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Perceived childhood adversities: Impact of childhood trauma to estimated intellectual functioning of individuals with bipolar disorder

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ABSTRACT

Maltreatments in childhood may have implications for neurodevelopment that could remain throughout life. Childhood trauma seems to be associated with the onset of bipolar disorder (BD), and its occurrence might accentuate the overall disease impairments related to cognitive deficits in BD. We aimed to evaluate the effects of a history of childhood trauma to estimated intellectual functioning (IQ) of individuals with BD. We included 72 subjects with BD during euthymia. Participants underwent a clinical interview and were assessed through the Childhood Trauma Questionnaire (CTQ) and Wechsler Abbreviated Scale of Intelligence (WASI). Most prevalent trauma subtypes were emotional abuse and neglect (54.1%). A linear regression model that included perceived childhood trauma, family history of severe mental disorders, age at diagnosis and psychotic symptoms during the first episode as main factors showed that only childhood trauma had a significant effect in predicting estimated IQ. Therefore, the history of childhood trauma in individuals with BD may play a role in intellectual development, suggesting that adversities during development result in decreased general cognitive abilities. These results reinforce the need to promote early interventions to protect childhood and to promote the well-being of children, contributing to the growth of healthy adults.

1. Introduction

Bipolar Disorder (BD) is a chronic psychiatric illness that affects 1% of the global population (Grande et al., 2016) and it is characterized by mood episodes of mania or hypomania and depression (Vieta et al., 2018). The etiology of BD is described as being influenced by different factors possibly related to gene-environment interactions (Vieta et al., 2018). Thus, despite the evidence of substantial genetic influence, there are critical environmental components related to the development of BD in adult life, such as childhood trauma (Aas et al., 2016; Jansen et al., 2016; Russo et al., 2015; Watson et al., 2014).

Childhood trauma includes physical, emotional and sexual abuse, and physical and emotional neglect (Bucker et al., 2013; Dualibe and Osório, 2017). Approximately 30% to 50% of individuals with BD have experienced some traumatic event in childhood (Brietzke et al., 2012; Dualibe and Osório, 2017), and a systematic review suggested that 24% of this population had a history of childhood trauma (Maniglio, 2013). Interestingly, there seems to be a relationship between early age of

disease onset and childhood trauma (Anand et al., 2015). Furthermore, the history of early trauma in individuals with BD is linked to more clinical comorbidities, psychotic symptoms, recurrence of episodes, suicide risk, use and abuse of drugs, cognitive deficits, poor response and adherence of drug treatment and worse prognosis (Aas et al., 2016; Brietzke et al., 2012; Daruy-Filho et al., 2011; Dualibe and Osório, 2017; Erten et al., 2014; Etain et al., 2017; Post et al., 2015; Watson et al., 2014).

However, individuals with BD present heterogeneous symptoms due to different courses of the disorder. The frameworks that attempt to explain this variability are the neuroprogression models (Fries et al., 2012; Gama et al., 2013; Kapczinski et al., 2009; Passos et al., 2016; Rodrigues et al., 2014). These models suggest a progressive deterioration in functionality and clinical course of BD that is related to biomarkers, treatment response, and cognitive impairment. The authors state that there would be four stages of the disorder, ranging from the most preserved to the most deteriorated, wherein the fourth stage the individual would have his autonomy significantly compromised (Fries

et al., 2012; Kapczinski et al., 2009). Both functional outcome and cognitive impairment are essential aspects of neuroprogression (Rosa et al., 2014). Interestingly, almost half of individuals with BD may present poor overall functioning even in euthymia (Samalin et al., 2016) what seems to be related to cognitive performance in addition to the clinical course, reinforcing the idea of a neuroprogressive disorder (Cardoso et al., 2015; Kapczinski et al., 2017; Rosa et al., 2014).

Cognitive deficits are increasingly considered as crucial components of BD, impacting several domains such as memory, executive functions, social cognition, attention, even periods of euthymia (Bourne et al., 2013; Bucker et al., 2013; Cullen et al., 2016; Torres et al., 2007). Interestingly, several studies report that the childhood trauma might accentuate these deficits (Jiménez et al., 2017; Masson et al., 2016; Quide et al., 2017; Russo et al., 2015). Thus, the cognitive impairments observed in these individuals could be related to the effects of childhood trauma to neurodevelopment (Alexandra et al., 2018; Brietzke et al., 2012; Tendolkar et al., 2018).

