patients having the highest scores in both variables and ADHD patients having lower scores in both variables than BPD patients, but higher scores than HC.

Procedure

All participants completed clinical and behavioral testing carried out by a trained psychologist within one session lasting approximately two hours.

Clinical and behavioral measures

The subjects underwent a test battery consisting of self-reporting and behavioral tests of impulsivity and cognitive function screening consisting of standardized measures in a fixed order (see online Supplementary Material for details). A validated Czech translation of the UPPS-P scale was used (Linhartová *et al.*, 2017). The UPPS-P has five subscales: lack of premeditation, lack of perseverance, sensation seeking, negative urgency, and positive urgency, with higher scores indicating higher impulsivity. Waiting impulsivity was measured by a Go/NoGo task (GNG), stopping impulsivity by a stop signal task (SST), and impulsive choice by a delay discounting task (DDT) and the Iowa gambling task (IGT). The behavioral tasks were delivered in computerized form, developed in E-Prime 2.0.

Three outcome measures were derived from GNG: *NoGo commissions* (percentage of NoGo trials erroneously followed by a key press), *Go omissions* (percentage of Go trials erroneously followed by no key press), and *Go reaction time* (*Go RT;* average reaction time on correct Go trials). *Stop signal reaction time* (*SSRT*) was derived as the outcome measure from SST by subtracting the average stop signal delay from the average Go RT. The SSRT provides an indication of the average time required for successful stopping; longer SSRTs indicate greater difficulty interrupting actions. Two delayed rewards (DR) were used in DDT: low (approx. 40 EUR) and high (approx. 980 EUR and approx. median salary in the

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Czech Republic at the time of data collection). Two DRs were chosen so that the influence of DR magnitude could be tested, since discounting becomes steeper in low DRs; in other words, people are less willing to wait if the DR is small (Estle *et al.*, 2006; Stanger *et al.*, 2012). *Area under the curve* (AUC; Myerson *et al.*, 2001) was used as the main result from DDT (*AUC low* for the low DR and *AUC high* for the high DR). The lower the AUC, the steeper the discounting, and the higher the impulsive choice. A computerized version of IGT was used (Odum, 2011). The task ended after 200 cards. To track the progress of advantageous decision making, we computed the *net score*, i.e. the difference between the number of cards drawn from advantageous decks (C + D) and the number of cards drawn from disadvantageous decks (A + B), separately for the first and the second half of the task (*1st half net score* and *2nd half net score*).

Working memory was assessed by the Digit Span subtest from the Wechsler Adult Intelligence Scale-III (Wechsler, 1997) with *total score* used as the outcome measure. Executive functioning was measured by the Tower of London (ToL), Drexel University, Second Edition (Culbertson and Zillmer, 2005). Three outcome measures were derived from ToL: *move score* represents the overall efficiency of the participant's problem solving, *initiation time* represents the time spent planning before acting, and *execution time* represents the time needed to solve the task. Attention was assessed by a paper-and-pencil cancellation test d2-R (Brickenkamp *et al.*, 2014). *Speed* (total number of items worked through) and *accuracy* (percentage of errors) scores were derived. Unstandardized scores were used in the analyses to preserve the score variability. Further details on the behavioral and cognitive tests are provided in the online Supplementary Material.

Statistical analysis

Differences in UPPS-P (*lack of premeditation*, *lack of perseverance*, *sensation seeking*, *negative urgency*, and *positive urgency*), GNG (*Go omissions*, *Go reaction time*, and *NoGo commissions*), SST (*stop signal reaction time*), digit span (*total score*), d2 (*speed, accuracy*), and ToL (*move score*, *initiation time*, and *execution time*) were compared between BPD, ADHD, and HC groups in ANOVA with Bonferroni post-hoc tests. DDT was analyzed by repeated-measures ANOVA with Bonferroni post-hoc tests with DR magnitude as a within-subject factor (*AUC low, AUC high*) and group as a between-subject factor. IGT was analyzed by repeated-measures ANOVA with Bonferroni post-hoc tests with time as a within-subject factor (*net score 1st half, net score 2nd half*) and group as a between-subject factor. Moreover, correlations between impulsivity and cognitive and clinical (DIB-R, MADRS, SAS) variables in the three groups were computed. Due to the relatively small sample sizes and the large number of variables, the correlations were not statistically compared between the groups, but significant correlation patterns were examined and commented on.

Results

Table 2 presents descriptive statistics and the results of ANOVAs comparing UPPS-P, GNG, SST, and cognitive tests between the BPD, ADHD, and HC groups. We found that both patient groups as compared to HC have higher lack of premeditation, lack of perseverance, negative urgency, and positive urgency. No group differences were found in sensation seeking. The only significant difference between BPD and ADHD patients was found in negative urgency, with higher scores in BPD patients. In GNG, the ADHD group had significantly more NoGo commissions (i.e. increased waiting impulsivity) than both HC and BPD. The ADHD group also had increased SSRT (i.e. increased stopping impulsivity) as compared to HC and on a trend level as compared to BPD. Regarding the cognitive variables, we found significantly worse performance in working memory in ADHD group as compared to HC and a borderline-significant difference in speed during the attention test, with ADHD having lower speeds than HC. The ADHD group also showed worse performance as compared to HC in executive functions, manifested as higher moves score in ToL.

