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Mood, dimensional personality, and suicidality in a longitudinal sample of patients with bipolar disorder and controls

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Abstract

Objective: To evaluate the effects of mood and anxiety symptoms in relation to personality dimensions and clinical features such as trauma and substance use on suicidal behaviors in a longitudinal sample of individuals with bipolar illness (BP) and healthy controls (HC).

Methods: Mood, personality, and clinical features were assessed in 151 individuals with BP I and 119 HC. Clinical data was collected at baseline and at 2-year follow-up. Personality traits were measured using the NEO PI-R.

Results: In bivariate analyses, personality measures were significantly different between BP and HC, and between BP based on suicide attempt history. However, in regression analyses, baseline measures of depression, mania, anxiety, trauma, education and age of BP onset correlated with personality domains, while a history of suicide attempts did not. Logistic regressions showed that prospective depression or mania, a pattern of mixed mood features and chronicity of illness, along with two Neuroticism facet scores (N4-Self-Consciousness and N6-Vulnerability) were predictive of suicidal ideation (SI) in the 2-year follow-up period.

Conclusions: While dimensions of personality, trauma, and substance use clearly correlated with suicidal behaviors in BP, in multivariate models emerging mood symptoms were the most robust predictors of suicidality. These results reinforce the importance and attributable role of mood and anxiety symptoms in evaluating suicidal risk.

Keywords: Bipolar Disorder, Depression, Suicide, Personality, Neuroticism

Introduction

The bipolar disorders are a spectra of complex psychiatric illnesses where the observed clinical phenotype is a manifestation of several underlying phenotype classes (e.g. Disease process, neurocognition, motivated behaviors, life events such as trauma, etc.) (Belmaker, 2004; McInnis et al., 2017); one of the associated classes is personality and temperament. Individuals with BP are at higher risk for personality disorder diagnoses (Barnett et al., 2011; Qiu, Akiskal, Kelsoe, & Greenwood, 2017) and similarly, among the personality disorders, BP is frequently co-morbid (Gunderson et al., 2006). Their comorbid occurrence bodes a more severe course of illness (Ng et al., 2017) and a higher risk of suicidal behavior (Baldessarini et al., 2012; Garno, Goldberg, Ramirez, & Ritzler, 2005; Leverich et al., 2003; Ucok, Karaveli, Kundakci, & Yazici, 1998; Zimmerman et al., 2014). Reported rates of comorbid personality disorders in BP vary widely and range from 12%-84% (Deltito et al., 2001; Fan & Hassell, 2008; O'Connell, Mayo,& Sciutto, 1991; Peselow, Sanfilipo, & Fieve, 1995; Pica et al., 1990). This high level of comorbidity has contributed to controversy over the diagnostic boundaries of BP and personality disorders, and led to debates about the over- versus under-diagnosis of BP (Bowden, 2001; Ghaemi, Sachs, Chiou, Pandurangi, & Goodwin, 1999; Karam et al., 2014; Moreno et al., 2007; Paris, Gunderson,& Weinberg, 2007; Ruggero, Zimmerman, Chelminski, & Young, 2010; Zimmerman, Ruggero, Chelminski, & Young, 2008).

An alternative to diagnosing personality as distinct categories is the use of dimensional measures of personality. Dimensional measures have a substantial advantage over categorical diagnoses in that they are able to quantify variations in personality traits using standardized instruments such as the NEO PI-R (Costa & McCrae, 1992) to capture self-reported responses and score them based on a recognized 5-factor model of personality, which consists of dimensions of Neuroticism, Extroversion, Openness, Agreeableness, and Conscientiousness. Several studies have documented differences in personality traits among BP individuals compared to controls(Bagby et al., 1997; Barnett et al., 2011; Chioqueta & Stiles, 2005; Farmer et al., 2001; Nowakowska, Strong, Santosa, Wang, & Ketter, 2005; Strong et al., 2007; Tackett, Quilty, Sellbom, Rector, & Bagby, 2008; Velting, 1999). However, there are few longitudinal studies of suicide risk in BP utilizing dimensional measures of personality traits that also control for clinical features that may co-vary with personality. Understanding the relative contribution

from personality, mood symptoms, trauma, substance use and other clinical features on suicide can guide treatment and intervention choices

This study assesses the relative contributions of mood states and clinical features (such as past trauma, substance use, chronicity of illness and particularly a history of suicide attempts) on measures of personality at baseline, and the contributions of personality domains, mood state, and clinical features for predicting suicide risk longitudinally.

Methods

Participants and Baseline Assessments

This study utilizes a subset (N=650) of the Prechter Longitudinal Study of Bipolar Disorder at the University of Michigan (McInnis et al., 2017) who were enrolled between October of 2004 and December of 2010. The study was approved by the Institutional Review Board of the University of Michigan Medical School (IRBMED). We included only those with a diagnosis of bipolar type I disorder (BP; N=151) and unaffected controls (HC; N=119) who had completed measures of childhood trauma and had a mood measurement within 30 days of the personality assessment (Mean difference=0.59 days, S.D. 5.67 days).

All participants were evaluated utilizing the Diagnostic Interview for Genetic Studies (DIGS) (Nurnberger et al., 1994). Mood state was determined at baseline using the Hamilton Rating Scale for Depression (HAMD-17) (Hamilton, 1960) and the Young Mania Rating Scale (YMRS) (Young, Biggs, Ziegler, & Meyer, 1978). Euthymia was defined as both a HAMD-17 and YMRS <8. History of abuse and neglect were obtained through the Childhood Trauma Questionnaire (CTQ) (Bernstein & Fink, 1998), a self-report questionnaire designed to assess five types of negative childhood experiences including emotional neglect, emotional abuse, physical neglect, physical abuse, and sexual abuse. Each item is rated on a 1-5 scale, ranging from never true when you were growing up to very often true when you were growing up. Scores ranged from 5-25 for each type of negative childhood experience. The CTQ has demonstrated test-retest reliabilities ranging from .79 to .86 over an average of four months as well as internal consistency reliability coefficients ranging from a median of .66 to a median of .92 across samples (Bernstein & Fink, 1998). If participants reported mood symptoms present for more than half the duration of their illness, they were categorized as having a chronic course. BP

participants were categorized based on the presence of a lifetime history of any comorbid substance use disorder (excluding nicotine dependence) and any comorbid anxiety disorder.

