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Impulsivity across bipolar disorder, attention deficit hyperactivity disorder (ADHD) and borderline personality disorder

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1. Introduction

Impulsivity is usually defined as “a predisposition toward rapid, unplanned reactions to internal or external stimuli without regard to the negative consequences of these reactions to the impulsive individuals or to others” (Moeller et al., 2001). Although impulsivity can be present in healthy individuals (Keizer, I., McQuillan, A., Bieler, 1999) an association between impulsivity and mental illness has also been noted since many years (Chamorro et al., 2012; Moeller et al., 2001). Notably, impulsiveness is a core feature of the attention-deficit/hyperactivity disorder (ADHD) (Matthies and Philipsen, 2014; Nandagopal et al., 2011). Also, impulsivity is one of the DSM-V (American Psychiatric Association [APA], 2013) diagnostic criteria for borderline personality disorder (BPD) and is considered as a core feature of this disease (Links et al, 1999; Matthies and Philipsen, 2014). Although not considered as a diagnostic criterion, impulsivity is also present in bipolar disorder (BD), especially during manic or depressive episodes (Lewis et al., 2009; Swann et al., 2007) but is also persistent during euthymia (Etain et al., 2013). Impulsivity can yield problematic behaviors in BPD and BD such as self-injury, suicidality, substance abuse and criminal behavior (Etain et al., 2017; Coulston et al., 2012; Mueser et al., 2006; Oquendo et al., 2014; Swann et al., 2005). In ADHD, impulsivity has notably deleterious consequences for affective and professional relationships, friendships and excessive involvement in pleasurable activities without recognizing risks of painful consequences (e.g., buying sprees, foolish business investments, reckless driving) (Wender et al., 2006). Despite the importance of this dimension, current diagnostic criteria do not differentiate the type of impulsivity and the different consequences according to the diagnosis, especially for ADHD, BD and BPD. The current diagnostic criteria are problematic because they do not differentiate impulsive from non-impulsive individuals within diagnostic groups (Moeller et al., 2001). Furthermore, dimensional approach offer powerful ways of thinking about psychopathology, beyond the structures of current diagnostic guidelines (Cuthbert, 2014, 2005). So, it seems important to have a dimensional approach, combined with a transnosographic approach, to compare the impulsivity between these three disorders, in terms of intensity and qualitative characteristics. Few studies have compared impulsivity in BPD and BD (Bøen et al., 2015; Henry et al., 2001; Leblanc et al., 2016; Wilson et al., 2007): BPD patients differed from euthymic bipolar patients in being more impulsive. Another compared ADHD and BPD (Ende et al., 2015): ADHD patients reported generally elevated impulsivity, stronger tendencies to act without thinking (motor impulsivity), more deficits in planning and future-orientation (non-planning impulsivity), and more problems maintaining attention on a task/being more distractible (attentional impulsivity). In addition, some authors suggest that there is an additive effect of impulsivity when there are some co-occurring disorders, especially for BPD and ADHD (Prada et al., 2014): ADHD and BPD-ADHD patients differed from BPD subjects by a higher level of impulsivity due to the contribution of motor

impulsivity to account for this difference.

Among the etiological factors associated with propensity to impulsiveness is history of childhood trauma. Several studies have indeed suggested that impulsivity is an outcome of traumatic childhood experiences (Brodsky et al., 2001; Etain et al., 2017; Roy, 2005). Stressful histories are frequent among BPD patients (Battle et al., 2004) possibly explaining the high rate of related impulsive-behaviors such as suicidal and self-damaging behaviors in this population. However it has been suggested that impulsivity is associated with the diagnosis of BPD itself, regardless of traumatic childhood experiences (Bøen et al., 2015) raising the question as to whether impulsivity is or not a consequence of such trauma. Traumatic childhood experiences are also frequent in BD (Aas et al., 2016; Etain et al., 2008) and have, as in BPD, been linked to impulsivity in adult BD patients (Bøen et al., 2015; Leverich et al., 2002; Etain et al., 2017). For ADHD, the relationship between impulsivity and child maltreatment is less clear as impulsivity in ADHD is considered as a core neurobiological correlate of the disorder linked to intrinsic impaired inhibitory functions. Nevertheless history of child maltreatment has poorly been investigated in ADHD and its link with impulsivity in this population is globally unknown (Sugimoto et al., 2015).

Thus, the aim of our study is to explore the different facets and levels of impulsivity in BPD, BD, ADHD and healthy controls (CTRL). We also aim at investigating the effect of a history of childhood maltreatment on the level of impulsivity. On the basis of previous findings, we hypothesized that (1) BPD, ADHD and BD would display a higher level of impulsivity compared to the CTRLs; (2) co-occurring disorders would increase the level of impulsivity (3) and severity of childhood trauma would be positively associated with increased level of impulsivity.