Descriptive statistics and results of repeated-measures ANOVA of DDT and IGT are displayed in Table 3 and Fig. 1. In DDT, significant effects of DR magnitude, group, and DR*group interaction were observed. Bonferroni post-hoc tests revealed that in the high DR as compared to low DR condition, all groups exhibited a significant increase in AUC ($p < 0.001$ for all the three groups). At the same time, HC showed higher AUC in both low DR and high DR conditions (i.e. lower impulsive choice) than either BPD patients ($p < 0.001$ for both low DR and high DR) or ADHD patients ($p = 0.007$ for low DR, $p < 0.001$ for high DR); there was no difference between the patient groups ($p = 1.000$ for both low and high DR). In IGT, significant effects of time, group, and time*group interaction were observed. Bonferroni post-hoc tests revealed that there were no significant group differences in the net score after the first half of the task ($p = 1.000$ for all intergroup contrasts). Only HC improved significantly from the first to the second half of the task ($p < 0.001$); neither of the patient groups did (BPD: $p = 0.762$; ADHD: $p = 0.570$). HC had higher net scores in the second half of the task than either BPD patients ($p < 0.001$) or ADHD patients ($p = 0.024$) and the two patient groups did not differ ($p = 1.000$).

Relationships between impulsivity and cognitive and clinical variables

Correlation matrices of impulsivity and cognitive and clinical variables are provided in the online Supplementary Materials for the BPD, ADHD, and HC groups separately. The UPPS-P dimensions were generally positively intercorrelated in all the three groups, except sensation seeking (and positive urgency in ADHD), while the behavioral dimensions were generally independent.

In the relationships between impulsivity and cognitive variables, two significant moderate (over $r = 0.4$) correlations were observed in BPD: a negative correlation between NoGo commissions and initiation time (ToL) and a negative correlation between Go omissions and speed (d2 attention test). A number of significant moderate associations were found in ADHD: a positive correlation between digit span and lack of perseverance and IGT, a positive correlation between initiation time (ToL) and Go omissions and IGT, a positive correlation between move score (ToL) and SSRT, and a positive correlation between accuracy (d2 attention test) and Go RT and DDT. In the relationships between impulsivity and clinical variables, the most prominent pattern was that UPPS-P dimensions (except sensation seeking) were positively correlated with DIB-R in BPD. Moreover, negative and positive urgency showed low to moderate positive associations with MADRS and SAS in ADHD and HC.

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Table 2. Descriptive statistics of dependent variables and results of ANOVAs comparing BPD, ADHD, and HC groups

								Bonferroni post-hoc tests		
Variable	Group	*N*	*M*	s.d.	*F* (*df1, df2*)	*p*	η^2	contrasts	*t* (*df*)	*p*
PRE	BPD	39	28.077	5.909	11.246 (2, 116)	<0.001	0.162	BPD *v.* HC	4.405 (116)	<0.001
	ADHD	25	27.320	6.122				ADHD *v.* HC	3.225 (116)	0.005
	HC	55	23.236	4.238				BPD *v.* ADHD	0.563 (116)	1.000
PER	BPD	39	26.487	5.301	17.898 (2, 115)	<0.001	0.237	BPD *v.* HC	5.368 (115)	<0.001
	ADHD	24	26.208	5.949				ADHD *v.* HC	4.375 (115)	<0.001
	HC	55	20.618	4.821				BPD *v.* ADHD	0.206 (115)	1.000
SS	BPD	39	31.051	7.108	1.153 (2, 115)	0.319	0.020	BPD *v.* HC	−0.668 (115)	1.000
	ADHD	24	33.875	7.261				ADHD *v.* HC	1.037 (115)	0.905
	HC	55	32.055	7.181				BPD *v.* ADHD	−1.517 (115)	0.396
NU	BPD	39	38.103	5.276	54.277 (2, 113)	<0.001	0.490	BPD *v.* HC	10.168 (113)	<0.001
	ADHD	22	34.182	6.037				ADHD *v.* HC	5.633 (113)	<0.001
	HC	55	26.309	5.521				BPD *v.* ADHD	2.654 (113)	0.027
PU	BPD	39	38.538	10.265	27.887 (2, 114)	<0.001	0.329	BPD *v.* HC	7.239 (114)	<0.001
	ADHD	23	34.739	8.086				ADHD *v.* HC	4.251 (114)	<0.001
	HC	55	26.018	6.581				BPD *v.* ADHD	1.749 (114)	0.249
Go omissions %	BPD	38	0.106	0.060	1.715 (2, 115)	0.184	0.029	BPD *v.* HC	1.534 (115)	0.383
	ADHD	25	0.109	0.058				ADHD *v.* HC	1.518 (115)	0.395
	HC	55	0.087	0.061				BPD *v.* ADHD	−0.165 (115)	1.000
Go RT	BPD	38	342.783	34.163	1.226 (2, 115)	0.297	0.021	BPD *v.* HC	1.379 (115)	0.512
	ADHD	25	342.649	24.726				ADHD *v.* HC	1.185 (115)	0.715
	HC	55	334.940	21.831				BPD *v.* ADHD	0.019 (115)	1.000
NoGo commissions %	BPD	38	0.281	0.166	6.955 (2, 115)	0.001	0.108	BPD *v.* HC	1.227 (115)	0.667
	ADHD	25	0.380	0.171				ADHD *v.* HC	3.728 (115)	<0.001
	HC	55	0.241	0.139				BPD *v.* ADHD	−2.486 (115)	0.043
SSRT	BPD	39	265.973	92.536	5.063 (2, 116)	0.008	0.080	BPD *v.* HC	0.886 (116)	1.000
	ADHD	25	310.748	53.767				ADHD *v.* HC	3.170 (116)	0.006
	HC	55	251.631	74.352				BPD *v.* ADHD	−2.261 (116)	0.077
Digit span	BPD	39	17.744	4.417	3.323 (2, 116)	0.040	0.054	BPD *v.* HC	−1.076 (116)	0.853
	ADHD	25	16.080	4.142				ADHD *v.* HC	−2.573 (116)	0.034
	HC	55	18.691	4.082				BPD *v.* ADHD	1.543 (116)	0.376
d2 (speed)	BPD	38	176.500	38.198	3.040 (2, 115)	0.052	0.050	BPD *v.* HC	−1.375 (115)	0.516
	ADHD	25	166.160	36.640				ADHD *v.* HC	−2.403 (115)	0.054
	HC	55	186.855	33.443				BPD *v.* ADHD	1.125 (115)	0.789
d2 (accuracy)	BPD	38	8.424	8.830	0.128 (2, 115)	0.880	0.002	BPD *v.* HC	0.485 (115)	1.000
	ADHD	25	8.213	6.937				ADHD *v.* HC	0.306 (115)	1.000
	HC	55	7.666	6.505				BPD *v.* ADHD	0.111 (115)	1.000
ToL moves	BPD	38	22.263	14.099	3.590 (2, 113)	0.031	0.060	BPD *v.* HC	0.942 (113)	1.000
	ADHD	24	29.625	21.986				ADHD *v.* HC	2.680 (113)	0.025
	HC	54	19.056	14.234				BPD *v.* ADHD	−1.756 (113)	0.245
ToL init. time	BPD	38	85.719	55.469	1.161 (2, 111)	0.317	0.020	BPD *v.* HC	−1.514 (111)	0.399
	ADHD	23	98.107	89.785				ADHD *v.* HC	−0.701 (111)	1.000
	HC	53	112.882	98.021				BPD *v.* ADHD	−0.556 (111)	1.000

