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The association between childhood trauma and facial emotion recognition in adults with bipolar disorder

Manuela Russo^a, Katie Mahon^a, Megan Shanahan^a, Carly Solon^a, Elizabeth Ramjas^a, Justin Turpin^a, and Katherine E. Burdick^{a,b}

^aDepartment of Psychiatry, Icahn School of Medicine at Mount Sinai, New York, NY, USA

^bJames J Peters VA Medical Center, Bronx, NY, USA

Abstract

Many patients with bipolar disorder (BD) have difficulties in facial emotion recognition, which may also be impaired in maltreated children and in subjects who have a positive history of childhood traumatic experiences. Childhood trauma is reported with a high prevalence in BD and it is considered a risk factor for the disorder. As the relationship between facial emotion recognition and childhood trauma in BD has not yet been directly investigated, in this study we examined whether the presence of a childhood trauma in affectively stable BD patients was associated with poorer performance in emotion recognition. Seventy-five BD I and II participants completed the Childhood Trauma Questionnaire retrospectively assessing five types of childhood trauma (emotional, physical and sexual abuse, and emotional and physical neglect) and the Emotion Recognition Task evaluating the ability to correctly identify six basic facial emotions (happiness, sadness, anger, disgust, fear and surprise). Our results suggest that the presence of childhood trauma in participants with BD is associated with a more severe clinical presentation (earlier onset, longer duration of illness, and higher depressive symptom ratings) and that BD patients with a positive childhood history of emotional neglect perform worse than those without such a history in recognizing anger.

Keywords

emotion recognition; childhood trauma; emotional neglect; anger; social cognition; bipolar disorder

1. INTRODUCTION

Emotion recognition is one of the subcomponents of the domain of social cognition and is often measured by assessing the ability to identify emotions based on facial expression (Ochsner, 2008). Data show that many patients with bipolar disorder (BD) have emotion

Corresponding Author: Katherine E Burdick, PhD, 1 Gustave L Levy Place Box 1230, NY, NY 10029, Katherine.burdick@mssm.edu, Telephone: +1 212-659-8841, Fax: +1 212-996-8931.

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recognition impairments (Kohler et al., 2011; Van Rheezen et al., 2013;). A meta-analysis by Kohler et al. (2011) including 51 studies revealed a moderately-sized deficit in identifying and discriminating facial emotions in participants with BD and major depression in comparison to healthy controls. This study suggested that the two diagnostic groups had a similar level of impairment in emotion identification and differentiation ($d=-.49$ and $d=-.46$ respectively), and that the same results held across a variety of emotion recognition tasks. Data suggest that deficits occur not only during the acute phases of the illness (Lembke and Ketter, 2002; Getz et al., 2003; Gray et al., 2006; Vederman et al., 2012), but also during symptom remission (Bozikas et al., 2006). Although less severe than in schizophrenia (Addington and Addington 1998; Lee et al., 2014), deficits have been shown to be profound in patients with BD who are experiencing acute psychotic symptoms. In particular, these deficits were most pronounced in the identification of subtle expressions of happiness and sadness which persisted even after treatment with antipsychotic medication (Daros et al., 2014). Recent data indicate that psychotic spectrum disorder patients had lower emotion recognition accuracy compared to healthy controls, and that schizophrenia and schizoaffective disorder patients performed more poorly than psychotic bipolar patients (Ruocco et al., 2014). It also emerged that regardless of diagnostic group, recognition of neutral faces was the most difficult and that all the psychiatric groups had lower accuracy rates for angry faces than the healthy control group (Ruocco et al., 2014).

There are mixed findings about whether the impairments in emotion processing in patients with BD are global or if they are specific to particular emotions. Several studies have suggested that emotion processing impairments in BD are limited to certain emotions, although there is inconsistency regarding which specific emotions may be affected. Findings have been reported for sadness and fear (Derntl et al., 2009; Vederman et al., 2012), happiness (Lawlor-Savage et al., 2014), and surprise (Summers et al., 2006). Other data suggest a more generalized level of impairment that is not limited to specific emotions *per se* (Brotman et al., 2008; Van Rheezen and Rossell, 2014). A general facial emotion perception deficit was reported in a meta-analysis by Kohler et al. (2011), such that participants with BD or major depressive disorder demonstrated deficits in perceiving all six basic emotions (sadness, happiness, anger, disgust, fear and surprise) with effect sizes ranging from $d=-0.14$ (for disgust) up to $d=-0.50$ (for happiness) with no significant differences in the degree of processing impairment among the six emotions.