During neurodevelopment, children acquire and develop cognitive abilities, such as speech, logical reasoning, and abstract thinking, through brain maturation (Masson et al., 2016). However, some studies discuss the impact of traumatic experiences on specific brain regions, and, consequently, on the development of cognition in general (Brietzke et al., 2012; Lee and Hoaken, 2007). A proxy of general cognitive ability could be the intellectual functioning, which is consolidated throughout neurodevelopment and may have its course affected by maltreatment during childhood (Masson et al., 2016; Vreeker et al., 2017). This construct refers to the ability to learn and adapt to environments using metacognitive processes (Sternberg, 2017) and is usually measured by an intelligence quotient (IQ).

Although there is much evidence on the role of trauma in the development of BD, few studies showed the relationship between childhood trauma and IQ in this population (Berthelot et al., 2015; Bucker et al., 2013; Jimenez et al., 2017; Vreeker et al., 2017). Therefore, we aimed to analyze the effects of the self-reported history of childhood trauma on estimated IQ in individuals with BD.

2. Methods

2.1. Participants

This was a cross-sectional study part of a larger study focusing on cognition of individuals with bipolar disorder from southern Brazil. Participants were selected conveniently from Bipolar Mood Disorder Program (PROTAHBI) of the Hospital de Clínicas de Porto Alegre (HCPA). The study was reviewed and approved by the Ethics Committee of the HCPA. The subjects included in the sample were informed about the study objectives and signed an Informed Consent Term before the evaluation.

The inclusion criteria for individuals with BD were: (a) diagnosis of Bipolar Disorder types I or II confirmed by experienced psychiatrist through the Structured Clinical Interview for DSM-IV (SCID) (Del-Ben et al., 2001); (b) to be between 18 and 70 years old; (c) euthymia according to the Hamilton Depression Rating Scale (HAM-D ≤ 7) (Freire et al., 2014) and Young Mania Rating Scale (YMRS ≤ 7) (Vilela et al., 2005); and d) reading and writing abilities. All participants were receiving pharmacological treatment according to the program's protocols. Individuals with unstable medical comorbidities and current alcohol and drug abuse were excluded.

2.2. Assessments

All participants underwent an interview to collect clinical and sociodemographic data (age, sex, marital status, years of education, work status, bipolar disorder type, estimated illness duration based on patients' recollection, age at diagnosis based on patients' medical records, psychotic symptoms during the first episode, family history of severe

mental disorders, lifetime suicide attempts, current psychopharmacological treatment), that also included an evaluation of euthymia (HAM-D and YMRS) and functional outcome through the Functioning Assessment Short Test (FAST) (Rosa et al., 2007).

We estimated IQ with the two-subtest form of the Brazilian version of the Wechsler Abbreviated Scale of Intelligence (Wagner et al., 2014), which considers the Vocabulary subtest to assess crystallized intelligence, i.e. the ability to use acquired knowledge of the world in solving problems, and Matrix Reasoning subtest to evaluate fluid intelligence, i.e. the ability to reason rapidly and flexibly in novel situations.

We verified the history of childhood trauma with the Childhood Trauma Questionnaire (CTQ) Brazilian version (Grassi-Oliveira et al., 2006). This instrument is self-applicable and has 28-items to assess the occurrence of abuse and/or neglect before the age of 18 years (Bernstein et al., 1994). The CTQ includes domains of emotional, physical, and sexual abuse, as well as emotional and physical neglect. Items are rated from 1 ("never true") to 5 ("very often true"), according to the frequency with which each event occurred in childhood. We considered the history of trauma as a dichotomic variable (yes/no) if the person rated items as moderate or severe according to each subscale cutoff criteria in at least one type of trauma, according to the manual.

2.3. Procedures

Participants were invited to participate in the study and signed the informed consent. After, they underwent a clinical interview to confirm the diagnosis with SCID, and to confirm euthymia through HAM-D and YMRS. Then, clinical, functional and sociodemographic data were collected, followed by the assessment of estimated intellectual functioning. The CTQ was performed at the end of the assessment.