Presence of a lifetime history of suicide attempts was captured during the DIGS interview. All BP participants who had at least one reported past suicide attempt were categorized as suicide attempters (BPSA+) vs. those with no history of suicide attempts (BPSA-).

Personality traits were measured using the NEO Personality Inventory-Revised (NEO PI-R) (Costa & McCrae, 1992), a 240 item self-report questionnaire that measures multiple dimensions of the individual's personality, including Neuroticism (N), Extraversion (E), Openness (O), Agreeableness (A) and Conscientiousness (C). Within each dimension, six individual facets are also calculated. Based on normative means and standard deviations provided by the test designer for adult populations (ages 21 and above) and college age populations (ages 17-20), the T scores for the 30 different facets were calculated separately for males and females and then using the formula provided, factor scores were calculated for each of these five personality traits (Costa & McCrae, 1992).

Follow-up Assessments

Of the 151 BP participants, 117 (77.5%) also underwent a Longitudinal Interval Follow-up Evaluation (LIFE) (Keller et al., 1987) interview approximately two years after the original interview date to identify changes in diagnosis and course of illness. The last LIFE interview providing data used in this study occurred in August 2013. We determined the number of depression or mania/hypomania episodes they experienced since the baseline evaluation, and the instances of suicidal ideation, suicide attempts or hospitalizations. Participants were dichotomized into groups, with or without at least one episode of depression, mania/hypomania or suicidal ideation over the entire course of follow up. The longitudinal analysis in this study is only based on the presence of suicidal ideation since the total number of suicide attempts during follow-up (n=8) were too few for statistical analysis.

Statistical analysis

We compared clinical and demographic variables between groups using the Chi square test or the independent *t*-test. We first compared NEO PI-R Factor and Facet scores with bivariate t-tests. Correlations were examined with Pearson's *r* for continuous data and Spearman's rho for ordinal data.   We then identified clinical variables that were significantly

different between groups and were also correlated with personality factors (at a *p* value of 0.1 or less). We performed separate linear regression analyses with the personality factors as the dependent variables to examine the associations between diagnostic status, comorbid anxiety or suicide history and these identified clinical variables with personality factors. In these models, BP was the main independent variable and personality factors were the dependent variables. A logistic regression analysis was used to assess the effects of different clinical variables on predicting the development of suicidal ideation prospectively. We ran models with interactions between depressive symptoms and personality factors on suicidal ideation, to test differential effects of depressive symptoms on suicidal ideation based on personality factors. Statistical significance was set at 0.05. All Statistics were performed using SPSS Version 20 (SPSS Inc., Chicago, IL).

Results:

Bivariate group comparisons:

The demographic and clinical characteristics of the BP and HC participants, categorized by mood state and suicide history status are presented in table 1. Scores for each of the 5 factors and 30 facets of the NEO PI-R were compared among groups. There were significant differences in the personality dimensions between BP and HC (table 2) for N, E, C and facets of O and A. All but 3 of the differences remained significant even when only the euthymic BP group was compared to HC group. Within the BP group, differences in personality factors between groups based on suicide status were identified, both in the factor (N) and in facet (N, E, O, A, C) scores. We also found differences in baseline personality scores among those who developed mood episodes during the follow-up period (N, C factors and N, E, O, C facets). We found no statistically significant difference in the personality scores among those BP participants that completed the follow-up evaluation (n=117) and those who did not (n=34).

Relationship between personality factors and clinical variables:

Table 3 summarizes the correlations of personality factors with clinical and demographic variables that differed between the BP and HC groups and between the BPSA+ and BPSA- groups (selected from table 1). As seen in the table, in bivariate analyses, personality factors had correlations with many clinical features (particularly N which was strongly correlated with almost all variables.)

Independent factors associated with 5 personality factors (N, E, O, A, C) at baseline:

        For each personality factor a multivariate linear regression model was constructed, with the personality factor as the dependent variable, and variables that were significant or marginally significant in bivariate analysis (table 3) as independent variables. These included diagnostic status, baseline mood state, demographic factors, and features of illness (table 4). Three linear regressions were done for each personality factor. One with all participants (BP and HC), one with only euthymic BP and HC, and one with only BP participants. The BP participants had higher N scores than HC (B=8.05, p<0.001). Comorbid anxiety disorder (B=8.39, p<0.001), baseline depression severity (B=0.47, p<0.001) and childhood trauma (B=0.12, p=0.003) were also each independently associated with increased N scores. In the models for E, O and A, BP diagnosis did not have a significant independent effect on the factor scores. E was associated with baseline depression scores (B=-0.42, p=0.001), O with years of education (B=1.17, p<0.001) and A with mania scores (B=-0.55, p=0.005). In the model for C, BP diagnosis was a significant predictor when the full sample was used (B=-5.06, p=0.015), but was only marginally significant when the analysis was limited to euthymic BP participants (B=-4.50, p=0.052). C was positively associated with more years of education (B=0.77, p=0.010) and comorbid anxiety (B=5.56, p=0.011).