2. Method

a. Participants

Subjects suffering from ADHD and/or from BPD were recruited in the Psychiatric Specialties Service of Geneva's University Hospitals (Switzerland), in an ambulatory unit specialized for adult ADHD and BPD sufferers. Patients were referred to this unit by general practitioners and private or hospital psychiatrists for diagnostic assessment and possibly care. Patients were assessed by psychiatrists specialized in adult ADHD and BPD according to the criteria of the DSM-IV-TR (APA, 2000) to ascertain the diagnosis of BPD and/or ADHD and to exclude any organic condition and/or Axis I disorders that might better explain the disorder. Clinical and anamnestic data (medical histories, family history, onset of the disorder and previous treatments) were collected during the interview with patient. BPD patients were also evaluated for comorbid Axis I disorders using the French version of the Diagnostic Interview for Genetic Studies (DIGS) (Preisig et al., 1999). The DIGS was used in BPD subjects to exclude a diagnosis of BD (in addition to the clinical interview) and to assess childhood ADHD and its persistence in adulthood. The diagnosis of BPD was based on the Screening Interview for Axis II disorders (SCID-II) BPD part (First et al., 1997), conducted by trained psychologists. ADHD patients were assessed using the Diagnostic Interview for ADHD in adults (DIVA 2.0) (Kooij and Francken, 2010). In ADHD patients, comorbid BD was assessed with a clinical interview. Finally BPD as well as ADHD patients filled in self-report questionnaires, the Adult ADHD Self-Report Scale (ASRSv1.1) (Adler et al., 2006; Kessler, 2005) and the short version (25 items) of the Wender Utah ADHD Rating Scale (WURS) (Romo et al., 2010; Ward, 1993). The ASRS v1.1 includes 18 items and has proved to be relatively reliable to detect ADHD subjects in adulthood (screening tools and not diagnostic tools). Subjects with a score > 46 at the WURS are usually considered as having ADHD a high probability of suffering from the disorder during childhood.

Following these clinical interviews, self-report questionnaires and structured interviews, five groups of patients were defined: 1) "pure" BPD subjects (without comorbid ADHD and BD) (n=168), 2) "pure" ADHD subjects (without comorbid BPD and BD) (n=173), 3) patients with BPD and ADHD and no BD (BPD_ADHD, n = 94), 4) patients with BD and BPD and no ADHD (BD_BPD, n = 29), 5) and finally patients with all three diagnostics (BD_BPD_ADHD, n = 13).

The group of subjects suffering from BD included 267 subjects recruited in France for a research protocol investigating the genetic and environmental susceptibility factors to bipolar disorders. The diagnoses of BD were established by either trained psychiatrists or psychologists using the French version of the DIGS. The patients with bipolar disorder were euthymic when they were included in the

study. Euthymic state was defined by a clinical examination by the treating psychiatrist and confirmed by 1) a score < 12 on the Montgomery-Åsberg Depression Scale (Montgomery and Åsberg, 1979) and a score < 6 on the Bech Mania Scale (Bech et al., 1974). The patients also filled in the WURS. Patients with a score > 46 at the WURS which is considered as having a high probability of suffering from ADHD in childhood were excluded from this group of patient.

The CTRL group includes 47 subjects recruited among dentistry students and doctors at the University of Geneva. The Ethics Committees in each center approved the study and all participants gave their written informed consent.

b. Measurements

Barrat Impulsivity Scale: one of the commonly used self-rated measures of impulsivity is the Barratt Impulsiveness Scale, Version 10(BIS-10) (Barratt et al., 1994; Patton et al., 1995) which incorporates three behavioral components of impulsivity: motor, which refers to acting on the spur of the moment without thinking; non-planning, which refers to a lack of future orientation; and cognitive, which refers to issues with concentration and tendency to shift attention rapidly. The French version of the BIS-10 total score demonstrated a Cronbach's alpha of 0,82 (Baylé et al., 2000). In this model, greater motor activation, less attention, or decreased planning are key factors of impulsivity.

Childhood Trauma Questionnaire: traumatic childhood experiences were assessed using the short version of the CTQ (Bernstein et al., 2003). This self report inventory comprises 25 items assessing 5 different types of childhood trauma: emotional abuse, physical abuse, sexual abuse, emotional neglect and physical neglect. Each item is rated on a five point ordinal scale (never true, rarely true, sometime true, often true, very often true). Seven items are reversed scored. Total score is obtained by summation of the 25 items corresponding to the five maltreatment domains (three remaining items are not scored). Each domain is scored between five and twenty-five for a total score ranging from 25 to 125. Higher CTQ score reflects more severe childhood maltreatment. The internal consistency of the five subscale of the CTQ French version is good with Cronbach's alpha ranging from 0.79 to 0.94 (Paquette et al., 2004).

Wender-Utah Rating Scale: this is one of several instruments used for ADHD diagnosis in adults that is designed to capture childhood symptoms. The original WURS questionnaire includes 61 items intended to identify behavioral symptoms of children with 'minimal brain dysfunction' (Wender et al., 1971). Ward et al. (1993) identified the subset of 25 items that best distinguishes ADHD patients from controls. They reported that a WURS-25 score ≥ 46 classifies adult ADHD patients,

when compared with unaffected individuals. Caci et al., (2010) reported a Cronbach's alpha of 0.92 for the french version of the WURS-25.

c. Statistical analysis

Analytic and descriptive statistics were done using STATA 13.0 software (Statacorp, 2013). Pearson's chi-squared test were performed for categorical data and Mann-Whitney test for continuous variables were used in order to compare demographic and clinical data across single diagnostic groups.