2.4. Statistical analysis

Statistical analysis was completed in SPSS v18. We first analyzed differences between groups in demographic and performance data through descriptive statistics and Student's t-test or chi-square test. Descriptive data were expressed as mean and standard deviation. After, we used Pearson's correlations to verify possible relationships between variables. Finally, we conducted multiple linear regression models to predict estimated IQ by childhood trauma and other clinical variables described in the literature as related to childhood trauma and estimated IQ that were available in our sample. The models included childhood trauma, years of education (for its relationship to acquired knowledge and learning of estimated IQ), family history of severe mental disorders (for its relationship to a genetic load that could impact neurodevelopment), and age at diagnosis and psychotic symptoms during the first episode (for its relationship to an earlier and a more severe disease that could also impact neurodevelopment). The first model included all mentioned variables, while the second model excluded years of education due to the possible collinearity with estimated IQ. Statistical significance was set at $p < 0.05$, 2-tailed.

3. Results

The sample consisted of 72 individuals with BD. Clinical and sociodemographic characteristics are presented in Table 1. Their mean age was 46 years. Two-thirds were female, and almost half were married. Their mean years of education was 11 years. Only 26% were currently employed, while almost half of them were receiving government aid due to the illness. The majority had a diagnosis of BD type I (86%), family history of mental disorder (70%), while half of them had previous suicide attempts (52%). Their mean estimated illness duration was 20 years, and their mean age at diagnosis was 31 years.

The sample presented 48.6% of individuals with BD that had a history of childhood trauma. Among them, 18.1% had experienced one

Table 1
Clinical and socio-demographic characteristics of individuals with bipolar disorder.

	Individuals with bipolar disorder (n = 72)	Participants according to self-reported childhood trauma		Group comparisons
		History of childhood trauma (n = 35)	No history of childhood trauma (n = 37)	
Age*	45.89 (± 13.50)	48.00 (± 12.16)	43.89 (± 14.54)	$t(70) = -1.297$; $p = 0.199$[#]
Sex (female)**	48 (66.67%)	26 (74.29%)	22 (59.46%)	$\chi^2(1) = 1.779$; $p = 0.182$[†]
Marital status**				$\chi^2(3) = 3.073$; $p = 0.380$[†]
Single	25 (34.72%)	9 (25.71%)	16 (43.24%)	
Married	32 (44.44%)	18 (51.42%)	14 (37.84%)	
Divorced	12 (16.67%)	7 (20.00%)	5 (13.51%)	
Widowed	3 (4.17%)	1 (2.85%)	2 (5.41%)	
Years of education*	10.79 (± 3.23)	10.09 (± 3.22)	11.46 (± 3.14)	$t(70) = 1.832$; $p = 0.071$[#]
Work status**				$\chi^2(6) = 5.459$; $p = 0.486$[†]
Employed	19 (26.39%)	6 (17.14%)	13 (35.14%)	
Unemployed	15 (20.83%)	9 (25.71%)	6 (16.21%)	
Receiving government aid due to illness	35 (48.61%)	18 (51.43%)	17 (45.95%)	
Retired	3 (4.17%)	2 (5.71%)	1(2.70%)	
Bipolar disorder type I**	61 (85. 92%)	28 (80%)	33 (91.67%)	$\chi^2(1) = 1.996$; $p = 0.158$[†]
Estimated illness duration*	20.03 (± 13.71)	23.55 (± 13.69)	16.80 (± 13.10)	$t(67) = -2.090$; $p = 0.040$[#]
Age at diagnosis*	30.73 (± 11.44)	31.94 (± 11.46)	29.63 (± 11.47)	$t(65) = -0.823$; $p = 0.413$[#]
Psychotic symptoms on first episode**	43 (64.18%)	22 (68.75%)	21 (60%)	$\chi^2(1) = 0.557$; $p = 0.456$[†]
Family history of severe mental disorder**	48 (69.56%)	25 (75.76%)	23 (63.89%)	$\chi^2(1) = 1.146$; $p = 0.284$[†]
Lifetime suicide attempts**	37 (52.11%)	23 (67.64%)	14 (37.84%)	$\chi^2(1) = 6.309$; $p = 0.012$[†]
Hamilton Depression Rating Scale (HAM-D)*	3.47 (± 2.10)	3.60 (± 2.03)	3.35 (± 2.17)	$t(70) = -0.500$; $p = 0.618$[#]
Young Mania Rating Scale (YMRS)*	1.26 (± 1.83)	1.26 (± 1.27)	1.27 (± 2.26)	$t(70) = 0.030$; $p = 0.976$[#]
Functioning Assessment Short Scale (FAST)*	26.24 (± 12.54)	29.71 (± 13.29)	22.95 (± 10.95)	$t(70) = -2.364$; $p = 0.021$[#]
Estimated IQ[a]**	86.94 (± 16.80)	82.80 (± 15.84)	90.86 (± 16.94)	$t(70) = 2.083$; $p = 0.041$[#]
History of childhood trauma (assessed by CTQ)[b]**	35 (48.61%)			
Medications**				
Lithium	19 (27.94%)	11 (36.37%)	8 (21.05%)	$\chi^2(1) = 2.030$; $p = 0.154$[†]
Anticonvulsant	49 (72.06%)	22 (73.33%)	27 (71.05%)	$\chi^2(1) = 0.043$; $p = 0.835$[†]
Atypical antipsychotic	41 (60.29%)	20 (66.67%)	21 (55.26%)	$\chi^2(1) = 0.911$; $p = 0.340$[†]
Typical antipsychotic	6 (8.82%)	2 (6.67%)	4 (10.53%)	$\chi^2(1) = 0.310$; $p = 0.577$[†]
Clozapine	9 (13.24%)	3 (10%)	6 (15.79%)	$\chi^2(1) = 0.489$; $p = 0.484$[†]
Benzodiazepines	17 (25%)	7 (23.33%)	10 (26.32%)	$\chi^2(1) = 0.080$; $p = 0.778$[†]
Antidepressant	8 (11.76)	4 (13.33%)	4 (10.52%)	$\chi^2(1) = 0.127$; $p = 0.721$[†]