The presence of a deficit in emotion recognition in children with and at risk of developing BD (Guyer et al., 2007; Brotman et al., 2008) suggests that this deficit could be a potential endophenotype for the disorder. Brotman et al. (2008) compared facial emotion labelling errors between children with BD ($n=54$), children at risk for developing BD ($n=24$) and control subjects ($N=78$) and found that there were no significant differences in errors between children with BD and those at-risk for the disorder. Nevertheless, both groups made significantly more errors than comparison controls in identifying emotions in adult and child faces. Other data reported that facial emotion recognition deficits in psychotic patients are also present in their non-psychotic relatives: relatives of probands with schizophrenia, schizoaffective and BD recognized fewer facial emotions compared to healthy controls, and relatives of psychotic BD performed significantly better than schizophrenia relatives

(Ruocco et al., 2014). Also, mirroring the performance of their probands unaffected relatives of all diagnostic groups had more difficulty than healthy controls recognizing neutral faces such that they were more likely to label an emotion when the faces were neutral (Ruocco et al., 2014).

Impairments in facial emotion processing occur not only in those with diagnosed psychiatric disorders, but may also occur in healthy children and adults with a history of childhood maltreatment (Pollak et al., 2000). In addition to an increased likelihood of developing anxiety and mood disorders, substance abuse and antisocial behavior in adulthood (MacMillan et al., 2001), maltreated children report difficulties in recognizing, expressing and understanding emotions (During and MacMahon, 1991). A recent prospective study (Young and Widom, 2014) investigating the long-term effect of child abuse and neglect on emotion processing demonstrated that adult subjects with a history of childhood maltreatment compared to those without such a history were less accurate in identifying emotions. Using a recognition task featuring positive, negative, and neutral stimuli from the International Affective Picture System (IAPS; Lang et al., 2008), the authors reported that physical abuse was associated with impaired accuracy for identifying neutral pictures; neglect and sexual abuse were associated with reduced accuracy for positive pictures. A study that used the Reading the Mind in the Eyes Test (RMET; Baron-Cohen et al., 2001), a somewhat more difficult task involving the recognition of more varied facial emotions (i.e. “joyful”, “bored”, “impatient”) using only partial face stimuli, found impaired accuracy in maltreated children compared to non-maltreated children, specifically with regard to positive emotions (Koizumi and Takagishi, 2014).

Although data suggest that facial emotion recognition deficits appear to be a common phenomenon in BD patients as well as in people with adverse childhood experiences, the relationship between childhood trauma and facial emotion processing has not been systematically examined in patients with BD. It is important to understand how childhood trauma, which occurs with a very high frequency in patients with BD [approximately 50% (Garno et al., 2005)], may be related to the emotion processing deficits in patients with BD. Among patients with BD, childhood trauma is known to be associated with a worse clinical expression of the disorder, including an earlier illness onset, increased rapid cycling, higher levels of impulsivity and rates of suicidal behaviors, more severe symptoms, and a higher number of comorbid psychiatric disorders including substance abuse (Leverich et al., 2002, 2006; Neria et al., 2005; Daruy-Filho et al., 2011; Etain et al., 2010, 2013; Aas et al., 2014). In addition, neurocognitive functioning (particularly verbal, visual recall memory, verbal fluency and cognitive flexibility) has been found to be negatively affected by the presence of childhood abuse (Savitz et al., 2008). We previously reported that childhood emotional abuse had a sex-specific effect on emotional decision-making [i.e. in the context of emotional abuse female participants with BD used a more conservative style than did the male counterpart (Russo et al., 2014)].

Given that emotion processing impairments may affect psychosocial functioning and quality of life of individuals suffering with BD (Green et al., 2007; Van Rheenen and Rossell, 2013), it is important to gain a better understanding of their potential correlates such as childhood traumatic events. In this study, we aimed to investigate the relationship between

childhood trauma and facial emotion recognition in a sample of affectively stable BD patients. We hypothesize that BD patients with a history of childhood trauma will show larger deficits in emotion recognition compared to BD patients without a history of childhood trauma.