The score distribution for the BIS subscales being normal, we performed one-way analysis ANOVA for the comparison of the four groups. Post-hoc test were performed using pairwise comparisons (Bonferroni correction). The score distribution for CTQ subscales was not normal. Therefore, we conducted non parametric Kruskal-Wallis tests to draw comparisons between the four single diagnostic groups. Post-hoc had been drawn with Mann Whitney tests. We then carried further analyses to explore interaction between BIS and CTQ, we performed linear regression model adjusted on age, gender, category of diagnosis as well as CTQ total score for the BIS total score. Statistical significance was accepted for p values < 0.05.

3. Results

a. Description of the sample

The sample for the main analyses included 608 subjects: 267 subjects with a diagnosis of BD, 168 with a diagnosis of BPD, 173 with a diagnosis of ADHD and 47 were control subjects (CTRL) (see Table 1). There were significantly more men in the ADHD group than in the other three groups (BD: $\chi^2(1) = 31.43, p < 0.0001$; BPD : $\chi^2(1) = 125.13, p < 0.0001$; CTRL : $\chi^2(1) = 3.97, p = 0.046$). And there were significantly more women in the BPD group than in the BD group and the CTRL group (BD: $\chi^2(1) = 48.70, p < 0.0001$; CTRL : $\chi^2(1) = 48.70, p < 0.0001$). The subjects in the BPD group were significantly younger than the other three groups (*Mann Whitney test*. BD: $|z| = 9.25, p < 0.0001$; ADHD: $|z| = 3.19, p = 0.0014$; CTRL: $|z| = 3.89, p = 0.0001$). The subjects in the BD groups were significantly older than the subjects in the ADHD and CTRL group (*Mann Whitney test*. ADHD: $|z| = 6.50, p < 0.0001$; CTRL: $|z| = 2.69, p = 0.0071$). The subjects in the CTRL group significantly more year of education the three other groups (*Mann Whitney test*. BD: $|z| = 3.95, p = 0.0001$; BPD: $|z| = 4.99, p < 0.0001$; ADHD: $|z| = 3.41, p = 0.0007$). Among the patient, only the BPD group shows a significantly shorter education than the ADHD group (*Mann Whitney test*. $|z| = 2.58, p = 0.0098$). There were significantly more married subjects in the bipolar group than in the BPD and ADHD group (BPD: $\chi^2(3) = 61.31.07, p < 0.0001$; ADHD: $\chi^2(3) = 24.23, p < 0.0001$). Comorbid disorders for the three main diagnostic categories are shown in Table 2. We define that mood episodes include depressive, mania, hypomania and mixed episodes as a total.

The mixed-diagnostic samples included 136 subjects: 94 subjects with both diagnosis of BPD and ADHD, 29 with a diagnosis of BD and BPD and 13 with all three diagnostics. For patients with BD or ADHD, the rate of married subject significantly dropped when BPD were also present (BD vs BD_BPD: $\chi^2(1) = 15.59, p = 0.008$; ADHD vs BPD_ADHD: $\chi^2(1) = 8.61, p = 0.035$).

Table 1: Sample demographic description

Table 1		BD		BPD		ADHD		CTRL		BPD_ADHD		BD_BPD		BD_BPD_ADHD	
		N = 267		N = 168		N = 173		N = 47		N = 94		N = 29		N = 13	
		<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Gender	Man	104	39	12	7.1	115	66.5	24	51.1	9	9.6	3	10.7	0	
Marital Status	Single	81	30.3	98	58.3	70	40.5	20	42.6	60	63.8	18	64.3	10	76.9
	Married	136	50.9	25	14.9	47	27.2	13	27.7	17	18.1	5	17.9	0	0
	Divorced/Separated	42	15.8	34	20.2	18	10.4	5	10.7	16	17.0	5	17.2	3	23.1
	Widower	2	0.7	0	0	0	0	0	0	0	0	0	0	0	0
	Not filled-in	6	2.2	11	6.5	38	22	9	19.1	1	1.1	0	0	0	0
Socio-prof. category	Active	174	65.2	64	38.1	74	42.8	0	0	75	79.8	2	7.1	2	15.4
	Unemployed/Students	75	28.1	57	33.9	39	22.5	0	0	45	47.9	17	60.7	5	38.5
	Disability pension	11	4.1	32	19	22	12.7	0	0	17	18.1	6	21.4	6	46.2
	Not filled-in	7	2.6	15	8.9	38	22	47	100	2	2.1	3	10.1	0	0
		<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>m</i>	<i>SD</i>	<i>m</i>	<i>SD</i>	<i>m</i>	<i>SD</i>
Age		44.6	12.1	32.7	10.4	36.6	11.1	39.6	11.2	30.6	8.5	30.1	8.6	34.4	11.3
Year of education		13.9	3.7	13.4	3.2	14.4	3.5	16.4	2.5	12	3.4	13.6	2.5	13.9	1.4