[*] Mean and standard deviation.
[**] n (%).
[#] Independent samples *t*-test.
[†] Chi-square test.
[a] IQ, intelligence quotient assessed by Wechsler Abbreviated Scale of Intelligence (WASI) short-version.
[b] Childhood Trauma Questionnaire.

Table 2
Frequency of subtypes of childhood trauma.

Self-reported childhood trauma - subscales		
	Yes	No
Emotional abuse	54.3%	45.7%
Physical abuse	37.1%	62.9%
Sexual abuse	37.1%	62.9%
Emotional neglect	54.3%	45.7%
Physical neglect	42.9%	57.1%

Fig. 1. Differences of estimated intellectual functioning between groups that had history of childhood trauma and did not have history of childhood trauma.

type of trauma, 12.5% had experienced two types of trauma, 9.7% had experienced three types of trauma, and 4.2% had experienced four or five types of trauma. The most common domain was of emotional abuse and neglect (54.3%). Table 2 presents the prevalence of the participants' types of trauma.

The individuals with a history of childhood trauma had longer estimated illness duration ($p = 0.040$), increased occurrence of previous suicide attempts ($p = 0.012$), worst psychosocial functioning ($p = 0.021$), and reduced estimated IQ ($p = 0.041$, Fig. 1) compared to individuals with no history of childhood trauma. There were no other statistically significant differences between these groups regarding other clinical and sociodemographic variables (Table 1). Fig. 2 displays the highest completed education between groups.