        In the models with only BP participants, a history of suicide attempts was not associated with personality scores. The variance within the personality scores was better explained by other variables. Higher N scores were related to the presence of comorbid anxiety disorders (B=7.04, p=0.006) and baseline depression severity (B=0.52, p=0.006). Baseline depression was also associated with lower E (B=-0.42, p=0.002) and baseline mania with lower A (B=-0.55, p=0.009) while O was significantly higher in the more educated (B=0.84, p=0.042), and was negatively associated with age at onset (B=-0.39, p=0.004). The model for C did not reach statistical significance.

Independent predictors of suicidal ideation during a prospective follow-up period

        Using binary logistic regression, we examined the predictors of suicidal ideation (SI) in the BP participants that completed the follow-up LIFE interview. In the first step, we added a personality factor or facet that was significantly related with SI from our bivariate analyses to a model in which SI was the dependent variable (from table 2: N, N1-6, C1, C3 and C5). We then added the significant and marginally significant clinical and demographic variables that were

different between the BP with suicidal ideation during follow up (BPSI+) and those without SI (BPSI-) groups (from table 1: Suicide attempt history, baseline depression, gender, chronic course, history of mixed episodes, rapid cycling, comorbid anxiety disorders and presence of at least one depression or mania/hypomania during follow-up period) and used a backward conditional method to remove non-significant variables. The strongest predictor of reporting SI during follow-up was having an episode of depression. Having a manic episode during follow-up, a chronic course of illness or having mixed episodes prior to baseline evaluation were also associated with elevated odds ratios for SI in some models (results are summarized in table 5). Although in the models including only personality scores (step 1 rows in table 5), many personality factors and facets showed a relation with prospective SI, they were no longer statistically significant when other clinical measures were added (step 2 rows in table 5). Only N4 (Self-Consciousness) and N6 (Vulnerability) had statistically significant higher odds ratios. To test interaction effects between follow-up depression and personality factor and facets scores, we performed logistic regression models to determine how depressive episodes during follow-up, baseline personality (N, N1-N6, C, C1, C3 and C5) and the interaction between them predicted follow-up SI (a moderator effect). The interaction effect was not significant in any of the N models (results not shown). The models showed significant interaction effects for C (O.R. for interaction =0.87, C.I. 0.78-0.98, p=0.022) and C1 (O.R. = 0.86, C.I. 0.76-0.96, p=0.009), suggesting that the effect of depressive symptoms over time on suicidal ideation depend on C and C1 levels. In individuals with depression during follow-up, higher C or C1 scores reduced the odds of SI and inversely, in those individuals without depression, higher C and C1 scores increased the odds of suicide (main effect O.R. for both C and C1=1.1, C.I. 1.0-1.2, p=0.04).

Discussion

Bipolar illness in the context of a history of childhood trauma, depressive symptoms, and comorbid anxiety in an individual with early onset disorder contributes to high levels of Neuroticism and low Extraversion and Conscientiousness, while manic symptoms contribute to lower Agreeableness. In this sample, mood and anxiety states impact the prospective risk for suicidal ideation more than personality factors, although two N facets, N4 (Self-Consciousness)

and N6 (Vulnerability) increased the odds of suicidal ideation, independent of depression. Higher Conscientiousness was a risk factor for suicidal ideation in those without depression.

The personality measures in the current BP sample were clearly different from healthy controls in our bivariate analysis and these differences remained significant throughout periods of euthymia, this is consistent with previous reports (Bagby et al., 1997; Barnett et al., 2011; Nowakowska et al., 2005; Strong et al., 2007; Tackett et al., 2008). Personality measures (higher N) were significantly different between groups based on suicide risk (both historical suicide attempts and future SI). However, in multivariate analyses history of suicide attempts did not correlate with personality, while severity of mood symptoms, anxiety, trauma and education level were better predictors of personality at baseline. The literature is divided in this area, with supportive (Sparding, Palsson, Joas, Hansen,& Landen, 2017) and counter (Bezerra et al., 2017) findings using a multivariate approach.

Studies have shown that personality traits like N influence the development of depressive symptoms (Duggan, Lee, & Murray, 1990; Heerlein, Richter, Gonzalez, & Santander, 1998; Lozano & Johnson, 2001; Quilty, Sellbom, Tackett, & Bagby, 2009), indirectly influencing SI. Our study also shows that individuals with higher N and lower C (and some facets of O and E) were more likely to have mood episodes or SI during follow up. However, our study examines this relationship further by using a multivariate model, longitudinal follow up, and exploring the moderating effects of personality factors on SI. The interactions of N (factors and facets) and depression with SI as an outcome were not significant, indicating that N does not have a moderating effect on the relationship between depression and SI (it does not affect the direction or strength of that relationship). The lack of moderation, and the lack of direct effect for N factor and most facets (other than N4 and N6) in predicting SI indicate that the higher levels of SI seen in the BP individuals with baseline higher N is primarily related to their predisposition to develop depression, rather than direct effects of the personality trait itself. Another novel finding in our sample was the interaction effect for C and C1 with depression. Individuals with higher C and Competence (C1) were more likely to have SI if they did not experience depression during follow-up. On the other hand, if depression occurred during follow-up, lower C and Competence (C1) increased the odds of SI; i.e. the effect of depressive symptoms on suicidal ideation of patients with BP depends on their personality. In this sample, C was positively correlated with anxiety diagnosis, while lower C has been associated with more impulsive behaviors like

smoking and drug use . One possible explanation for the differential effect of C based on mood is that in individuals without depression, higher C may lead to SI through elevated anxiety, while in those with depression, impulsivity leads to SI.

Overall, the strongest associations in this study between personality dimensions and clinical features and suicide risk were with Neuroticism factor and facet scores. This correlation was both cross sectional and prospective in nature. However, the effects of Neuroticism were nonspecific (for example, in predicting both future mania and depression). This is consistent with the suggestion that N represents a general predisposition to psychopathology with limited specificity.