Table 2: Clinical data and co-morbidities

Table 2	BD		BPD		ADHD		BPD_ADHD		BD_BPD		BD_BPD_ADHD	
	N = 267		N = 168		N = 173		N = 94		N = 29		N = 13	
	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%	<i>n</i>	%
Alcohol or substance abuse/dependence	33	12.4	97	57.7	56	32.4	72	76.6	11	24.4	11	84.6
Anxiety Disorder (Panic Disorder, Social phobia or GAD)	67	25.1	110	65.5	45	26	73	77.7	18	40	11	84.6
Eating disorder	16	6	73	43.5	12	6.9	45	47.9	8	17.8	8	61.5
History of suicide attempts	62	23.2	87	51.8	19	11	56	59.6	20	44.4	9	69.3
	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>m</i>	<i>SD</i>	<i>m</i>	<i>SD</i>	<i>m</i>	<i>SD</i>
Lifetime depressive episodes	3.7	3.5	3.5	4	1.3	1.8	4.1	6.5	3.9	2.9	4.7	5.6
Lifetime mood episodes	6	4.7	3.4	4	1.4	1.9	4.5	5.7	6.1	3.7	6.8	6.1

Impulsivity - Barratt Impulsivity Scale

After adjustment for age and gender, the total score for BIS was significantly different between the four groups (BD: $m=47.0$ ($SD=12.4$); BPD: $m=65.7$ ($SD=17.4$); ADHD: $m=76.4$ ($SD=16.9$); CTRL: $m=41.2$ ($SD=10.5$)); $F(55, 590) = 9.16$; $p < 0.001$) (Figure 1). The table 3 shows that the scores for the three BIS subscales were also significantly different between the four groups, the gradient being mainly the same with BPD and ADHD, scoring higher than BD and higher than controls. Post-hoc analyses showed that there was no significant difference between BD patients and CTRL subjects for the BIS total score, the motor impulsivity subscale and the anticipation subscale. BD patients only scored significantly higher than CTRL on the Cognitive Impulsivity subscale. All the other pairwise comparison were significant, meaning that for all the impulsivity subscale, the BPD patients score were significantly higher than BD patients and CTRL subjects and the ADHD group scores significantly higher than the three other groups.

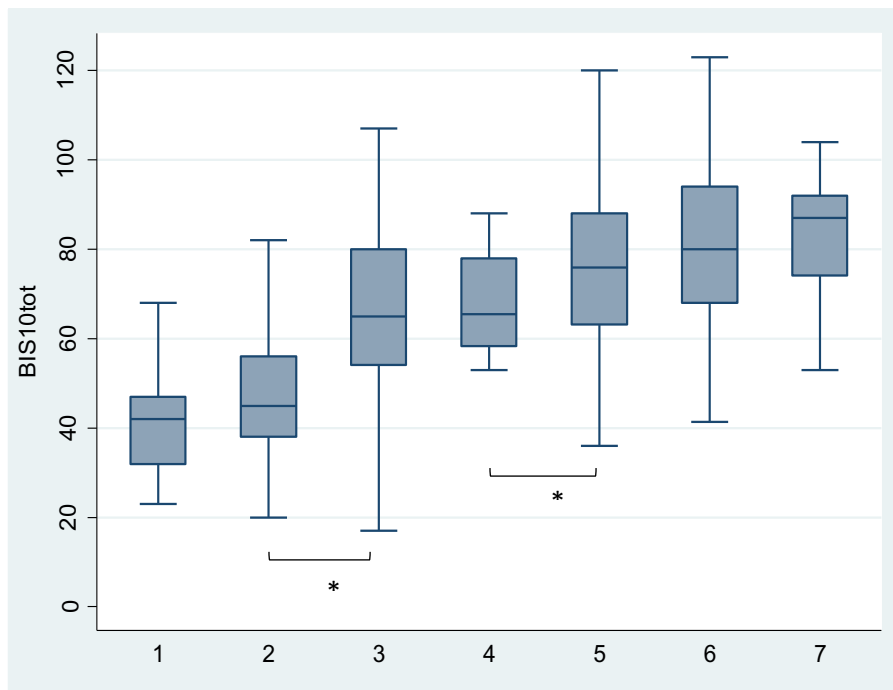


Figure 1: Box Plot of Barratt Impulsivity Scale (BIS) total scores

1 : CTRL; 2 : BD; 3 : BPD; 4 : BD_BPD; 5 : ADHD; 6 : BPD_ADHD; 7 : BD_BPD_ADHD. * : p -value < 0.0001 .