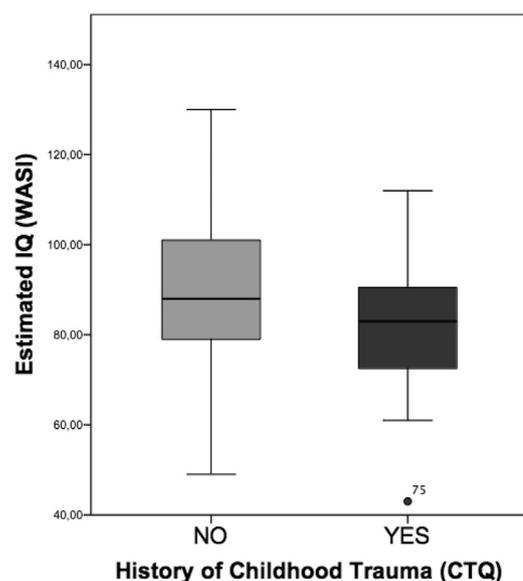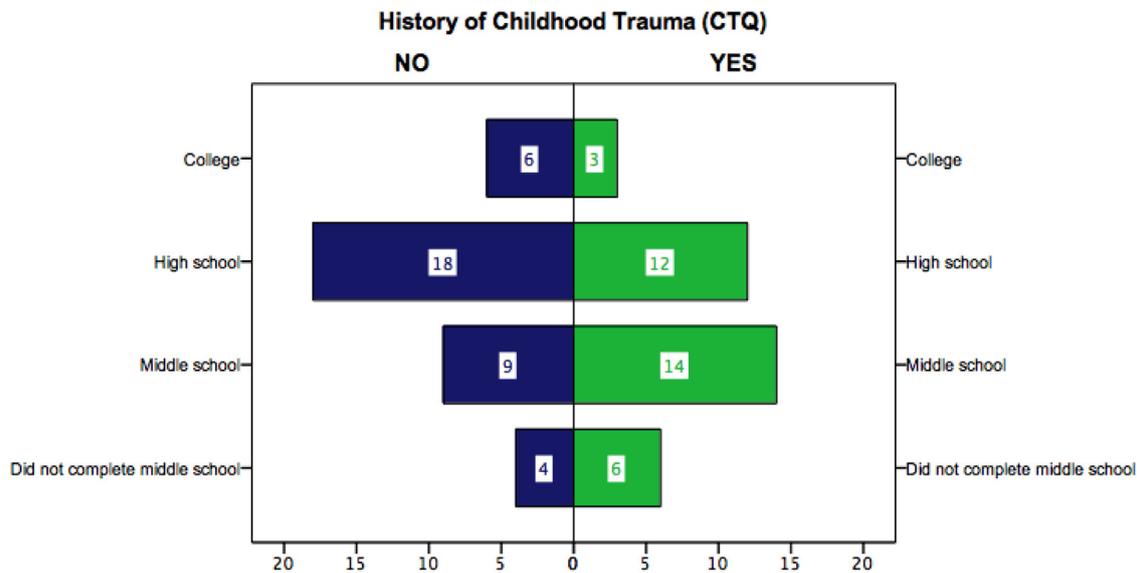When we looked at the relationships between variables to estimated

History of Childhood Trauma (CTQ)

Fig. 2. Highest completed education of individuals with bipolar disorder according to perceived childhood trauma.

Table 3
Correlations between estimated intellectual functioning (IQ) and clinical and trauma variables.

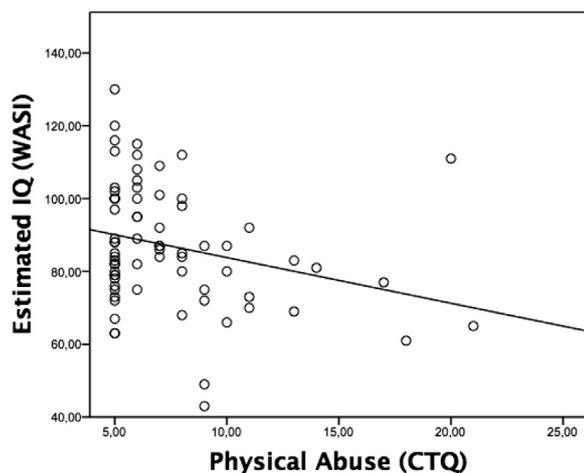|	Estimated IQ
Years of education	$r = 0.556$, $p < 0.001^*$
Family history of severe mental disorders	$r = 0.100$, $p = 0.416$
Age at diagnosis	$r = 0.147$, $p = 0.235$
Psychosis during the first episode	$r = 0.246$, $p = 0.045^*$
HAM-D total score	$r = -0.054$, $p = 0.588$
YMRS total score	$r = 0.011$, $p = 0.924$
FAST total score	$r = -0.228$, $p = 0.054$
History of childhood trauma	$r = -0.242$, $p = 0.041$
History of emotional abuse	$r = -0.200$, $p = 0.092$
History of physical abuse	$r = -0.250$, $p = 0.035^*$
History of sexual abuse	$r = -0.191$, $p = 0.108$
History of emotional neglect	$r = -0.060$, $p = 0.615$
History of physical neglect	$r = -0.189$, $p = 0.112$

Fig. 3. Correlation between estimated intellectual functioning and history of self-reported physical abuse in individuals with bipolar disorder.