(*Continued*)

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Table 2. (*Continued.*)

								Bonferroni post-hoc tests		
Variable	Group	*N*	*M*	S.D.	*F* (*df1, df2*)	*p*	η^2	contrasts	*t* (*df*)	*p*
ToL exec. time	BPD	38	194.498	96.181	0.222 (2, 111)	0.802	0.004	BPD *v.* HC	−0.365 (111)	1.000
	ADHD	23	211.306	85.658				ADHD *v.* HC	0.391 (111)	1.000
	HC	53	201.942	99.835				BPD *v.* ADHD	−0.663 (111)	1.000

BPD, borderline personality disorder; ADHD, attention-deficit/hyperactivity disorder; HC, healthy controls; PRE, lack of premeditation; PER, lack of perseverance; SS, sensation seeking; NU, negative urgency; PU, positive urgency; Go RT, Go reaction time; SSRT, stop signal reaction time; ToL, Tower of London; init. Time, initiation time; exec. time, execution time; MADRS, Montgomery Åsberg Depression Rating Scale; SAS, Zung self-reported anxiety scale.

Table 3. Descriptive statistics and results of ANOVA for delay discounting and Iowa gambling task

Variable	Group	*N*	*M*	S.D.	*F* (*df1, df2*)	*p*	$_p\eta^2$
DDT AUC low	BPD	39	0.310	0.242	*Group effect*		
	ADHD	25	0.328	0.269	17.77 (2, 114)	<0.001	0.24
	HC	53	0.545	0.243	*Delayed reward magnitude effect*		
DDT AUC high	BPD	39	0.551	0.289	197.45 (1, 114)	<0.001	0.63
	ADHD	25	0.503	0.299	*Interaction effect*		
	HC	53	0.824	0.190	3.17 (2, 114)	0.046	0.05
IGT 1st half net score	BPD	39	6.41	29.59	*Group effect*		
	ADHD	25	10.96	40.77	7.09 (2, 115)	0.001	0.11
	HC	54	21.63	37.39	*Time effect*		
IGT 2nd half net score	BPD	39	18.15	44.73	35.67 (1, 115)	<0.001	0.24
	ADHD	25	26.56	56.99	*Interaction effect*		
	HC	54	58.67	42.03	6.08 (2, 115)	0.003	0.10

BPD, borderline personality disorder; ADHD, attention-deficit/hyperactivity disorder; DDT, delay discounting task; HC, healthy controls; IGT, Iowa gambling task; AUC, area under the curve. *Note*. In DDT: delayed reward magnitude is a within-subject factor, group is a between-subject factor. In IGT: time is a within-subject factor (1st half *v.* 2nd half of the task), group is a between-subject factor.

Discussion

Self-reported impulsivity

Our results confirm previous research in that both the BPD patients and the ADHD patients, in comparison with HC, manifested increased lack of premeditation, lack of perseverance, and positive and negative urgency. Neither patient group manifested elevated sensation seeking. We found that BPD patients had higher negative urgency than the HC and ADHD groups, with the highest effect size of the intergroup contrast from all impulsivity variables.