	BD		BPD		ADHD		CTRL		<i>F</i> (55 df)	<i>p</i>	<i>Post-hoc</i> B = BD D = BPD A = ADHD C = CTRL	<i>Summary statistic</i> R ²
	N = 267		N = 168		N = 173		N = 47					
	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>				
Motor Impulsivity	13.5	6.7	22.3	7.8	25.7	7.8	11.0	4.8	8.0	<0.0001	C,B < D < A	0.447
Cognitive Impulsivity	18.1	6.1	22.2	6.9	26.6	6.3	15.0	4.3	5.4	<0.0001	C < B < D < A	0.352
Anticipation	16.1	5.8	21.3	7.1	24.1	7.4	15.3	5.3	3.8	<0.0001	C,B < D < A	0.278
BIS Total	47.0	12.8	65.7	17	76.4	16.9	41.2	10.5	9.2	<0.0001	C,B < D < A	0.485

Table 3: Mean scores for the different dimensions of the Barratt Impulsivity Scale (BIS) for single diagnostic groups and pairwise comparison between groups.

Sensitivity analyses

After comparing groups with a single diagnostics we explored impulsivity among patients with at least two of the three diagnostic of interest in our study.

After adjustment on age and gender, the total score for BIS was not significantly different between the four groups (BPD_ADHD: m=80.0 (SD=18.8); BD_BPD: m=68.6 (SD=11.6); BD_BPD_ADHD: m = 82.7 (SD=15.9)); $F(36, 165) = 1.48$; $p = 0.0543$). The table 4 shows the results obtained for BIS subscales and ANOVA models.

	BPD_ADHD		BD_BPD		BD_BPD_ADHD					
	N = 94		N = 29		N = 13					
	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>F</i>	<i>p</i>	<i>Post-hoc</i>	<i>Summary</i>
							<i>(36 df)</i>		E = BPD_ADHD F = BD_BPD G = BD_BPD_ADHD	<i>statistic</i>
										R ²
Motor Impuls.	28.0	8.3	22.6	7.3	30.8	6.9	1.3	0.140	F = E = G	0.353
Cognitive Impuls.	26.3	6.8	23.2	5.4	27.0	6.5	1.2	0.241	F = E = G	0.330
Anticipation	25.8	7.9	23.0	4.8	24.9	8.1	0.7	0.898	F = E = G	0.221
BIS Total	80.0	19	68.6	11.6	82.7	15.9	1.1	0.375	F = E = G	0.309

Table 4: Mean scores for the different dimensions of the Barratt Impulsivity Scale (BIS) for multiple diagnostic groups, difference and pairwise comparison between groups.

	BD			BPD			ADHD		
	F (54 df)	<i>p</i>	B = BD F = BD_BPD G = BD_BPD_ADHD	F (41 df)	<i>p</i>	D = BPD E = BPD_ADHD F = BD_BPD G = BD_BPD_ADHD	F (45 df)	<i>p</i>	A = ADHD E = BPD_ADHD G = BD_BPD_ADHD
Motor Impulsivity	3.8	<0.001	B < F < G	1.9	0.0012	D=F; D<E,G; F=E=G; G<F	1.8	0.0028	A = E = G
Cognitive Impulsivity	1.8	0.003	B < F, G	2.0	0.0007	F=D; D<E,H; E=F=G	1.0	0.4530	A = E = G
Anticipation	1.9	0.001	B < F, G	1.2	0.1996	D<E; D=F=G=E	1.0	0.4119	A = E = G
BIS Total	4.0	<0.001	B < F < G	2.2	0.0002	D,F < E, H	1.3	0.1505	A = E = G

Table 5: Comparison of BIS subscale for BD, BPD and ADHD patient against co-morbid patients. Adjusted for gender and age

We then compared each single population groups with groups with matching diagnosis added with others one (Table 5).

When a diagnostic of BPD was added to the BD one, impulsivity increased to the level of the impulsivity of the added diagnostic (BD_BPD = BPD). The results showed that adding the BD diagnostic to the BPD one did not increase significantly any of the impulsivity subscale. Patients who were diagnoses with both with BPD and ADHD reported a significant higher score than sole BPD patients and reached the level of impulsivity of ADHD patients. The patients who were diagnoses with the three pathologies scored significantly higher than all the other groups for the motor impulsivity and the cognitive impulsivity.

b. Traumatic childhood experiences

The average total score for CTQ was significantly different between the 4 groups (BD: $m=38.1$ ($SD=10.4$); BPD: $m=51.7$ ($SD=18.3$); ADHD: $m = 46.1$ ($SD=14.7$); CTRL: $m=34.4$ ($SD=12.7$)); *Kruskall-Wallis test* : $\chi^2(3) = 85.3$; $p < 0.0001$). Table 6 shows that the scores for the five CTQ subscales were also significantly different between the 4 groups.