2. METHODS

2.1 Participants

Data were derived from a sample of seventy-five participants with BD recruited through the community from the Icahn School of Medicine at Mount Sinai. To be included in the study, subjects needed to meet criteria for a diagnosis of BD I and II type. Diagnosis was ascertained using the Structured Clinical Interview for DSM-IV (SCID; First et al., 2002). Exclusion criteria for the study were: history of CNS trauma, neurological disorder, attention deficit hyperactivity disorder (ADHD) or a learning disorder (LD) diagnosed during childhood; history of electroconvulsive therapy in the previous 12 months; a diagnosis of substance abuse/dependence within the past 3 months; and any active or unstable medical problems. The Mount Sinai Institutional Review Board reviewed and approved all study procedures prior to commencement of the protocol and all participants provided written informed consent.

Of the 75 participants with BD, 51 were males (68.0%), the mean age was 47.1 years ($SD = \pm 10.2$), and 20 (26.7 %) were Caucasian. Fifty-three (70.7%) subjects had a diagnosis of BD type I and 22 of BD type II (29.3%); among the participants with BD type I, 24 (32.0%) had a history of psychosis vs 8 (10.7%) among those with BD type II. Subjects were affectively stable with a mean score for depression [as measured by the Hamilton Depression Rating Scale (HDRS; Hamilton, 1967) - 24 item version] of 7.3 (± 6.1) and a mania score [measured through the Young Mania Rating Scale (YMRS; Young et al., 1978)] of 3.2 (± 3.4). The mean duration of illness was 24.1 (± 11.4) years and the premorbid IQ [measured using the Wide Range Achievement Test-3rd edition-Reading subtest (WRAT-3; Wilkinson, 1993)] was 97.8 (± 14.4 ; all above data are reported in Table 1).

2.2 Measures of Childhood Trauma and Facial Emotion Recognition

The presence of childhood trauma was assessed with the Childhood Trauma Questionnaire (CTQ; Bernstein et al., 1997). The CTQ is a 28-item self-report questionnaire rating the frequency of certain experiences or feelings during childhood up to the age of 16, using a 5-point Likert scale ranging from 1 (never true) to 5 (very often true). The questionnaire investigates 5 different types of childhood trauma: emotional abuse, physical abuse, sexual abuse, emotional neglect and physical neglect. We determined whether a subject had a positive history of childhood trauma in a specific category based on different cutoff points previously described in the literature (Heim et al., 2009): 13 or higher for emotional abuse, 10 or higher for physical abuse, 8 or higher for sexual abuse, 15 or higher for emotional neglect, and 10 or higher for physical neglect.

The Emotion Recognition Task (ERT) as part of the Cambridge Neuropsychological Test Automated Battery (CANTAB; Robbins et al., 1994) is a computer-generated paradigm for

the recognition of six basic facial emotional expressions: happiness, sadness, anger, disgust, fear, and surprise. The emotions (15 stimuli for each emotion with different levels of intensity) are mimicked by actors and presented randomly in two blocks (90 stimuli each). After each stimulus presentation (200ms), the participant is asked to choose between the six emotional expressions displayed in labels on the screen. The task provides a percentage of correctness for each emotion and an overall mean of response latency.

2.3 Data Analysis

BD subjects with and without a history of childhood trauma (of any type) were compared in terms of demographic, clinical characteristics and emotion recognition using independent sample *t*-test and χ^2 tests where appropriate. Multivariate Analysis of Covariance (MANCOVA) was conducted to explore the effect of a positive history of childhood trauma (any type of childhood trauma, as well as each of the five types of childhood trauma) on each of the six emotions and on the overall response latency. Those variables that were statistically different (current age and duration of the illness) between subjects with and without any type of childhood trauma were used as covariates in the model in order to remove the variance they accounted for. Also to remove variance due to subclinical depressive and manic symptoms, premorbid IQ, and processing speed, as some evidence suggests that this domain is involved in facial emotion recognition (Lawlor-Savage et al., 2014), scores from the HDRS and YMRS, premorbid IQ, and processing speed domain (as measured by a composite score derived from the Brief Assessment of Cognition in Schizophrenia and the Trail Making Test-A [Nuechterlein et al., 2008]) served as covariates. Partial eta squared (η^2) was used to measure the effect size (Maher et al., 2013). Type I error was controlled by applying Bonferroni correction.