IQ (Table 3), our analysis showed a positive correlation between estimated IQ and years of education as expected due to the strong influence of formal education on this construct. Furthermore, we found a negative correlation between estimated IQ and perceived childhood trauma. There were no significant correlations between estimated IQ and other

clinical variables, except for psychotic symptoms during the first episode. Regarding the different types of trauma, physical abuse was surprisingly the only form of violence that was negatively correlated to both years of education ($r = -0.284$; $p = 0.015$) and estimated IQ (Table 3 and Fig. 3).

Then, to further understand the role of childhood trauma on estimated IQ, we conducted a linear regression for the prediction IQ using a model that included history of childhood trauma, years of education, history family of severe mental disorders, age at diagnosis and psychotic symptoms on the first episode as main factors. This model was statistically significant ($F(5) = 6.426$; $p < 0.001$, $R^2 = 0.365$), with only a significant main effect of years of education (Table 4).

Once formal education has a strong impact on estimated IQ due to the obvious relationship between these two variables, we conducted a second model excluding this main effect to investigate if childhood trauma presented any influence on estimated IQ. When we took years of education out of the model, childhood trauma turned out as a statistically significant main effect, with no significant effects from the other factors ($F(4) = 3.949$; $p = 0.007$; $R^2 = 0.217$) (Table 4).

Table 4
Multiple linear regression models predicting estimated intellectual functioning of individuals with bipolar disorder.

Model 1.			
Variables	Coefficients		
	β	t	p
History of childhood trauma	−0.188	−1.662	0.102
Years of education	0.408	3.606	0.001
Family history of severe mental disorders	0.113	1.034	0.305
Age at diagnosis	0.105	0.978	0.332
Psychotic symptoms during the first episode	0.206	1.887	0.064

Model 2.			
Variables	Coefficients		
	β	t	p
History of childhood trauma	−0.315	−2.663	0.010
Family history of severe mental disorders	.142	1.186	0.241
Age at diagnosis	.125	1.059	0.294
Psychotic symptoms during the first episode	.220	1.833	0.072

4. Discussion

In this study, we investigated the impact of childhood trauma on estimated intellectual functioning (IQ) in a sample of individuals with bipolar disorder (BD). Although we found an expected strong relationship between years of study and estimated IQ, we additionally found that childhood trauma might influence the development of general intelligence, corroborating our initial hypothesis of an impact of childhood adversities on cognitive maturation. This finding, although supported by previous literature (Bucker et al., 2013; Jiménez et al., 2017; Malarbi et al., 2017; Masson et al., 2016), is the first to show the association between estimated IQ and perceived childhood trauma in individuals with bipolar disorder assessed during euthymia.

History of trauma was highly prevalent among participants. We found that the most prevalent type of childhood trauma was emotional abuse and neglect. However, this finding is not entirely supported by the literature. While some studies have suggested an increased prevalence of emotional neglect in BD (Larsson et al., 2013; Watson et al., 2014) others indicate a higher association between emotional abuse in childhood and BD diagnose in adulthood (Etain et al., 2017; Janiri et al., 2015; Larsson et al., 2013; Pavlova et al., 2016; Russo et al., 2015). Nonetheless, there is a consensus suggesting that history of childhood trauma is associated with an unfavorable course of BD (Dualibe and Osório, 2017; Etain et al., 2017; Marangoni et al., 2016; Pavlova et al., 2016). In our results, this could be indicated by the association between the history of childhood trauma to longer estimated duration of illness, worse psychosocial functioning, and more lifetime suicide attempts, reinforcing the idea that childhood trauma is related to a worse prognosis.

The development of BD in adult life is described as influenced by the interaction of genetic and environmental factors. Individuals with BD are more likely to have parents with mental disorders, what suggests a genetic influence (Vieta et al., 2018). However, it could also be thought of as an additional environmental risk, once caregivers could have difficulties in carrying out sensitive and responsive care. A context which promotes negligence and active violence could result in significant impacts throughout life, what is related to the evidence of childhood trauma as an essential risk factor to mental disorders (Jaffee, 2017; Masson et al., 2016), especially to BD (Aas et al., 2016; Brietzke et al., 2012; de Codt et al., 2016; van Velzen et al., 2016; Vieta et al., 2018). In our sample, almost half of participants had at least one type of traumatic experience during childhood, what highlights childhood trauma as an important environmental risk factor. Indeed, individuals with BD might have a higher prevalence of trauma than other mental disorders such as depression and schizophrenia, or unaffected subjects (Xie et al., 2018).