	BD		BPD		ADHD		CTRL		<i>F</i> (56 <i>df</i>)	<i>p</i>	<i>Post-hoc</i> B = BD D = BPD A = ADHD C = CTRL
	N = 267		N = 168		N = 173		N = 47				
	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>	<i>mean</i>	<i>SD</i>			
Emotional Abuse	8.3	4.0	13.8	5.8	11.6	5.3	8.3	5.2	5.5	<0.0001	B,C < A = D
Physical Abuse	5.9	2.1	8.1	4.5	7.4	3.7	6.1	2.6	2.9	<0.0001	B,C < A < D
Sexual Abuse	5.6	2.0	8.1	5.0	6.1	2.6	5.4	1.0	3.2	<0.0001	B,C,A < D
Emotional Neglect	11.8	4.2	14.0	5.2	13.3	5.0	8.7	4.6	3.4	<0.0001	B < C < A < D
Physical Neglect	6.5	1.9	8.1	3.3	7.6	2.9	6.0	2.0	3.0	<0.0001	B,C < A,D
CTQ Total	38.1	10.4	51.7	18.3	46.1	14.7	34.4	12.7	5.5	<0.0001	B,C < A = D

Table 6: Average scores the different dimension of the CTQ and difference between groups.

Compared to CTRL, BD patients report a higher level emotional abuse, emotional neglect and physical neglect. BPD patients showed significant higher score than CTRL and BD patients for all subscales, and significant higher score for emotional and sexual abuse than ADHD patients. BPD patients were the only population reporting a significantly higher level of sexual abuse than any another population. That being said, when linear regression was performed for sexual abuse taking gender into account, the diagnostic group was no longer significant. (Gender: $t = 5.68$, $p < 0.0001$; Group: $|t| = 0.46$, $p = 0.644$). ADHD patient's scores were significantly higher than CTRL except for sexual abuse. They also showed higher scores than BD patients for emotional and physical abuse and physical neglect. Regarding the BPD and ADHD patients, the two groups significantly differed for the emotional abuse and sexual abuse subscales for which BPD patients shows higher scores.

4. Relation between BIS and CTQ

We performed a linear regression with age, gender, group and CTQ total score as independent variable. This model showed that BIS total score was significantly influenced by group (coef.: 6.43, $t = 16.58$, $p < 0.001$), age (coef. : -0.17, $t = -3.10$, $p = 0.002$), gender (coef. : 4.00, $t = 2.89$, $p = 0.004$) and CTQ total score (coef. : 0.21, $t = 4.81$, $p < 0.001$), meaning, that regardless of the diagnostics, a higher score on the CTQ was linked to a higher level of impulsivity.

Interestingly, the relation between BIS and CTQ varied across the populations. When we performed linear regression for the BIS total score among each group (still with age and gender adjustment), we found that the CTQ total score linear regression coefficient was significant among the CTRL group and the BD patient (CTRL : coef. 0.42, $t = 3.76$, $p = 0.001$; BD: coef. : 0.22, $t = 2.61$, $p = 0.010$) but not any more for the BPD patient (coef. 0.07, $t = 0.89$, $p = 0.377$) and for the ADHD patient (coef. : 0.14, $t = 1.49$, $p = 0.139$).

5. Discussion

To our knowledge, this is the first study to assess impulsivity in patients with BD, BPD and ADHD. Our study shows that the level of global impulsivity differs significantly among disorders: with ADHD subjects being the most impulsive, followed by BPD subjects, then subjects diagnosed with BD and controls. These results are the same for two BIS subscales: “motor impulsivity” and “anticipation”. Though, for the subscale “cognitive Impulsivity”, we observed a significant difference among the four groups, including BD patients and controls. Secondly, patients who were diagnosed with both with BPD and ADHD reported a significant higher score than sole BPD patients and reached the level of impulsivity of ADHD patients. The patients who were diagnosed with the three disorders scored significantly higher than all the other groups for the motor impulsivity and the cognitive impulsivity. Thirdly, the intensity of impulsivity increased with the severity of childhood trauma for the BD patients and controls but not for BPD patients and ADHD patients.

a. Impulsivity

For patients with BPD or ADHD, the high levels of impulsivity found in our study support previously published data on this topic (Domes et al., 2006; Moeller et al., 2001; Paris, 2004). For BD patient, our data are in line with some studies (Bøen et al., 2015; Lewis et al., 2009), but in contradiction with others (Etain et al., 2013; Moeller et al., 2001; Peluso et al., 2007; Swann et al., 2001; Swann et al., 2013; Swann et al., 2003; Tu et al., 2017). Some authors suggest that the contribution of impulsiveness to BD remains a matter of debate (Henry and Etain, 2010), because these contrasting results can be attributed to the clinical features of patient samples (Lewis et al., 2009). Furthermore, Strakowski and colleagues (2010) report that BIS-11 total and all subscale scores, except the attentional subscale score, remained significantly elevated in BD patients during euthymia as compared with healthy subjects but upon achieving euthymic, BD subjects exhibited no significant differences from healthy subjects on any behavioral task (tasks designed to study response inhibition, ability to delay gratification, and attention; namely a stop signal task, a delayed reward task, and a continuous performance task).