Our study has notable limitations. We did not have measures of personality at multiple (>2) time points and during various mood states. Due to this, the dynamic effects of mood on personality are not measured in this study. Our prospective measure of suicide risk was only the presence of suicide ideation and we were not able to consider suicide attempts as the main outcome due to the small number of attempts. This limits the generalizability of our findings to other forms of suicide risk. Follow up was incomplete, only 77% of the BP participants completed the follow-up interview. However, the difference in personality scores between the group who completed follow up and the group who were lost to follow up were small (numerical differences for each personality factor score were as follows: N=1.2, E=0.7, O=1.0, A=3.1 and C=0.3) and not statistically significant. The collection of data at the baseline and the follow-up visit were retrospective in nature and limited by issues of recall and memory. We utilized structured interviews and scales and used a best estimate process to minimize any bias. Finally, although we examined multiple clinical variables, unknown confounders may have affected our results. The strengths of this study include the availability of detailed clinical outcomes data and dimensional measures of personality.

Similar to previous studies showing the high comorbidity of BP and personality disorders, and in line with what practitioners observe clinically, we found differences in personality dimensions between BP and HC, and between those with and without a history of suicide. However, this study further advances our understanding of this complex relationship by showing that the differences identified in personality scores in our sample were due to different levels of mood symptoms, comorbid anxiety, trauma, education level and age of onset, while a diagnosis of BP or history of suicide attempts were not correlated with personality traits in

multivariate analyses. The most compelling driving influence on suicidality was the level of depressive symptoms, which clearly had a differential effect on SI, with influence from the level of Conscientiousness. These findings in BP align with evidence from depression that suicide risk can be reduced by the adequate treatment or prevention of depression (Isacsson, Bergman, & Rich, 1996; Rihmer, Barsi, Veg,& Katona, 1990; Rutz, von Knorring, & Walinder, 1992). Although Neuroticism factors and some of its facets (particularly Self-Consciousness and Vulnerability) are associated with future suicidal ideation, mood episodes, particularly depression, are much stronger predictors of suicidal ideation in our BP sample. Attention to treatment of mood episodes and residual mood symptoms, even in instances of comorbid personality abnormality is critical to reduce suicidal risk.

Declaration of Interest

Drs. Kamali, Saunders, Assari, Ryan and Marshall report no competing interest related to the content of this study. Dr. McInnis has consulted for Janssen and Otsuka Pharmaceuticals in the past 3 years.

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Table 1. Demographic characteristics of unaffected healthy controls and bipolar participants

	Baseline					Follow up (BP only)					
	Diagnosis			Suicide status of BP participants		Suicide status of BP participants		Depressive episodes during follow-up		Manic/hypomanic episodes during follow-up	
	HC (N=119)	All BP[b] (N=151[a])	Euthymic BP[b] (N=73[a])	BPSA- (N=100)	BPSA+[c] (N=51)	BPSI- (N=71[a])	BPSI+[d] (N=45)	None (N=42[a])	At least one[e] (N=75)	None (N=48[a])	At least one[e] (N=69)
Age, Mean (S.D.)	31.6 (13.9)	**40.6***** (12.2)	**42.3***** (12.0)	40.7 (12.6)	40.4 (11.6)	41.3 (11.9)	41.0 (11.2)	41.3 (11.7)	41.1 (11.5)	41.3 (11.6)	41.1 (11.6)
Number Female (Percent)	63 (52%)	99* (65%)	46 (63%)	60 (60%)	**39*** (76%)	42 (59%)	**34 †** (75%)	22 (52%)	**55 * (73%)**	29 (60%)	48 (69%)
Years of Education, Mean (S.D.)	15.6 (2.4)	15.7 (2.5)	**16.3 *** (2.3)	16.4 (2.5)	**14.2***** (1.9)	16.1 (2.5)	15.6 (2.8)	16.1 (2.8)	15.8 (2.5)	16.1 (2.7)	15.8 (2.5)
Total HAMD-17, Mean (S.D.)	0.7 (1.2)	**8.0***** (6.8)	**2.8 *** (2.4)	7.3 (6.5)	9.5 (7.1)	6.6 (6.2)	**10.1 **** (7.2)	6.3 (6.4)	**9.0 *** (6.9)	7.5 (7.4)	8.4 (6.4)
Total YMRS, Mean (S.D.)	0.1 (0.6)	**2.9***** (4.7)	**1.4 *** (1.8)	2.8 (4.9)	3.2 (4.3)	2.6 (5.1)	3.1 (3.9)	2.9 (6.2)	2.8 (3.6)	1.7 (3.3)	**3.6 * (5.3)**
Total CTQ, Mean (S.D.)	32.2 (8.8)	**47.4***** (19.4)	**44.4 *** (17.9)	42.6 (15.4)	**56.9 ***** (22.8)	44.1 (17.2)	48.8 (19.1)	41.4 (15.1)	**48.8 * (19.1)**	41.5 (13.1)	**49.3* (20.3)**
Number with Anxiety Diagnosis (Percent)	0 (0%)	55 (36 %)	17 (23%)	30 (30%)	**25 *** (49%)	19 (26%)	**20 †** (44%)	9 (21%)	**31 * (41%**	10 (20%)	**30 * (43%)**
Substance use disorder, Number (Percent)	N/A	80 (53%)	35 (47%)	43 (43%)	**37***** (72.5%)	30 (42%)	26 (57%)	17 (40%)	40 (53%)	19 (39%)	38 (55%)
Years Ill, Mean (S.D.)	N/A	22.6 (12.9)	23.1 (13.3)	20.8 (13.5)	**26.1 *** (11.0)	21.9 (12.4)	23.3 (12.8)	21.8 (13.3)	22.7 (12.1)	21.4 (12.4)	23.1 (12.5)
Age of illness onset, Mean (S.D.)	N/A	17.8 (7.3)	19.1 (7.4)	19.6 (7.2)	**14.2 ***** (6.2)	19.4 (8.0)	17.6 (7.1)	19.4 (7.7)	18.3 (7.7)	19.8 (7.8)	18.0 (7.5)
Mood State at — Euthymic	N/A	73 (48%)	73 (100%)	52 (52%)	21 (41%)	39 (54%)	18 (40%)	24 (57%)	33	27 (56%)	**30 † (48%)**