The concept of negative urgency combines affective instability and impulsivity, and the importance of this combination for BPD was stressed in previous studies (Tragesser and Robinson, 2009; Sebastian *et al.*, 2013; Barteček *et al.*, 2019). Negative urgency was found to be associated with BPD features in non-clinical samples (Tragesser and Robinson, 2009; DeShong and Kurtz, 2013; Peters *et al.*, 2013, 2017), and increased in BPD patients as compared to patients with antisocial personality disorder (Taherifard *et al.*, 2015) and to patients with bipolar disorder (Bøen *et al.*, 2015). Thus, markedly increased negative urgency seems to be specific for BPD patients even in comparison with other impulsive patient groups and constitutes a possible marker for BPD. Comparisons of negative urgency between BPD patients and patients with other impulsive disorders, such as patients with addiction or eating disorders, would be beneficial in future studies.

Negative urgency was found to be associated with self-harm or partner violence (Peters *et al.*, 2013, 2017) in non-clinical samples and with suicidal attempts and healthcare utilization in BPD patients (Barteček *et al.*, 2019). BPD patients show elevated not only negative, but also positive urgency (Bøen *et al.*, 2015; Paret *et al.*, 2016). Positive urgency was found to be associated with several types of risky behavior in other than BPD samples, such as with substance abuse, compulsive buying, or risky sexual behavior in non-clinical samples (Zapolski *et al.*, 2009; Rose and Segrist, 2014; Dinc and Cooper, 2015) and with risky behavior in patients with PTSD (Weiss *et al.*, 2015). In general, positive urgency received less attention than negative urgency in the literature on BPD. This might relate to the fact that negative affect states, but not positive, are related to self-harming and suicidal behavior in BPD. However, BPD patients also experience negative emotions more often than healthy people (Nica and Links, 2009; Steenkamp *et al.*, 2015; Law *et al.*, 2016). In other words, patients with BPD not only tend to act impulsively in intense emotional states, but they also have a higher chance of experiencing intense negative emotional states, in which they are prone to self-harming and life-threatening behavior. This typical pattern seems to be captured by highly elevated negative urgency in BPD patients.

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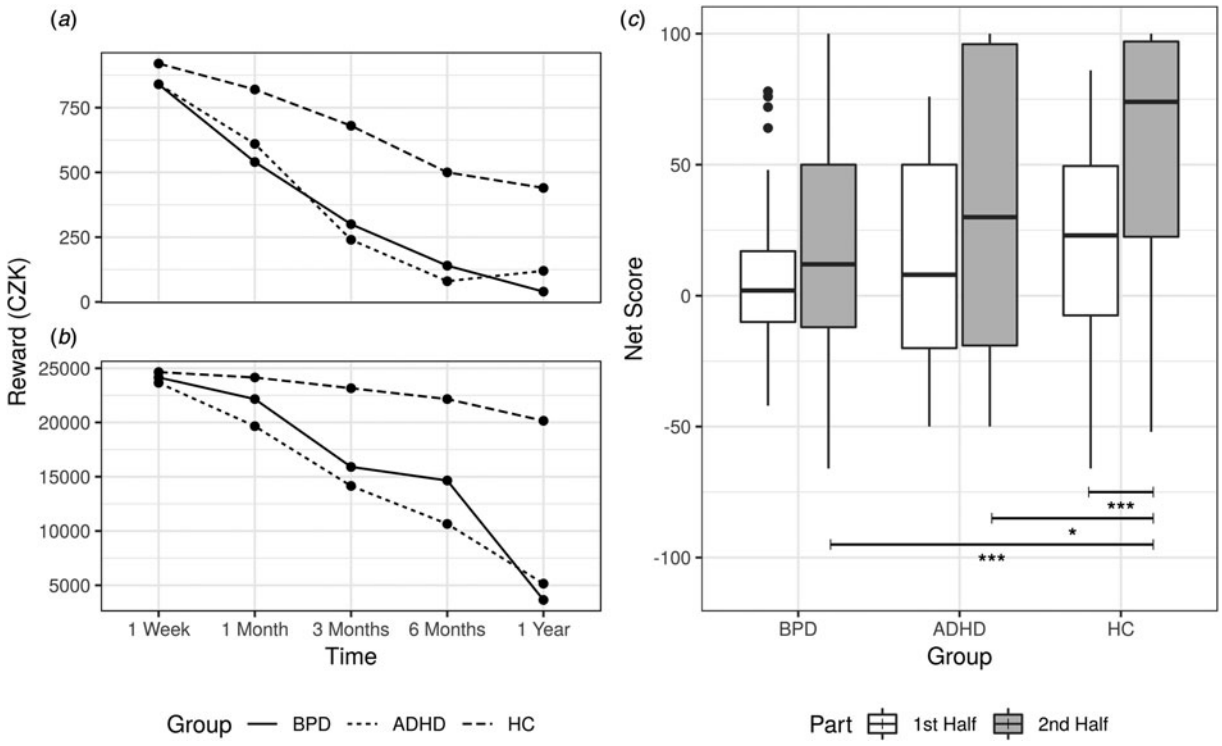

Fig. 1. (a) Results of delay discounting for low delayed reward, (b) Results of delay discounting for high delayed reward, (c) Results of Iowa gambling task. *Note.* (a) Median indifference points from delay discounting with low delayed reward in Czech *koruna* (CZK; y axis) with delay on x axis per group. (b) Median indifference points from delay discounting with high delayed reward in Czech *koruna* (y axis) with delay on x axis per group. (c) Boxplots of net scores per groups split for the first and the second half of the task. Net score was computed by counting frequency of cards drawn from the four decks according to the following equation: (C + D) − (A + B). Higher scores indicate more advantageous decision making.*$p < 0.05$, ***$p < 0.001$.