When we compared BD patients with subjects with a single diagnosis of BPD, our results are in line with two previous studies which reported a significantly higher impulsivity, evaluated with the BIS, among BPD patients than in BD patients (Henry et al., 2001; Wilson et al., 2007). Two additional studies using UPPS (Whiteside and Lynam, 2001) to evaluate impulsivity also showed

similar results (Bøen et al., 2015; Leblanc et al., 2017). The UPPS (urgency, (lack of) premeditation, (lack of) perseverance, and sensation seeking) is a scale assessing impulsivity facets. The scale was originally developed by Whiteside and Lynam (2001) in order to provide consensus on which traits are measured across different existing impulsivity measures. Moreover, in 2013, Feliu-Soler and colleagues reported that both impulsivity and attention differ between BD patients, BPD patients and controls: patients with BPD exhibit an impulsive behavior while BD patients showed slowness with impaired performance (Feliu-soler et al., 2013). The fact that the BD patients have increased levels of attentional impulsiveness, which has been defined as a lack of ability to focus on a task and a tendency toward racing thoughts and distractibility, is not surprising. BD, but not BPD, is often characterized by the disturbances of cognition captured by the attentional impulsiveness subscale. Conversely, higher levels of non-planning impulsiveness, defined by Patton and colleagues (1995) as a difficulty with planning actions carefully and thinking about consequences of actions, might be expected with BPD patients, who are often partly characterized by impulsive behaviors with high likelihood of self-harm (Wilson et al., 2007). Bøen's study reported different impulsivity profile between BD and BPD patients: BPD patients showed significantly higher impulsivity scores than healthy controls on all UPPS subscales except sensation seeking, and significantly higher impulsivity than BD type II patients on the Urgency and Lack of Perseverance subscales. BD type II patients showed significantly higher impulsivity than healthy controls on the Urgency and Lack of Perseverance subscales (Bøen et al., 2015). Some other finding from Leblanc (2016) showed slightly different results regarding the UPPS: BPD patients scored significantly higher than BD patients for the dimensions "lack of premeditation" and "lack of perseverance"; however, BD patients had significantly higher scores than BPD patients for the dimension "negative emergency".

For ADHD patients compared to BPD patients, our data support previously published data on this topic. Ende and colleague, in a study published in 2015, reports that compared to BPD patients, ADHD patients have higher impulsivity in all BIS-11 facets (non-planning, motor, and attentional impulsivity). The authors also stated that BPD and ADHD patients differed in every aspect of impulsivity. ADHD patients reported generally elevated impulsivity (BIS-11 total score), stronger tendencies to act without thinking (motor impulsivity), more deficits in planning and future-orientation (non-planning impulsivity), and more problems maintaining attention on a task/being more distractible (attentional impulsivity) (Ende et al., 2015).

For ADHD patients compared to BD patients, there is no study comparing impulsivity in ADHD and BD for adult's population. Only one study in adolescents suggest that impulsivity is elevated in adolescents with BD, as well as in adolescents with ADHD, relative to healthy adolescents, but

with no significant differences between ADHD and bipolar groups (Nandagopal et al., 2011). One notable exception is that non-planning impulsivity was not significantly different between adolescents with ADHD and healthy adolescents. This may suggest that non-planning impulsivity is relatively specific to adolescents with BD.

Co-morbidity BPD and BD

When we looked at the impulsivity within the BPD/BD co-morbid population, our data suggested that adding the BD diagnostics to the BPD one does not increase significantly any of the impulsivity subscale. Our results are in line with the previous studies (Carpiniello et al., 2011; Swann et al., 2013). Carpiniello (2011) demonstrated that BD/BDP co-occurring patients are more impulsive and have a higher suicidality rate than the patients with the sole BD diagnostic or with other personality disorder as co-morbidity. Swann (2013) asserted that the BPD co-morbidity in BD is an aggravation factor in the course of the illness, with more hospitalization and higher occurrence of substance abuse due to the increased impulsivity. However, some other studies, which included 'pure' BD patients and 'pure' BPD patients did not demonstrate significant impact of the BPD/BD co-morbidity on the issue of impulsivity (Henry et al., 2001; Wilson et al., 2007). Moreover, considering the high scores for the BIS reported by BPD group in our study, we might also postulate a ceiling effect for this population, an intense impulsivity, intrinsic to BPD, which is in the end, not really influenced by the contribution of the rather small impulsiveness inherent to BD.

Co-morbidity ADHD and BPD

Ferrer et al. 2016 found that adult patients with BPD could be categorized into two subgroups, based on ADHD co-morbidity: patients with comorbid ADHD-BPD had a more homogeneous and impulsive profile, while patients with BPD without ADHD were more likely to have anxiety and depressive disorders. The co-occurrence of these two disorders, ADHD and BPD, would be associated with more severe symptoms (Philipsen et al., 2008). More recently, a study using the BAARS impulsivity scale (O'Malley et al., 2016) concluded that patients diagnosed with both BPD and ADHD exhibited increased impulsivity compared with pure ADHD. However, there is no significant difference between the two groups for neuropsychological measures of impulsivity, these results add blur to the previous contradictory publication (Dijk et al., 2014; Krause-Utz et al., 2013; Lampe et al., 2007; Speranza et al., 2011). According to the authors, inconsistent results may reflect problems at a conceptual level. Impulsivity is not a unitary construct but refers to a range of similar capabilities. Consequently, the use of global measures of impulsivity, which

cannot detect subtle differences between impulsivity in ADHD and BPD, may explain inconsistency across results. It is also to notice that there were no pure BPD patients in this study (O'Malley et al., 2016). For ADHD and BPD, neuro-imaging studies suggest that there may be dysfunctions of the prefrontal cortex, a core region for attentional mechanisms and impulse CTRL, and in the orbito-frontal cortex, a core region for impulsivity and emotional CTRL (Asherson et al., 2014).