3. RESULTS

The majority (70.7%) of the subjects reported at least one type of childhood trauma. The mean number of traumatic experiences per participant was 1.9 (± 1.7), with 21.3% having experienced one type of trauma, 13.3% having experienced two to three types of trauma, 10.7% having experienced four types of trauma, and 12% having experienced five types of trauma. With regard to the specific types of childhood trauma experienced, emotional abuse was reported in 43.2% of participants, physical abuse in 34.2%, sexual abuse in 33.8%, emotional neglect in 33.3%, and physical neglect in 48.0% (Table 2).

In comparing participants with and those without any type of history of childhood trauma significant differences emerged for current age and duration of illness which were different also between participants with a history of emotional, physical, sexual abuse, and emotional neglect (Table 3). Also higher depressive symptoms were found in participants with a history of emotional abuse and neglect compared to participants without such a history. Sex differences emerged only between those participants with a history of sexual abuse, with a significantly higher proportion of female participants having experienced sexual abuse as children compared to males (Table 3).

Performance on emotion recognition was measured by percentage of correct answers, with the participants' accuracy as follows: 62.6% for happiness, 65.7% for sadness, 64.5% for

anger, 49.2% for disgust, 44.8% for fear, and 50.0% for surprise. The mean overall response latency time was 2.0 (± 0.8) seconds (Table 2). BD Type I patients showed a higher percentage of correct answers than BD Type II in identifying disgust (52.4% vs 35.4% respectively; $p=0.01$) as well as surprise (at a trend-level of significance; $p=0.056$ (51.4% vs 50% respectively)). When comparing participants with and without a history of childhood trauma, there was no significant difference in overall response latency. Level of accuracy, however, did differ between participants with diverse trauma histories. In particular, decreased accuracy in correctly identifying anger was detected in those participants with a history of physical abuse [mean percentage of correct answer was 54.5 ± 17.3 versus 66.9 ± 21.8 , $t(63)=2.50$; $p=0.015$], emotional neglect [53.1 ± 18.5 versus 68.1 ± 20.7 , $t(65)=2.93$; $p=0.005$] and/or physical neglect [57.8 ± 15.9 versus 67.7 ± 24.1 , $t(59)=2.0$; $p=0.049$] compared to participants without such traumatic experiences. From the MANCOVA emotional neglect showed an effect on facial emotion recognition (Wilks's Lambda=0.776; $F(6, 50)=2.408$, $p=0.040$). Specifically we found that patients with a history of emotional neglect performed worse than those without such a history [$F(1,55)=6.31$; $p=0.015$ (adjusted with Bonferroni correction), partial $\eta^2=0.103$] in recognizing angry faces. The Estimated Marginal Mean (EMM) for participants with a positive history of emotional neglect was 67.1 [standard error (SE)= ± 2.8] versus an EMM of 54.0 (SE= ± 4.0) for those participants without a history of emotional neglect.

4. DISCUSSION

In this study, we investigated the effect of a history of childhood trauma on facial emotion recognition in a sample of affectively stable BD patients. Our results are consistent with previous data suggesting that the presence of childhood trauma in participants with BD negatively affects the clinical course of the illness (Leverich et al., 2002; 2006; Neria et al., 2005; Etain et al., 2008, 2013; Daruy-Filho et al., 2011; Aas et al., 2014). Specifically, we found that a longer duration of illness was associated with all types of childhood trauma except for physical neglect, an earlier illness onset was associated with emotional abuse and that more severe depressive symptoms were associated with childhood emotional abuse as well as emotional neglect. A history of sexual abuse was reported at a higher rate in female participants than in males.

Results showed that in BD patients sadness seems to be the most correctly identifiable emotion at 65.7% accuracy, followed by anger (64.5%), happiness (62.6%), surprise (50%), disgust (49.2%), and fear (44.8%). Although we do not have a sample of healthy controls with which to compare our patients, we can deduce that these results denote a moderate level of impairment when compared with the performance of 24 healthy controls who underwent an emotion recognition task similar to ours and whose accuracy ranged between 77% (in identifying fear) and 100% (in identifying happiness) (Nicol et al., 2014). As hypothesized, our data suggest that the presence of a childhood trauma is associated with poorer performance in facial emotion recognition, particularly for the recognition of anger. We found that, even when covarying for demographic, clinical, and neurocognitive variables, a past history of emotional neglect in patients with BD is associated with deficits in the ability to recognize facial expressions of anger. Although this is the first study investigating the association between childhood maltreatment and facial emotion recognition