In contrast to the study by Krause-Utz *et al.* (2016), we found no differences in lack of perseverance or lack of premeditation between the patient groups. A possible confounding variable might be sex, which was not equally distributed in the patient groups in our study. Future studies could explore the role of sex in UPPS-P dimensions in BPD and ADHD patients.

Behavioral impulsivity

Our results showed that impulsive action, i.e. both the ability to withhold premature actions (waiting impulsivity) and to stop ongoing actions (stopping impulsivity), is intact in BPD patients; these results are similar to previous studies (under emotionally neutral circumstances; Jacob *et al.*, 2010; Cackowski *et al.*, 2014; Barker *et al.*, 2015; Krause-Utz *et al.*, 2016). Impulsive action was elevated in ADHD patients as compared to HC, similarly as in previous studies (Lampe *et al.*, 2007; Pani *et al.*, 2013). We also found close-to-significant differences in both waiting (NoGo commissions) and stopping (SSRT) impulsivity between patients with BPD and ADHD. Thus, the elevation in impulsive action seems to be specific for the ADHD group; and it is not present in patients with BPD.

On the other hand, BPD patients and ADHD patients showed increased impulsive choice in both relevant tasks. As expected, all the three groups showed less steep delay discounting in the high DR condition as compared to low DR condition. In other words, all the participants were willing to wait longer for the delayed reward that had a high value. Both patient groups had steeper delay discounting in both low and high DR conditions than HC did, as in previous studies (Patros *et al.*, 2016; Paret *et al.*, 2017). In sum, BPD patients, as well as ADHD patients, exhibit a higher preference for immediate rewards than HC regardless of delayed reward magnitude.

In the Iowa gambling task, both patient groups showed less advantageous decision-making than HC, as in previous studies (Toplak *et al.*, 2005; Paret *et al.*, 2017), but only after the second half of the task, i.e. after 200 cards. This result was due to the fact that HC improved during the task; the patient groups did not. We administered the prolonged IGT version containing 200 cards since it was previously shown that the standard 100 cards might not be sufficient to learn advantageous decision-making, even in healthy people (Fernie and Tunney, 2006). Our data support this hypothesis by showing that a longer time (i.e. 200 cards) was needed to detect group differences between HC and impulsive patients. To sum, both BPD patients and ADHD patients manifested impairment in IGT, indicating a reduced ability to learn from consequences and increased impulsive decision making, but this difference was not shown earlier than after the second half of the prolonged task.

Cognitive functions

The results of cognitive tests in our study are clear: as compared to HC, BPD patients did not show any deficit in cognitive functioning; ADHD patients manifested deficits in attention, working memory, and executive functioning. However, there were no significant differences in the cognitive tests between the two patient groups. This pattern of results is due to the fact that in all the

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variables with significant differences between the ADHD group and HC, the BPD patients scored on average between the ADHD patients and HC. Our results support studies that excluded ADHD comorbidity and found no attention deficit in BPD patients as compared to HC (Lampe *et al.*, 2007; Hagenhoff *et al.*, 2013) and lend further support to the hypothesis that the attention deficits in BPD patients observed in some studies might have been driven by ADHD comorbidity. Evidence about deficits of BPD patients in executive functioning remains limited, and our study supports the hypothesis that executive functioning of patients with BPD is usually intact.

However, impaired working memory in BPD patients was previously found in studies that excluded ADHD comorbidity (Stevens *et al.*, 2004; Hagenhoff *et al.*, 2013). Differences in the literature could be also influenced by the heterogeneity of working memory measures used in the studies. For example, in our study we used a relatively straightforward and short working memory test; both previously mentioned studies used more complex and possibly more demanding tests, like computerized n-back tasks (Stevens *et al.*, 2004; Hagenhoff *et al.*, 2013). It is possible that BPD patients without ADHD comorbidity could show some cognitive impairment only in highly demanding situations. It is also possible that highly demanding tasks could induce stress levels that influence the cognitive performance of BPD patients, similarly as high stress levels were found to increase impulsive action in BPD (Krause-Utz *et al.*, 2016). Future studies should explore the question of whether BPD patients fail in highly demanding working memory tasks as compared to less demanding tasks and, if such impairment was found, whether it could have been caused by higher stress levels during demanding tasks as opposed to insufficient cognitive function capacity.

More support for the importance of emotions in cognitive functioning in BPD can be drawn from the perspective of comparison between performances in ToL and IGT. ToL can be considered a measure of 'cool', i.e. emotionally neutral, executive functioning requiring predominantly cognitive planning and correct execution of the plan (Chan *et al.*, 2008). On the other hand, IGT can be considered a measure of 'hot' executive functions that include an emotional aspect by providing a rewards and punishments (gains and losses) environment (Chan *et al.*, 2008). Importantly, BPD patients showed impairment only in IGT, but their decision-making was intact in ToL.

Relationships between impulsivity and cognitive and clinical variables

Our study confirms the results of the previous studies (MacKillop *et al.*, 2016; Linhartová *et al.*, 2019) in that dimensions of self-reported impulsivity are related, while low to very low correlations are present between behavioral tests of impulsivity. Worse performance in attention and working memory was associated with higher impulsive choice, and worse performance in executive functioning was associated with higher stopping impulsivity and higher impulsive choice in patients with ADHD. Similar associations were not present in patients with BPD or in HC. The results indicate that impulsivity in ADHD is more closely linked with cognitive functions than in BPD.