In addition to the effect on disease onset, childhood trauma could also play a role in modifying brain development. The experience of trauma during childhood seems to impact neurodevelopment, leading to emotional, social, cognitive and behavioral impairments (Dualibe and Osório, 2017; Glaser, 2000; Henry et al., 2007; Lee and Hoaken, 2007). Childhood trauma could be mediated by the hypothalamic-pituitary-adrenal (HPA) axis and its response to stress. Repeated and chronic exposure to stressful situation results in the dysregulated release of hormones, especially glucocorticoid, which could modify neurogenesis and affect the structure of young brains (Gunnar and Quevedo, 2007). The first five years of life is the period when the brain develops with greater intensity, although its complete maturation only occurs during early adult life. Therefore, the impact of this hormonal imbalance may affect the normal course of brain development (Danese et al., 2017; Malarbi et al., 2017), what could explain the association between childhood trauma and alterations on prefrontal cortex, corpus callosum amygdala, hippocampus, and hypothalamic-pituitary-adrenal axis (Aas et al., 2012; Alexandra et al., 2018; Brietzke et al., 2012; Glaser, 2000; Lee and Hoaken, 2007; McCrory et al., 2010; Pakulak et al., 2018; van Velzen et al., 2016).

Consequently, these brain abnormalities are linked to cognitive impairments. Two meta-analyses that investigated the impact of childhood maltreatment on cognition found deficits in working memory, verbal episodic memory, processing speed, attention, executive function, and intelligence. Moreover, they emphasized that the combination of mental disorder diagnosis and maltreatment can accentuate these deficits (Alexandra et al., 2018; Masson et al., 2016). However, what may be more critical to deficits in working memory, verbal episodic memory and intelligence is the exposure to childhood maltreatment and not the psychiatric diagnosis itself (Alexandra et al., 2018). Two critical studies in the literature show this effect. The first analyzed the cognitive function of victimized children and found cognitive deficits in intelligence, executive functions, memory, processing speed, perceptual reasoning, and verbal comprehension. The authors observed that these deficits remained in adolescence and adulthood, but suggested that cognitive impairments could be prior to trauma, indicating a genetic component in the development of these abilities (Danese et al., 2017). The second, the Romanian Adoptees study, showed that the exposure to early life stress, like profound institutional deprivation, can have a substantial psychological impact on the adult life with long-term effects on well-being (Sonuga-Barke et al., 2017). In other words, adversities in childhood leave traces in neurodevelopment that could trigger noteworthy difficulties throughout life.

Intriguingly, although there is a well-described association between childhood trauma and cognitive deficits, the evidence of the relationship between childhood trauma and estimated IQ is still scarce. A study that evaluated the IQ of individuals with BD compared to individuals with schizophrenia and healthy controls verified that the sample with BD had lower IQ compared to the controls, but higher than individuals with schizophrenia. Curiously, individuals with BD presented higher educational levels compared to the unaffected group. The authors suggested that these results could be related to medication, the number of hospitalizations, and the history of childhood trauma (Vreeker et al., 2016). Another study with individuals with type I BD and healthy controls found a significant negative correlation between IQ and the presence of childhood trauma in the entire sample (Vreeker et al., 2017). In our study, our regression models showed that what predicted estimated IQ was the history of childhood trauma, and not a family history of severe mental disorders, age at diagnosis, and psychotic symptoms on the first episode, but only when the model did not include years of education. Curiously, none of the studies investigating this association have controlled for years of education in their analyses. One could think that the best model is the model that controls for years of education. However, it should be mentioned that there is a large relationship between years of study and IQ ($r = 0.556$), and also a similar magnitude of the relationship between both years of study and estimated IQ to the history of childhood trauma ($r = -0.214$ and $r = -0.242$, respectively). Therefore, considering the impact of collinearity in the model with both main effects, we believe that the model not controlling for years of study may bring small but important information related to neurodevelopment of our population. Interestingly, we did not find significant effects of family history of severe mental disorders, age at diagnosis, or psychotic symptoms during the first episode, which are clinical variables related to worse prognosis. This finding reinforces the idea that insults during neurodevelopment are more relevant to the intellectual functioning of individuals with bipolar disorder than possible markers of disease progression.