in adults with BD, our results are broadly consistent with previous work conducted in maltreated children (e.g. During and MacMahon, 1991; Pollak et al., 2000; Koizumi and Takagishi, 2014; ; Young and Widom, 2014). Our findings most closely resemble those from Pollak et al., (2000), who found that recognition of angry faces was impaired in children who had recently experienced physical or emotional neglect. Their findings showed that physically abused children did not differ from control children in the recognition of anger, whereas emotionally and physically neglected children had reduced accuracy for identifying anger compared to both the control group and the physically abused children and were also impaired in distinguishing angry, sad, and fearful expressions versus controls. In another study, this group reported a broader effect of recent childhood abuse with abused children showing deficits on facial recognition of anger and fear when compared with non-abused children (Pollak and Kistler, 2002). Although few studies have looked at the relationship between emotion recognition and childhood maltreatment among adult psychiatric populations, there is some evidence that among individuals with borderline personality disorder, a history of emotional and/or physical abuse is associated with impaired identification of disgust (Nicol et al., 2014). Further work is required to understand the interaction between childhood maltreatment and vulnerability to developing affective dysregulation.

Although the mechanisms that may underlie the association between childhood maltreatment and subtle impairments in emotional processing remain poorly understood, there are several speculative possibilities that require further investigation. One hypothesis is that BD patients who were neglected by caregivers during childhood experienced a relatively emotionally-deprived environment with less exposure to appropriate social and emotional stimuli, which may have interfered with the development of accurate emotion recognition. However, the subtle impairment we identified in the current study appears to be emotion specific (i.e. anger) and not generalized to a broader range of emotional valences.

Another possibility is that a lack of exposure to nurturing and safe behaviors from caregivers, and exposure to neglect or abuse, may impact neurodevelopment in such a way that subtle differences in early emotional processing result. For example, it is well-known that the amygdala plays a crucial role in the generation and recognition of emotion regulation neural network (e.g. Ledoux, 2000; Adolphs 2001) and that abnormal amygdala response plays a role in the development and maintenance of affective dysregulation in BD (Townsend and Altshuler, 2012). Data suggest that abnormally increased amygdala activity is associated with a history of childhood maltreatment in response to sad faces in depressed patients (Grant et al., 2011) and to negative faces (i.e. fearful/angry/sad faces) in healthy individuals (Dannlowski et al., 2013; van Harmelen et al., 2013;). Another study provided evidence of hypoactivation of the fusiform gyrus (a region involved in face processing and also in social communication; Haxby et al., 2002) during the viewing of facial expressions of happiness, sadness, fear, and especially anger in children with BD (Perlman et al., 2013). Reduced gray matter volume of the fusiform gyrus was recently reported to be associated with experiences of childhood maltreatment across adults with and without a substance use disorder (Van Dam et al., 2014). Abnormalities in this region have relevance for facial emotion recognition, which in turn has implications for higher-order emotional processing. Given the exploratory nature of our study, no firm conclusions can be drawn about the

association between childhood trauma and emotion recognition; however we can speculate that the experience of childhood maltreatment might lead to an increased vulnerability to develop more severe emotional dysregulation, such as in BD, through aberrant neurodevelopment and subsequently impaired emotional processing.

Our study presents several limitations. One is the lack of a healthy control group with comparable data in childhood trauma and emotion recognition; the absence of this group did not allow us to clarify whether our results extend to the general population or if they are specific to BD. Another limitation is related to the measure used to assess childhood trauma. Since the CTQ is a subjective and retrospective measure (assessing the presence of a trauma in childhood up to age of 16), the reporting accuracy of traumatic events is unknown. Nevertheless, several studies have provided extensive evidence of the reliability and validity of retrospective self-report of childhood maltreatment (Dill et al., 1991; Hardt and Rutter, 2004). As we did not assess for comorbid personality disorders in our sample and there are data showing that borderline personality disorder in particular (Daros et al., 2013) present with some bias in facial emotion recognition, the potential contribution of personality traits should be taken into account when interpreting our findings. Finally, given that this is the first study, to our knowledge, exploring the relationship between emotion recognition and childhood trauma history in adults with BD, our results should be considered preliminary.

In summary, our study confirms previous findings that traumatic childhood experiences have a detrimental effect on the overall clinical presentation of patients with BD. We also provide novel evidence that BD participants with a self-reported history of emotional neglect during childhood demonstrate a relative impairment in the recognition of angry faces when compared to BD patients without such a history. Given their trait-like presentation and association with genetic risk, emotion processing deficits and their relationship with environmental risk factors such as childhood trauma require further study in an effort to better understand the possible contribution of these factors on the pathophysiology of BD.