Importantly, we found moderate positive correlations of BPD severity with all the UPPS-P subscales except sensation seeking. BPD severity was not correlated with any other variable including depression and anxiety symptoms. This result puts more emphasis on the importance of impulsivity for BPD patients.

Limitations

The differences in sex and inpatient/outpatient status between the BPD and ADHD samples can be considered as a limitation of our study. However, our sample has high ecological validity, since there is a prevalence of women among BPD patients and a prevalence of men among ADHD patients in clinical samples (American Psychiatric Association, 2013). Both sex and inpatient/outpatient status influence could not have been tested, since the vast majority of the BPD patients were women and inpatients, and the majority of the ADHD patients were men and all the ADHD patients were outpatients. However, we acknowledged the state severity of the patients by measuring depression and anxiety symptom levels. It can be viewed as a possible limitation that a single pooled sample of healthy controls was used for comparison with the patient groups. However, this approach was chosen to strengthen the statistical power of the analyses and to enable direct comparison of the two patient groups within ANOVA. Further, the influence of several possible confounding variables on impulsivity, specifically depression and anxiety symptoms, could not have been tested directly in the linear models due to small sample sizes for such a complex analysis. However, we included depression and anxiety in the correlation analysis to track a possible interrelatedness with impulsivity or cognitive measures. The differences between the groups in correlations were not statistically tested due to the high number of variables included in this analysis. Thus, the results should be interpreted carefully and should serve as hypotheses-generating rather than definite results.

Conclusion

Comprehensive analysis of impulsivity measures showed that the major diagnostically specific contributor to impulsive behavior in patients with BPD is negative urgency. BPD patients, unlike ADHD patients, do not show impairments in impulsive action and their cognitive functions seem to be intact. Thus, it is crucial to distinguish the ADHD comorbidity in BPD samples.

Supplementary material. The supplementary material for this article can be found at https://doi.org/10.1017/S0033291719001892.

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Ethical standards. The authors assert that all procedures contributing to this work comply with the ethical standards of the relevant national and institutional committees on human experimentation and with the Helsinki Declaration of 1975, as revised in 2008.

References

Alderson RM, Kasper LJ, Hudec KL and Patros CHG (2013) Attention-deficit/hyperactivity disorder (ADHD) and working memory in adults: a meta-analytic review. *Neuropsychology* **27**, 287–302.

American Psychiatric Association (2013) *Diagnostic and Statistical Manual of Mental Disorders: DSM 5*. Washington DC, London: American Psychiatric Association.

Andreasen NC, Flaum M and Arndt S (1992) Comprehensive assessment of symptoms and history (CASH): an instrument for assessing diagnosis and psychopathology. *Archives of General Psychiatry* **49**, 615–623.

Barker V, Romaniuk L, Cardinal RN, Pope M, Nicol K and Hall J (2015) Impulsivity in borderline personality disorder. *Psychological Medicine* **45**, 1955–1964.

Barteček R, Hořínková J, Linhartová P and Kašpárek T (2019) Emotional impulsivity is connected to suicidal attempts and health care utilization in patients with borderline personality disorder. *General Hospital Psychiatry* **56**, 54–55.

Bazanis E, Rogers RD, Dowson JH, Taylor P, Meux C, Staley C, Nevinson-Andrews D, Taylor C, Robbins TW and Sahakian BJ (2002) Neurocognitive deficits in decision-making and planning of patients with DSM-III-R borderline personality disorder. *Psychological Medicine* **32**, 1395–1405.

Berenson KR, Gregory WE, Glaser E, Romirowsky A, Rafaeli E, Yang X and Downey G (2016) Impulsivity, rejection sensitivity, and reactions to stressors in borderline personality disorder. *Cognitive Therapy and Research* **40**, 510–521.

Bøen E, Hummelen B, Elvsåshagen T, Boye B, Andersson S, Karterud S and Malt UF (2015) Different impulsivity profiles in borderline personality disorder and bipolar II disorder. *Journal of Affective Disorders* **170**, 104–111.

Brickenkamp R, Schmidt-Atzert L, Liepmann D, Hoskovcová S and Černochová D (2014) *d2 Attention Test Revised* (*Czech Version*). Prague: Hogrefe – Testcentrum.

Cackowski S, Reitz AC, Ende G, Kleindienst N, Bohus M, Schmahl C and Krause-Utz A (2014) Impact of stress on different components of impulsivity in borderline personality disorder. *Psychological Medicine* **44**, 3329–3340.

Chan RCK, Shum D, Toulopoulou T and Chen EYH (2008) Assessment of executive functions: review of instruments and identification of critical issues. *Archives of Clinical Neuropsychology* **23**, 201–216.

Culbertson W and Zillmer E (2005) *Tower of London – Drexel University*, 2nd Edn. Toronto: Multi-Health Systems.

Cyders MA and Smith GT (2007) Mood-based rash action and its components: positive and negative urgency. *Personality and Individual Differences* **43**, 839–850.

DeShong HL and Kurtz JE (2013) Four factors of impulsivity differentiate antisocial and borderline personality disorders. *Journal of Personality Disorders* **27**, 144–156.

Dinc L and Cooper AJ (2015) Positive affective states and alcohol consumption: the moderating role of trait positive urgency. *Addictive Behaviors* **47**, 17–21.

Estle SJ, Green L, Myerson J and Holt DD (2006) Differential effects of amount on temporal and probability discounting of gains and losses. *Memory & Cognition* **34**, 914–928.