Thus, a potential explanation for our main finding would be the combination of developmental factors, which are influenced by the occurrence of trauma during the neurodevelopmental period, and the triggering of a mental disorder. However, according to literature, the specific BD diagnosis might implicate significant cognitive impairments due to chronicity of the disorder. Recent research analyzed the impact of childhood trauma in three subgroups according to the participant´s cognitive performance (Jiménez et al., 2017). They found that the "low" cognitive group showed higher scores in the CTQ. Furthermore,

the combination of the history of childhood trauma to lower IQ could influence other cognitive domains. The authors emphasize that higher IQ could function as a potential protective factor for cognition in general. Thus, childhood trauma could result in alterations in brain development that would leave the individual more vulnerable to neuroprogression. These findings highlight the need for conducting complex cognitive assessments including IQ to better understand the patient's cognitive reserve and the neuroprotective effect it could have on disease course. Furthermore, it may also suggest the importance of including estimated IQ as a covariate when analyzing different aspects of psychiatric disorders, once it might be considered a proxy of neurodevelopment.

Interestingly, our analysis found a negative correlation between physical abuse and estimated IQ. One hypothesis may be related to the physical consequences of violence, such as injuries, that would keep children away from school, consequently affecting their learning process. There is evidence that physical maltreatment and neglect, like sexual abuse, are associated with worse performance in working memory and executive function in individuals with severe mental disorders (Aas et al., 2012). Similar findings were reported in a sample of individuals with ultra-high risk of psychosis and history of physical trauma that presented impairments in attention, working memory, cognitive flexibility, and interference inhibition tests, suggesting an association with an acute and chronic neuronal loss (Üçok et al., 2015). Thus, in addition to leaving possible covert marks, physical abuse may also result in structural impairments.

Our study presents some limitations. First, the cross-sectional design does not enable to conclude a cause-effect relationship. Second, the absence of a control group with unaffected people prevented us from better understanding the influence of childhood trauma on estimated IQ. Third, the small sample size makes it difficult to generalize the results. Fourth, we did not have data regarding the socioeconomic background of the participants, a factor that could influence brain development (Black et al., 2017). Furthermore, our sample had lower estimated IQ compared to other studies in literature (e.g., Bucker et al., 2013; Jiménez et al., 2017), what could also be related to cultural and economic characteristics of the sample. However, it is essential to explore this issue in developing countries, where the social context could have more significant impacts. However, we did not exclude for lower estimated IQs, what could limit the validity and generalization of our results, since individuals with intellectual disadvantages could have difficulties interpreting self-report scales, such as the CTQ. Nonetheless, we believe that our results from this naturalistic sample could be relevant to better understand the impacts of trauma on estimated IQ, and should be further replicated on other samples with different socioeducational backgrounds. Additionally, we did not have data on other possible relevant clinical variables, such as the number of episodes or the actual disease onset, which could be confounders. We considered age at diagnosis because it was a more reliable variable, although we did have an estimated illness duration. Also, we did not control for psychiatric comorbidities, which could have some impact on our analysis. Finally, the CTQ is a limited scale, once its scores are based on subjective and retrospective self-report, therefore a recall bias should be considered. Regardless, CTQ is widely used and is still a good measure to assess childhood trauma, and its reliability has been well demonstrated in people with BD (Dualibe and Osório, 2017; Jansen et al., 2016).

In summary, our study found a small but important influence of the history of childhood trauma on estimated IQ in individuals with bipolar disorder, especially related to physical abuse, suggesting that adversities during development result in decreased general cognitive abilities. However, it may be difficult to confirm what has more responsibility for intellectual development; thus, longitudinal studies are mandatory to understand these relationships. According to the WHO (2014) Global Status Report, the prevention of violence should have the same concern as climatic change, traffic safety, and alcohol and drug abuse, among others. Furthermore, it highlights the need to invest in evidence-based prevention programs (WHO, 2014). Therefore, our results reinforce the need to develop early interventions to protect childhood and to promote the well-being of children, contributing to the growth of healthy adults.

Declaration of conflicting interests

The authors declare no conflict of interest.

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.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2019.02.046.

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