b. Impulsivity and traumatic childhood experience

We firstly found that the CTQ total score was positively correlated to the level impulsivity in controls and in BD patients but in BPD and ADHD patients. These data may suggest that impulsivity is intrinsic to BPD and ADHD, regardless of the presence or absence of traumatic childhood experience. Although the relationship between the severity of ADHD symptoms and child maltreatment is unclear and there is a lack of data in the literature (Sugimoto et al., 2015). Impulsivity might be more biologically determined in ADHD and BPD and more environmentally driven in BD and controls. In this perspective, adverse childhood experiences may increase impulsivity related to negative emotions in BD patient (Bøen et al., 2015).

Our data show that impulsivity in BD patients is not significantly higher than CTRL subjects but increases considerably when BD patients suffered also from traumatic childhood experience. Previously, some authors suggested that BD patients who endorsed a history of child or adolescent physical or sexual abuse, compared with those who did not, had a history of an earlier onset of bipolar illness, an increased number of Axis I, II, and III comorbid disorders, including drug and alcohol abuse, faster cycling frequencies, a higher rate of suicide attempts, and more psychosocial stressors occurring before the first and most recent affective episode and a worse response to treatment, mediated by more impulsivity (Belzeaux et al., 2015; Daruy-Filho et al., 2011; Garo et al., 2005; Leverich et al., 2002). Moreover, impulsivity could be the link between early trauma and suicidality (Braquehais et al., 2010; Carli et al., 2010). These results seem very important for the treatment of BD and could explain the contradictory results about the impulsivity in euthymic BD patients and can bring a new element of the debate about impulsiveness in BD.

c. Limitations

Our study has several limitations. Impulsivity was assessed on the basis of a self-report questionnaire and not by the mean of an objective measure such as a neuropsychological test.

However, the BIS-10 has been shown to be elevated in a number of different types of impulsive conditions these findings provide face validity that the BIS-10 provides a measurement of 'real-life' trait impulsiveness, despite the limitations of a self-report (Strakowski et al., 2010). More objective measures of impulsivity such as neuropsychological tests using for instance Continuous Performance Test (CPT) or a Go-NoGo condition might be suitable candidates in order to better define specific brain functions associated with impulsive behavior and thus better distinguish forms of impulsivity between our clinical populations (Fallgatter and Herrmann, 2001). Another limitation is the presence of BPD and/or ADHD co-morbidities in the BD group, since not assessed for BPD (not assessed and not an exclusion criteria) and WURS was used as screening tool for ADHD without any confirmation of a genuine ADHD diagnosis. Another limitation is that we had little to none insight about what kind of treatment our pathological subjects were receiving. As well as for the psychostimulants (Sharma and Couture, 2014), it is known that lithium, valproate and antipsychotics have anti-impulsive and anti-aggressive effects (Gobbi et al., 2006; Swann et al., 2002). Moreover, in different clinical studies with assess impulsivity in BDL, BD and/or ADHD, the problematic of medicines is not or rarely discussed (Etain et al., 2013; Prada et al., 2014; Swann et al., 2013). Otherwise, in our study, participants completed the questionnaires before being treated in our units. Finally, it is important to note that despite the probable use of mood stabilizers, antipsychotics and psychostimulants that reduce impulsivity, ADHD patients and BPD patients were more impulsive than healthy CTRLs who did not take medications. The question is still open for the BD patients but a study reported that the use of psychotropic medication in general did not have any significant influence on the UPPS scores between BD and BPD (Bøen, 2015). More recently, in a morphometric study, authors mention that effect of antipsychotics on cortical thickness is not totally consistent and compared with antipsychotics, the studies of antidepressant and mood stabilizers are less abundant (Tu, 2017).

d. Conclusions

To conclude, our study suggests that impulsivity is probably not a feature of BD but is associated with the presence of traumatic childhood experiences, especially for euthymic patients, unlike BPD and ADHD. So, it seems essential to assess the presence of early trauma for each BD patient. To take care of early trauma could reduce the impulsivity and improve the evolution of BD (less relapse into a hypomanic or manic mode, less substance abuse, less suicide, for example). Our findings suggest that each diagnosis is associated with a different facet of impulsivity and there may be distinct neuropathology underlying each disorder. Additional research is needed if we are to fully understand the differences between these disorders.

Competing conflicts of interest

There no conflicts of interest in relation with this article.

Declaration of interest

The authors declare no financial or other conflicts of interest in relation with this article.

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