Feliu-Soler A, Soler J, Elices M, Pascual JC, Pérez J, Martín-Blanco A, Santos A, Crespo I, Pérez V and Portella MJ (2013) Differences in attention and impulsivity between borderline personality disorder and bipolar disorder. *Psychiatry Research* **210**, 1307–1309.

Fernie G and Tunney RJ (2006) Some decks are better than others: the effect of reinforcer type and task instructions on learning in the Iowa Gambling Task. *Brain and Cognition* **60**, 94–102.

Hagenhoff M, Franzen N, Koppe G, Baer N, Scheibel N, Sammer G, Gallhofer B and Lis S (2013) Executive functions in borderline personality disorder. *Psychiatry Research* **210**, 224–231.

Jacob GA, Gutz L, Bader K, Lieb K, Tüscher O and Stahl C (2010) Impulsivity in borderline personality disorder: impairment in self-report measures, but not behavioral inhibition. *Psychopathology* **43**, 180–188.

Kooij JJS (2012) *Adult ADHD: Diagnostic assessment and treatment (3rd ed.)*. London: Springer-Verlag.

Krause-Utz A, Cackowski S, Daffner S, Sobanski E, Plichta MM, Bohus M, Ende G and Schmahl C (2016) Delay discounting and response disinhibition under acute experimental stress in women with borderline personality disorder and adult attention deficit hyperactivity disorder. *Psychological Medicine* **46**, 3137–3149.

Lampe K, Konrad K, Kroener S, Fast K, Kunert HJ and Herpertz SC (2007) Neuropsychological and behavioural disinhibition in adult ADHD compared to borderline personality disorder. *Psychological Medicine* **37**, 1717–1729.

Law M, Fleeson W, Arnold E and Furr R (2016) Using negative emotions to trace the experience of borderline personality pathology: interconnected relationships revealed in an experience sampling study. *Journal of Personality Disorders* **30**, 52–70.

LeGris J, Toplak M and Links PS (2014) Affective decision making in women with borderline personality disorder. *Journal of Personality Disorders* **28**, 698–719.

Lieb K, Völlm B, Rücker G, Timmer A and Stoffers JM (2010) Pharmacotherapy for borderline personality disorder: cochrane systematic review of randomised trials. *British Journal of Psychiatry* **196**, 4–12.

Linhartová P, Širůček J, Barteček R, Theiner P, Jeřábková B, Rudišinová D and Kašpárek T (2017) Czech versions of impulsivity self-report scales and their psychometric properties. *Czech and Slovak Psychiatry* **113**, 149–157.

Linhartová P, Širůček J, Ejova A, Barteček R, Theiner P and Kašpárek T (2019) Dimensions of impulsivity in healthy people, patients with borderline personality disorder, and patients with attention-deficit/hyperactivity disorder. *Journal of Attention Disorders*.

Lopez R, Dauvilliers Y, Jaussent I, Billieux J and Bayard S (2015) A multidimensional approach of impulsivity in adult attention deficit hyperactivity disorder. *Psychiatry Research* **227**, 290–295.

MacKillop J, Weafer J, Gray J, Oshri A, Palmer A and de Wit H (2016) The latent structure of impulsivity: impulsive choice, impulsive action, and impulsive personality traits. *Psychopharmacology* **233**, 3361–3370.

McClure G, Hawes DJ and Dadds MR (2016) Borderline personality disorder and neuropsychological measures of executive function: a systematic review. *Personality and Mental Health* **10**, 43–57.

Mowinckel AM, Pedersen ML, Eilertsen E and Biele G (2015) A meta-analysis of decision-making and attention in adults with ADHD. *Journal of Attention Disorders* **19**, 355–367.

Myerson J, Green L and Warusawitharana M (2001) Area under the curve as a measure of discounting. *Journal of the Experimental Analysis of Behavior* **76**, 235–243.

Nica E and Links P (2009) Affective instability in borderline personality disorder: experience sampling findings. *Current Psychiatry Reports* **11**, 74–81.

Nigg JT (2017) Annual research review: on the relations among self-regulation, self-control, executive functioning, effortful control, cognitive control, impulsivity, risk-taking, and inhibition for developmental psychopathology. *Journal of Child Psychology and Psychiatry and Allied Disciplines* **58**, 361–383.

Odum AL (2011) Delay discounting: I'm a k, you're a k. *Journal of the Experimental Analysis of Behavior* **96**, 427–439.

Pani P, Menghini D, Napolitano C, Calcagni M, Armando M, Sergeant JA and Vicari S (2013) Proactive and reactive control of movement are differently affected in attention deficit hyperactivity disorder children. *Research in Developmental Disabilities* **34**, 3104–3111.

Paret C, Hoesterey S, Kleindienst N and Schmahl C (2016) Associations of emotional arousal, dissociation and symptom severity with operant conditioning in borderline personality disorder. *Psychiatry Research* **244**, 194–201.

Paret C, Jennen-Steinmetz C and Schmahl C (2017) Neuroscience and biobehavioral reviews disadvantageous decision-making in borderline personality disorder: partial support from a meta-analytic review. *Neuroscience and Biobehavioral Reviews* **72**, 301–309.

Patros CHG, Alderson RM, Kasper LJ, Tarle SJ, Lea SE and Hudec KL (2016) Choice-impulsivity in children and adolescents with attention-deficit/hyperactivity disorder (ADHD): a meta-analytic review. *Clinical Psychology Review* **43**, 162–174.