baseline, Number (Percent)										(44%)		
	Depressed	N/A	61 (40%)	0	37 (37%)	24 (41%)	27 (38%)	21 (46%)	14 (33%)	35 (46%)	20 (41%)	**29 † (42%)**
	Manic, Hypomanic, Mixed	N/A	17 (11%)	0	11 (11%)	6 (11%)	5 (7%)	6 (13%)	4 (9%)	7 (9%)	1 (2%)	**10 † (14%)**
Chronic Illness course, Number (Percent)		N/A	88 (59%)	29 (40%)	46 (46%)	**42***(82%)	32 (46%)	**33** * (73%)	17 (42%)	**49** * (65%)	22 (46%)	**44 † (64%)**
Psychotic symptoms present, Number (Percent)		N/A	93 (61%)	48 (65%)	65 (65%)	28 (54%)	47 (66%)	26 (57%)	31 (73%)	42 (56%)	30 (62%)	43 (62%)
Rapid Cycling present, Number (Percent)		N/A	60 (40%)	19 (26%)	32 (32%)	**28** * (54%)	18 (25%)	**23** ** (51%)	9 (21%)	**33** * (44%)	8 (16%)	**34 *** (49%)**
Mixed episodes present, Number (Percent)		N/A	63 (42%)	22 (30%)	32 (32%)	**31***(60%)	24 (33%)	**26** * (59%)	14 (33%)	37 (50%)	13 (27%)	**38 ** (55%)**
Prior suicide attempt, Number (Percent)		N/A	51 (33%)	21 (28%)	0	51 (100%)	15 (21%)	**44** * (44%)	5 (11%)	**30 *** (40%)	12 (25%)	23 (33%)
At least one depressive episode during follow up period. Number (Percent)		N/A	N/A	N/A	N/A	N/A	33 (46%)	**41 *** (91%)	0 (0%)	75 (100%)	23 (47%)	**52 ** (75%)**
At least one manic/hypomanic episode during follow up period. Number (Percent)		N/A	N/A	N/A	N/A	N/A	34 (47%)	**34** ** (75%)	17 (40%)	**52** ** (69%)	0 (0%)	69 (100%)
Suicidal Ideation During follow up period Number (Percent)		N/A	N/A	N/A	N/A	N/A	N/A	N/A	4 (9%)	**41***(55%)	11 (22%)	**34**(50%)

BP=Bipolar Disorder, HC=Healthy Control, BPSA- =Bipolar without a past suicide attempt, BPSA+ =Bipolar with a past suicide attempt, BPSI- =Bipolar without suicidal ideation, BPSI+ =Bipolar with suicidal ideation, HAMD-17= Hamilton depression rating scale-17 item, YMRS= Young mania rating scale, CTQ= Childhood trauma questionnaire.

[a] Except for Years of Education, where there is one fewer participant.

[b] Compared to HC

[c] Compared to BPSA-

[d] Compared to BPSI-

[e] Compared to no episodes during follow up

*** *p ≤0.001*

** *p ≤0.01*

* p <0.05

† $p \leq 0.1$

Table 2. Comparison of baseline personality factor scores[a] between unaffected healthy controls and patients with bipolar disorder.

	Baseline Mean S.D.					Follow up (BP only) Mean S.D.					
	Diagnosis			Suicide status of BP participants		Suicide status of BP participants		Depressive episodes during follow-up		Manic/hypomanic episodes during follow-up	
	HC (N=119)	All BP[b] (N=151)	Euthymic BP[b] (N=73)	BPSA- (N=100)	BPSA+[c] (N=51)	BPSI- (N=71)	BPSI+[d] (N=45)	None (N=42)	At least one[e] (N=75)	None (N=48)	At least one[e] (N=69)
N Factor (Neuroticism)	43.5 9.3	**60.8*** 13.5	**57.2*** 13.1	58.8 14.3	**64.7*** 11.0	56.6 12.6	**65.8*** 10.9	56.3 12.8	**62.9*** **12.8**	55.4 10.6	**64.1*** **13.6**
E Factor (Extraversion)	49.7 8.6	**45.5*** 11.0	**46.9*** 9.7	46.4 10.9	43.8 11.1	45.6 11.3	46.0 11.7	45.6 10.6	45.7 11.9	44.9 10.5	46.2 12.0
O Factor (Openness)	57.1 10.7	58.0 11.8	59.4 11.0	58.8 12.0	56.5 11.3	58.2 12.7	57.1 11.7	57.1 12.0	58.2 12.4	55.5 13.4	59.4 11.2
A Factor (Agreeableness)	51.5 10.3	49.3 12.5	51.3 12.0	50.0 12.1	48.0 13.3	48.7 11.5	48.8 14.7	48.8 11.1	48.5 13.7	50.3 12.0	47.4 13.3
C Factor (Conscientiousness)	49.1 10.4	**43.5*** 13.7	**44.6*** 13.8	45.0 13.5	40.6 13.7	44.9 13.9	41.5 13.8	47.3 12.5	**41.5*** **14.2**	44.4 12.5	43.0 14.7
N1 T Score (Anxiety)	44.8 9.0	**56.8*** 11.6	**54.0*** 11.8	55.5 12.1	**59.4*** 10.0	53.9 11.6	**59.4*** 10.4	53.5 10.5	57.8 11.9	52.2 10.0	**59.1*** **11.8**
N2 T Score (Angry Hostility)	44.3 8.7	**56.7*** 13.5	**53.8*** 12.6	55.9 13.9	58.2 12.7	55.0 13.0	59.6 10.4	54.7 12.8	58.3 13.5	54.1 11.0	**59.0*** **14.4**
N3 T Score (Depression)	43.3 7.3	**63.5*** 12.8	**58.6*** 12.7	61.5 13.0	**67.4*** 11.3	59.1 13.0	**68.2*** 9.1	57.8 11.8	**65.6*** **12.1**	59.1 11.7	**65.4*** **12.5**
N4 T Score (Self-Consciousness)	45.6 9.0	**57.4*** 12.8	**55.6*** 13.6	55.0 12.6	**62.2*** 12.0	53.2 11.6	**62.3*** 10.0	52.6 11.7	**59.4*** **11.6**	53.3 11.2	**59.4*** **12.0**
N5 T Score (Impulsiveness)	44.9 9.7	**57.1*** 11.2	**55.0*** 11.0	55.8 11.4	59.4 10.3	55.7 10.6	**60.4*** 10.8	55.2 9.6	59.1 11.7	54.5 10.2	**60.0*** **11.2**
N6 T Score (Vulnerability)	45.0 8.2	**60.6*** 13.8	**56.9*** 14.0	58.3 13.4	**64.9*** 13.5	55.7 11.3	**66.8*** 12.9	55.0 10.4	**63.1*** **13.7**	56.3 12.2	**62.9*** **13.2**
E1 T Score	53.3	**46.9*** 	**49.6*** 	48.8	**43.3*** 	47.0	46.8	47.6	46.0	47.2	46.2