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Highlights

- We examine the relationship between childhood trauma and facial emotion recognition in a sample of affectively stable bipolar disorder (BD) patients.
- The majority (70.7%) of the subjects reported at least one type of childhood trauma.
- BD patients with childhood trauma had a more severe clinical presentation compared to those patients without such a history.
- The following percentages of emotion recognition accuracies emerged: 62.6% for happiness, 65.7% for sadness, 64.5% for anger, 49.2% for disgust, 44.8% for fear, and 50.0% for surprise.
- A childhood history of emotional neglect in patients with BD is associated with lower ability to recognize facial expressions of anger.

Table 1

Demographic and Clinical Characteristics of the Sample

	BD patients (N=75)
	Mean (SD)
Age (in years)	47.1 (10.2)
Young Mania Rating Scale (YMRS)	3.2 (3.4)
Hamilton Depression Rating Scale (HDRS)	7.3 (6.1)
Duration of illness (in years)	24.1 (11.4)
Premorbid Intellectual Functioning (WRAT-3)	97.8 (14.4)
	N (%)
Race	
<i>Caucasian</i>	20 (26.7%)
<i>Not-Caucasian</i>	55 (73.3%)
Sex	
<i>Male</i>	51 (68.0%)
<i>Female</i>	24 (32.0%)
DSM-IV Diagnosis	
<i>Bipolar Disorder I without history of psychosis</i>	29 (38.7%)
<i>Bipolar Disorder I with history of psychosis</i>	24 (32.0%)
<i>Bipolar Disorder II without history of psychosis</i>	14 (18.6%)
<i>Bipolar Disorder II with history of psychosis</i>	8 (10.7%)

Table 2
Scores for the Childhood Trauma Questionnaire and the Emotion Recognition Task

Childhood Trauma Questionnaire						
	Emotional Abuse	Physical Abuse	Sexual Abuse	Emotional Neglect	Physical Neglect	
	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
Total score	11.6 (5.9)	9.5 (5.0)	8.1 (5.1)	11.8 (5.3)	10.6 (3.0)	
History of childhood trauma	N (%)	N (%)	N (%)	N (%)	N (%)	
No	42 (56.8%)	48 (65.8%)	49 (66.2%)	50 (66.7%)	39 (52.0%)	
Yes	32 (43.2%)	25 (34.2%)	25 (33.8%)	25 (33.3%)	36 (48.0%)	
Emotional Recognition Task % of Correctly Identified Emotions						
Happiness	Sadness	Anger	Disgust	Fear	Surprise	
Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	Mean (SD)	
62.6 (17.3)	65.7 (18.7)	64.5 (19.9)	49.2 (20.5)	44.8 (21.9)	50.0 (12.7)	