Pedersen SL, Walther CAP, Harty SC, Gnagy EM, Pelham WE and Molin BSG (2016) The indirect effects of childhood attention deficit hyperactivity disorder on alcohol problems in adulthood through unique facets of impulsivity. *Addiction* **111**, 1582–1589.

Peters JR, Upton BT and Baer RA (2013) Brief report: relationships between facets of impulsivity and borderline personality features. *Journal of Personality Disorders* **27**, 547–552.

Peters J, Derefinko K and Lynam D (2017) Negative urgency accounts for the association between borderline personality features and intimate partner violence in young men. *Journal of Personality Disorders* **31**, 16–25.

Pievsky MA and Mcgrath RE (2018) The neurocognitive profile of attention-deficit / hyperactivity disorder: a review of meta-analyses. *Archives of Clinical Neuropsychology* **33**, 143–157.

Robinson ESJ, Eagle DM, Economidou D, Theobald DEH, Mar AC, Murphy ER, Robbins TW and Dalley JW (2009) Behavioural characterisation of high impulsivity on the 5-choice serial reaction time task: specific deficits in "waiting" versus "stopping". *Behavioural Brain Research* **196**, 310–316.

Rose P and Segrist DJ (2014) Negative and positive urgency may both be risk factors for compulsive buying. *Journal of Behavioral Addictions* **3**, 128–132.

Sebastian A, Jacob G, Lieb K and Tüscher O (2013) Impulsivity in borderline personality disorder: a matter of disturbed impulse control or a facet of emotional dysregulation. *Current Psychiatry Reports* **15**, 339.

Sheehan DV, Lecrubier Y, Sheehan KH, Amorim P, Janavs J, Weiller E, Hergueta T, Baker R and Dunbar GC (1998) The mini-international neuropsychiatric interview (M.I.N.I.): the development and validation of a structured diagnostic psychiatric interview for DSM-IV and ICD-10. *The Journal Of Clinical Psychiatry* **59**, 22–33.

Stanger C, Ryan SR, Fu H, Landes RD, Jones BA, Bickel WK and Budney AJ (2012) Delay discounting predicts adolescent substance abuse treatment outcome. *Experimental and Clinical Psychopharmacology* **20**, 205–212.

Steenkamp MM, Suvak MK, Dickstein BD, Shea MT and Litz BT (2015) Emotional functioning in obsessive-compulsive personality disorder: comparison to borderline personality disorder and healthy controls. *Journal of Personality Disorders* **29**, 794–808.

Stevens A, Burkhardt M, Hautzinger M, Schwarz J and Unckel C (2004) Borderline personality disorder: impaired visual perception and working memory. *Psychiatry Research* **125**, 257–267.

Stoffers-Winterling J, Völlm B, Rücker G, Timmer A, Huband N and Lieb K (2012) Psychological therapies for people with borderline personality disorder. *The Cochrane Database of Systematic Reviews* **8**, 1–259.

Svěrák T, Linhartová P, Fiala A and Kašpárek T (2018) Repetitive transcranial magnetic stimulation treating impulsivity in borderline personality disorder and attention deficit/hyperactivity disorder. In Ustohal L (ed.), *Transcranial Magnetic Stimulation in Neuropsychiatry*. London: IntechOpen, pp. 41–63.

Taherifard M, Abolghasemi A and Hajloo N (2015) Positive and negative urgency and sleep quality among patients with borderline and antisocial personality disorder. *Archives of Psychiatry and Psychotherapy* **17**, 105–112.

Toplak ME, Jain U and Tannock R (2005) Executive and motivational processes in adolescents with attention-deficit-hyperactivity disorder (ADHD). *Behavioral and Brain Functions* **12**, 1–12.

Tragesser SL and Robinson RJ (2009) The role of affective instability and UPPS impulsivity in borderline personality disorder features. *Journal of Personality Disorders* **23**, 370–383.

van Eijk J, Sebastian A, Krause-Utz A, Cackowski S, Demirakca T, Biedermann SV, Lieb K, Bohus M, Schmahl C, Ende G and Tüscher O (2015) Women with borderline personality disorder do not show altered BOLD responses during response inhibition. *Psychiatry Research – Neuroimaging* **234**, 378–389.

Wechsler D (1997) *Wechsler Adult Intelligence Scale – Third Edition Manual*. San Antonio: The Psychological Corporation.

Weiss NH, Tull MT, Sullivan TP, Dixon-Gordon KL and Gratz KL (2015) Posttraumatic stress disorder symptoms and risky behaviors among trauma-exposed inpatients with substance dependence: the influence of negative and positive urgency. *Drug and Alcohol Dependence* **155**, 147–153.

Whiteside SP and Lynam DR (2001) The five factor model and impulsivity: using a structural model of personality to understand impulsivity. *Personality and Individual Differences* **30**, 669–689.

Winstanley CA, Eagle DM and Robbins TW (2006) Behavioral models of impulsivity in relation to ADHD: translation between clinical and preclinical studies. *Clinical Psychology Review* **26**, 379–395.

Zanarini MC, Gunderson JG, Frankenburg FR and Chauncey DL (1989) The revised diagnostic interview for borderlines: discriminating BPD from other axis II disorders. *Journal of Personality Disorders* **3**, 10–18.

Zapolski TCB, Cyders MA and Smith GT (2009) Positive urgency predicts illegal drug use and risky sexual behavior. *Psychology of Addictive Behaviors* **23**, 348–354.