(Warmth)	9.0	14.6	12.9	14.1	15.0	14.9	14.9	13.5	16.1	13.2	16.5
E2 T Score	54.5	**48.0***	**50.1**	49.7	**44.5***	48.3	49.3	48.6	48.4	50.5	47.1
(Gregariousness)	10.5	13.8	12.0	13.8	13.3	14.7	13.1	13.8	14.4	11.6	15.6
E3 T Score	53.1	**50.6***	51.4	51.5	48.9	51.9	49.2	51.2	50.7	50.5	51.1
(Assertiveness)	9.1	11.5	12.0	12.0	10.4	11.6	11.9	12.6	11.2	12.2	11.4
E4 T Score	50.4	48.4	48.8	49.6	45.8	49.5	47.6	51.1	47.5	45.7	**51.0***
(Activity)	8.8	11.8	11.2	11.8	11.5	10.5	12.5	11.2	11.1	10.2	**11.5**
E5 T Score	53.5	51.6	51.4	50.3	**54.2***	50.0	52.5	48.4	52.5	48.8	52.6
(Excitement-Seeking)	10.6	10.9	11.3	10.9	10.4	11.5	10.8	10.7	11.3	10.9	11.2
E6 T Score	54.8	**48.0***	**51.4***	49.0	46.2	48.5	47.6	48.2	47.8	46.8	48.8
(Positive Emotions)	9.0	13.3	10.9	13.7	12.2	13.1	14.7	13.1	14.3	14.1	13.7
O1 T Score	52.6	**56.6**	**57.0**	56.5	56.8	56.8	56.3	55.5	57.5	54.1	**58.7***
(Fantasy)	10.3	11.1	10.4	11.3	10.8	11.0	11.5	12.2	10.9	12.0	**10.6**
O2 T Score	55.4	55.7	56.6	55.8	55.5	55.3	56.0	54.3	56.4	53.8	57.0
(Aesthetics)	10.6	11.7	11.3	11.7	11.7	11.7	11.9	12.2	11.5	12.9	10.8
O3 T Score	52.2	**57.3***	**57.0**	57.5	57.1	56.4	58.2	56.2	57.9	54.3	**59.3***
(Feelings)	10.6	10.1	9.4	10.6	9.3	10.3	11.0	11.0	10.5	11.0	**9.9**
O4 T Score	53.0	**48.9**	50.5	50.5	**45.7***	49.4	47.5	48.4	48.5	47.3	49.4
(Actions)	10.6	13.6	12.5	14.5	11.0	13.7	13.5	13.3	13.8	12.4	14.3
O5 T Score	57.8	55.4	57.5	56.0	54.1	56.0	54.3	56.4	54.5	54.3	55.8
(Ideas)	9.4	12.1	11.1	12.0	12.4	12.0	12.6	10.9	13.1	13.0	11.9
O6 T Score	54.7	56.8	57.0	56.6	57.0	56.5	57.1	55.4	57.2	55.6	57.3
(Values)	10.3	10.9	10.7	11.7	9.4	11.5	9.7	11.7	10.5	10.8	11.0
A1 T Score	52.5	**45.0***	**47.7**	47.4	**40.3**	46.1	42.9	47.1	43.3	47.4	42.7
(Trust)	9.9	14.9	12.9	13.3	16.9	14.9	14.6	14.3	15.2	12.8	16.1
A2 T Score	48.0	46.9	48.7	47.7	45.3	47.6	47.1	49.0	46.1	48.9	45.9
(Straightforwardness)	10.4	11.6	10.7	12.0	10.5	11.2	12.2	11.4	12.0	10.7	12.5
A3 T Score	52.2	49.5	50.5	49.8	49.0	50.1	48.8	49.6	49.2	50.4	48.6
(Altruism)	10.7	12.0	10.6	12.1	12.1	11.6	13.7	11.5	13.2	12.0	13.0
A4 T Score	51.4	**46.6***	49.7	47.4	45.1	46.4	44.9	47.0	45.2	48.6	43.8
(Compliance)	9.3	13.2	12.2	12.3	14.9	11.4	16.3	11.1	14.6	11.3	14.4
A5 T Score	50.1	50.9	50.9	50.4	52.0	50.1	51.7	50.9	51.0	51.5	50.6
(Modesty)	10.6	11.3	11.5	11.3	11.2	11.7	10.2	11.6	11.3	11.1	11.6
A6 T Score	53.3	55.3	55.7	55.0	55.9	54.2	53.9	51.7	55.5	51.8	55.8
(Tender-Mindedness)	10.8	11.1	12.1	11.8	9.7	12.0	9.6	13.5	9.4	12.2	10.0
C1 T Score	52.8	**45.1***	**46.2***	46.6	42.2	47.3	**41.0***	49.3	**42.1**	47.2	43.0