Table 3

Comparison between Subjects with and without History of Childhood Trauma

	Any type of childhood trauma		Emotional Abuse		Physical Abuse		Sexual Abuse		Emotional Neglect		Physical Neglect	
	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No	Yes
Age	Mean (SD)		Mean (SD)		Mean (SD)		Mean (SD)		Mean (SD)		Mean (SD)	
	42.4 (10.2)	49.1 (9.6)	44.5 (10.4)	50.2 (8.9)	44.8 (10.1)	52.4 (8.4)	45.8 (10.3)	49.4 (9.9)	44.7 (10.6)	52.0 (7.3)	46.2 (11.0)	48.2 (9.3)
Age of onset	t(73)=-2.69 p=0.009		t(72)=-2.48 p=0.015		t(71)=-3.25 p=0.002		t(72)=-1.4 p>0.05		t(73)=-3.09 p=0.003		t(73)=-0.85 p>0.05	
	24.9 (10.2)	21.1 (8.5)	23.8 (9.4)	19.5 (7.9)	22.8 (9.3)	21.3 (9.2)	23.5 (9.6)	19.8 (7.9)	22.9 (9.4)	21.0 (8.6)	23.5 (9.0)	20.8 (9.2)
Duration of illness	t(72)=-1.66 p>0.05		t(71)=-2.04 p=0.045		t(70)=0.65 p>0.05		t(71)=1.60 p>0.05		t(72)=0.85 p>0.05		t(72)=1.28 p>0.05	
	17.2 (10.1)	27.0 (10.7)	19.7 (10.6)	30.0 (9.9)	20.8 (10.6)	30.4 (10.3)	21.5 (10.9)	28.7 (10.9)	20.7 (10.2)	30.7 (10.7)	22.3 (11.6)	25.9 (11.0)
YMRS	t(69)=-3.56 p=0.001		t(68)=-4.13 p<0.001		t(68)=-3.67 p<0.001		t(68)=-2.62 p=0.011		t(69)=-3.84 p<0.001		t(69)=-1.34 p>0.05	
	3.3 (3.6)	3.2 (3.4)	3.1 (3.6)	3.4 (3.3)	3.2 (3.7)	3.3 (3.0)	3.2 (3.6)	3.2 (3.2)	2.9 (3.0)	3.8 (4.1)	3.5 (3.9)	3.0 (2.9)
HRDS	t(72)=0.14 p>0.05		t(71)=-0.26 p>0.05		t(71)=-0.08 p>0.05		t(71)=-0.78 p>0.05		t(72)=-1.10 p>0.05		t(72)=.63 p>0.05	
	6.5 (5.5)	7.7 (6.4)	6.0 (5.7)	9.4 (6.3)	6.8 (5.9)	8.7 (6.4)	6.7 (5.7)	8.8 (6.8)	6.3 (5.3)	9.4 (7.2)	6.2 (5.8)	8.6 (6.3)
WRAT-3	t(72)=-0.77 p>0.05		t(71)=-2.38 p=0.020		t(71)=-1.28 p>0.05		t(71)=-1.37 p>0.05		t(72)=-2.09 p=0.040		t(72)=-1.72 p>0.05	
	100.0 (14.1)	97.0 (14.6)	98.1 (14.5)	98.3 (14.1)	99.2 (14.4)	96.0 (14.3)	98.3 (14.7)	97.0 (14.5)	97.0 (14.8)	99.5 (13.9)	100.4 (14.8)	95.2 (13.8)
	t(71)=0.81 p>0.05		t(70)=-0.08 p>0.05		t(70)=0.91 p>0.05		t(70)=-0.37 p>0.05		t(71)=-0.69 p>0.05		t(71)=1.55 p>0.05	
	N (%)		N (%)		N (%)		N (%)		N (%)		N (%)	
Sex	M		29 (69.0)		32 (66.7)		37 (75.5)		35 (70.0)		23 (59.0)	
	F		13 (31.0)		16 (33.3)		12 (24.5)		15 (30.0)		16 (41.0)	
Race	CA		11 (26.2)		12 (25.0)		15 (30.6)		14 (28.0)		14 (35.9)	
	N-CA		31 (73.8)		36 (75.0)		34 (69.4)		36 (72.0)		25 (64.1)	
Diagnosis	BD-I		17 (77.3)		34 (70.8)		34 (69.4)		37 (74.0)		30 (76.9)	
	BD-II		5 (22.7)		14 (29.2)		15 (30.6)		13 (26.0)		9 (23.1)	
	Chi ² (1)=0.00 p>0.05		Chi ² (1)=0.105 p>0.05		Chi ² (1)=0.01 p>0.05		Chi ² (1)=4.17 p=0.041		Chi ² (1)=0.28 p>0.05		Chi ² (1)=2.7 p>0.05	
	Chi ² (1)=3.2 p>0.05		Chi ² (1)=0.03 p>0.05		Chi ² (1)=0.40 p>0.05		Chi ² (1)=0.94 p>0.05		Chi ² (1)=0.04 p>0.05		Chi ² (1)=3.54 p>0.05	
	17 (77.3)		31 (73.8)		34 (70.8)		34 (69.4)		37 (74.0)		30 (76.9)	
	5 (22.7)		11 (26.2)		14 (29.2)		15 (30.6)		13 (26.0)		9 (23.1)	
	Chi ² (1)=0.65 p>0.05		Chi ² (1)=0.23 p>0.05		Chi ² (1)=0.80 p>0.05		Chi ² (1)=0.05 p>0.05		Chi ² (1)=0.80 p>0.05		Chi ² (1)=1.5 p>0.05	
	Chi ² (1)=0.65 p>0.05		Chi ² (1)=0.23 p>0.05		Chi ² (1)=0.80 p>0.05		Chi ² (1)=0.05 p>0.05		Chi ² (1)=0.80 p>0.05		Chi ² (1)=1.5 p>0.05	