(Competence)	9.5	13.8	13.4	13.9	13.3	12.3	15.8	11.8	**14.7**	12.1	15.2
C2 T Score (Order)	48.4	**43.5****	**44.9***	43.9	42.9	43.7	42.9	47.0	**41.6***	45.0	42.6
	10.7	13.7	13.5	13.8	13.5	13.7	13.9	12.1	**14.3**	12.9	14.3
C3 T Score (Dutifulness)	50.2	**42.6*****	**44.7*****	44.7	**38.4****	44.6	**39.5***	46.8	**40.1****	45.1	40.7
	9.9	12.3	12.0	11.3	13.3	11.9	12.6	9.8	**13.0**	11.5	12.6
C4 T Score (Achievement Striving)	52.3	**45.4*****	**46.9****	47.4	**41.4****	46.6	44.9	47.4	45.3	46.4	45.8
	9.7	13.3	13.6	12.9	13.4	13.2	14.3	12.8	14.1	11.6	14.9
C5 T Score (Self-Discipline)	50.3	**38.4*****	**41.0*****	40.1	**35.3***	41.1	**33.6****	42.9	**35.4****	40.0	36.8
	10.2	14.2	15.6	14.6	13.0	14.1	14.4	12.7	**14.9**	13.2	15.4
C6 T Score (Deliberation)	52.7	**44.3*****	**46.2*****	46.0	**41.0***	45.4	42.9	45.2	43.6	47.0	42.2
	9.0	12.6	11.8	12.4	12.3	13.6	11.8	12.8	13.4	11.0	14.2

BP=Bipolar Disorder, HC=Healthy Control, BPSA- =Bipolar without a past suicide attempt, BPSA+ =Bipolar with a past suicide attempt, BPSI- =Bipolar without suicidal ideation, BPSI+ =Bipolar with suicidal ideation,

HAMD-17= Hamilton depression rating scale-17 item, YMRS= Young mania rating scale, CTQ= Childhood trauma questionnaire.

[a] We used the test designers formula to calculate factor scores from raw data. These represent T scores with a mean of 50 and a standard deviation of 10.

[b] Compared to HC

[c] Compared to BPSA-

[d] Compared to BPSI-

[e] Compared to no episodes during follow up

*** $p \leq 0.001$

** $p \leq 0.01$

* $p \leq 0.05$

Table 3. Bivariate correlations between clinical variables and personality factor scores in patients with bipolar disorder and healthy controls.

	N Factor (Neuroticism)	E Factor (Extraversion)	O Factor (Openness)	A Factor (Agreeableness)	C Factor (Conscientiousness)
Total Sample (all BP and HC) (N=270)					
HAMD-17 (correlation coefficient)	0.584 ***	-0.279 ***		-0.112 †	-0.195 ***
YMRS (correlation coefficient)	0.410 ***	-0.176 **		-0.139 *	-0.199 ***
CTQ (correlation coefficient)	0.515 ***	-0.241 ***		-0.152 *	-0.251 ***
Years of Education (correlation coefficient)			0.241 ***		0.148 *
Age (correlation coefficient)	0.222 ***				
Only BP sample (N=151)					
History of Suicide Attempts (Yes/No)	Yes>No *				Yes<No †
Comorbid Anxiety (Yes/No)	Yes>No ***	Yes<No †		Yes<No †	
HAMD-17 (correlation coefficient)	0.387 ***	-0.259 ***	-0.149 †		
YMRS (correlation coefficient)	0.184 *			-0.190 *	-0.145 †
CTQ (correlation coefficient)	0.331 ***			-0.221 **	
Years of Education (correlation coefficient)	-0.185 *	0.145 †	0.210 **		0.211 **
Substance Abuse History (Yes/No)	Yes>No *			Yes<No *	Yes<No *
Chronicity of illness (Yes/No)	Yes>No **				Yes<No †
Mixed Episodes (Yes/No)	Yes>No ***				
Rapid Cycling (Yes/No)	Yes>No ***				
Age of onset (correlation coefficient)	-0.313 ***		-0.156 †		

BP=Bipolar Disorder, HC=Healthy Control, HAMD-17= Hamilton depression rating scale-17 item, YMRS= Young mania rating scale, CTQ= Childhood trauma questionnaire.

*** p ≤*0.001*

** p ≤0.01

* p≤0.05

† p ≤0.1

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Table 4. Summary of linear regressions on the associations between bipolar disorder, depressive symptoms, and anxiety with personality traits at baseline[a].

	N Factor (Neuroticism)			E Factor (Extraversion)			O Factor (Openness)			A Factor (Agreeableness)			C Factor (Conscientiousness)		
	All BP and HC N=270	Euthymic BP and HC N=192	All BP N=124	All BP and HC N=270	Euthymic BP and HC N=192	All BP N=150	All BP and HC N=269	Euthymic BP and HC N=191	All BP N=149	All BP and HC N=270	Euthymic BP and HC N=192	All BP N=151	All BP and HC N=269	Euthymic BP and HC N=191	All BP N=148
Adjusted R^2	**0.46** ***	**0.33** ***	**0.29** ***	**0.08** ***	**0.05** **	**0.06** **	**0.05** ***	**0.05** **	**0.08** **	**0.05** **	-0.01 N.S.	**0.08** **	**0.07** ***	0.03 †	0.03 †
Diagnosis	**8.05** ***	**7.51** ***		N.S.	N.S.		N.S.	N.S.		N.S.	N.S.		**-5.06** *	-4.50 †	
Comorbid Anxiety	**8.39** ***	**7.49** *	**7.04** **	N.S.	N.S.	N.S.	N.S.	N.S.		N.S.	N.S.	N.S.	**5.56** *	N.S.	
HAM D-17	**0.47** ***	N.S.	**0.52** **	**-0.42** ***	N.S.	**-0.42** **			N.S.	N.S.	N.S.		N.S.	N.S.	
YMRS	N.S.	N.S.	N.S.	N.S.	N.S.					**-0.55** **	N.S.	**-0.55** **	N.S.	N.S.	N.S.
CTQ	**0.12** **	**0.13** *	N.S.	N.S.	N.S.					N.S.	N.S.	N.S.	N.S.	N.S.	
Years of Education			N.S.		N.S.		**1.17** ***	**1.02** **	**0.84** *				**0.77** *	N.S.	N.S.
Age	N.S.	N.S.													
History of Suicide			N.S.			N.S.			N.S.			N.S.			N.S.
Substance Abuse history			N.S.									N.S.			N.S.
Chronic Course			N.S.												N.S.

Mixed Episodes			N.S.												
Rapid Cycling			N.S.												
Age of Onset			N.S.						-0.39**						

BP=Bipolar Disorder, HC=Healthy Control, HAMD-17= Hamilton depression rating scale-17 item, YMRS= Young mania rating scale, CTQ= Childhood trauma questionnaire.

[a] Reported numbers for variables are B values (Amount of change in personality factors with one point change in each independent variable, controlling for other variables in the equation).

*** *p ≤0.001*

** *p ≤0.01*

* *p≤0.05*

† *p ≤0.1*

Table 5: Summary of logistic regressions to investigate predictors of suicidal ideation at follow-up in patients with bipolar disorder

		Nagelkerke R square	Personality Measure	Depression during follow-up	Mania during follow-up	Chronic course of illness	History of mixed episodes	-Suicide attempt history -Baseline depression -Sex -Rapid cycling -Comorbid anxiety disorders
N Factor (Neuroticism)	Step 1	0.167	p=.001					
	Step 2 O.R. (95% CI)	0.409	1.0 (0.99-1.08) p=0.084	**5.5 (1.5-19.7) p=0.008**	3.0 (0.98-9.2) p=0.053	**2.9 (1.0-8.6) p=0.042**	N.S.	N.S.
N1 T Score (Anxiety)	Step 1	0.070	p=0.031					
	Step 2 O.R. (95% CI)	0.387	1.0 (0.97-1.06) p=0.313	**5.7 (1.6-20.0) p=0.006**	**3.4 (1.1-10.4) p=0.027**	**3.4 (1.2-9.6) p=0.021**	N.S.	N.S.
N2 T Score (Angry Hostility)	Step 1	0.47	p=0.074					
	Step 2 O.R. (95% CI)	0.385	1.0 (0.97-1.05) p=0.379	**5.6 (1.6-19.7) p=0.007**	**3.5 (1.2-9.8) p=0.022**	**3.5 (1.2-9.81) p=0.018**	N.S.	N.S.
N3 T Score (Depression)	Step 1	0.140	p=0.003					
	Step 2 O.R. (95% CI)	0.393	1.02 (0.98-1.07) p=0.213	**5.1 (1.4-18.2) p=0.01**	**3.4 (1.1-10.5) p=0.027**	**2.9 (1.01-8.6) p=0.047**	N.S.	N.S.
N4 T Score (Self-Consciousness)	Step 1	0.209	p<0.001					
	Step 2 O.R. (95% CI)	0.410	**1.06 (1.01-1.1) p=0.008**	**7.7 (2.1-27.6) p=0.001**	N.S.	N.S.	**3.3 (1.2-9.1) p=0.020**	N.S.
N5 T Score (Impulsiveness)	Step 1	0.104	p=0.01					
	Step 2 O.R. (95% CI)	0.395	1.03 (0.98-1.08) p=0.19	**5.5 (1.5-19.3) p=0.01**	**3.5 (1.1-10.6) p=0.022**	**3.0 (1.0-8.7) p=0.04**	N.S.	N.S.
N6 T Score (Vulnerability)	Step 1	0.162	P=0.001					
	Step 2 O.R. (95% CI)	0.396	**1.05 (1.01-1.09) p=0.013**	**7.3 (2.1-25.5) p=0.001**	N.S.	N.S.	**3.9 (1.4-10.7) p=0.008**	N.S.
C1 T Score (Competence)	Step 1	0.058	p=0.048					
	Step 2 O.R. (95% CI)	0.393	0.98 (0.94-1.02) p=0.35	**5.6 (1.5-20.8) p=0.009**	2.9 (0.97-9.1) p=0.056	2.7 (0.95-8.1) p=0.062	2.4 (0.85-7.1) p=0.094	N.S.

C3 T Score (Dutifulness)	Step 1	0.028	p=0.168					
	Step 2 O.R. (95% CI)	0.377	1.0 (0.96-1.04) p=0.93	**5.6 (1.6-19.6) p=0.007**	**3.8 (1.2-11.4) p=0.015**	**3.6 (1.2-10.2) p=0.014**	N.S.	N.S.
C5 T Score (Self-Discipline)	Step 1	0.059	p=0.044					