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Facial Emotion Recognition in First-Episode Schizophrenia and Bipolar Disorder with Psychosis

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Abstract

Patients with schizophrenia and bipolar disorder have difficulties recognizing facial expressions of emotion. Differences in deficits between these disorders and the effects of treating acute symptoms of illness with antipsychotic medication on these deficits are not well characterized. First-episode patients with schizophrenia ($n = 24$) and psychotic bipolar I disorder ($n = 16$) were compared to a healthy control group ($n = 32$) on the Penn Emotional Acuity Test. Patients were studied during an acute psychotic episode and after seven weeks of treatment with antipsychotic medication. During acute psychosis, bipolar patients showed deficits recognizing subtle facial expressions of happiness and sadness, and this deficit did not resolve with treatment. Schizophrenia patients similarly had difficulty recognizing subtle happy faces during acute illness that also did not resolve with treatment. In addition, problems recognizing subtle expressions of sadness among schizophrenia patients were apparent after treatment. Poorer emotion recognition at follow-up was related to negative symptom severity for schizophrenia patients. These findings highlight the severity and persistence of emotion recognition deficits early in the course of psychotic bipolar disorder and schizophrenia, and demonstrate an association of emotion processing deficits to negative symptoms in schizophrenia during periods of relative clinical stability.

Keywords

schizophrenia; bipolar disorder; psychosis; antipsychotic medication; emotion recognition

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Contributors

Dr. Sweeney and Dr. Reilly designed the study. Mr. Daros and Dr. Ruocco performed statistical analyses. All authors contributed to drafting the manuscript.

Conflict of Interest

Janssen Pharmaceuticals provided a grant related to this project. Dr. Sweeney is a consultant for Bristol-Myers Squibb, Eli Lilly, Roche, and Takeda.

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1. Introduction

Difficulty identifying facial displays of emotion is a well-recognized impairment in schizophrenia (SCZ) (Kohler et al., 2010). This deficit has been reported early in the illness and generalizes across emotional valences (Addington et al., 2006; Edwards et al., 2001; Kohler et al., 2010; Wolwer et al., 1996). Emotion processing deficits are believed to persist beyond the acute phases of illness in SCZ and into periods of symptomatic recovery (Addington and Addington, 1998; Harvey et al., 2006; Wolwer et al., 1996), suggesting a trait-like emotion recognition deficit in this illness.

Deficits in facial emotion recognition also have been reported in bipolar disorder (BP) (Kohler et al., 2011). Differentiating these and other neurobehavioral deficits from those found in SCZ has become a prominent issue as the two disorders share other important features especially in BP patients with a history of psychosis (Thaker, 2008). Research examining this question has revealed greater facial emotion processing deficits in SCZ than BP (Addington and Addington, 1998; Goghari and Sponheim, 2013). Difficulties processing emotional information in these disorders may also stem from a broader deficit in social cognition (Ibañez et al., 2012). Some studies indicate that emotion recognition deficits in BP may be isolated to specific emotions (Summers et al., 2006), although a more generalized deficit has been most commonly described (Addington and Addington, 1998; Bozikas et al., 2006; Derntl et al., 2009; Getz et al., 2003; Rich et al., 2008).

The extent to which emotion recognition and other cognitive deficits vary with state of illness in SCZ and BP remains an important unanswered question (Gopin et al., 2011; Harris et al., 2009; Hill et al., 2009). It has been proposed that emotion processing deficits in BP may involve mood-congruent biases in emotion perception while patients are acutely manic or depressed (Gray et al., 2006; Lennox et al., 2004; Venn et al., 2004). These suggestions, however, are based on cross-sectional studies of BP patients tested either during an acute mood episode or during euthymia, not direct examination of effects of changing mood states on emotion processing over time in individual patients. Longitudinal studies following patients after treatment for an acute episode of illness are needed to better understand the role of state of illness factors on emotion processing in BP. Given the prominence of affective symptoms in BP and their relation to level of acute illness, one might speculate that psychotic BP patients may show similar, if not more severe, deficits in emotion recognition than patients with SCZ. This might be especially true during periods of acute illness, although these deficits would be expected to remit on clinical recovery, perhaps to a greater degree than in SCZ.

The purpose of the present study was twofold: first, to compare the deficits in psychotic BP and SCZ during an acute phase of illness, and second, to investigate the extent of change in any observed emotion recognition deficits across these disorders following antipsychotic treatment.

2. Methods

2.1. Procedure

Approval for this study was obtained from the Institutional Review Board at the University of Illinois at Chicago where participants were recruited. Written informed consent was obtained from adult participants. For those under 18 years old, we obtained assent and parental consent. Detailed study procedures and inclusion/exclusion criteria are described elsewhere (Herbener et al., 2005; Hill et al., 2009). Briefly, participants were recruited when they sought treatment for their first-episode of psychosis. Patients (SCZ: $n = 29$; BP I

disorder with psychosis: $n = 28$) were evaluated with the Structured Clinical Interview for DSM-IV Axis I Disorders (SCID) (First et al., 2002) and diagnoses were made based upon a consensus review using these and other available clinical data. Diagnostic subtypes for SCZ patients with baseline and follow-up data were as follows: paranoid (79.2%), undifferentiated (16.7%), and disorganized (4.2%). For BP patients with baseline and follow-up data, 50.0% were manic, 18.8% were in a mixed episode, and 31.3% were depressed. Patients were rated on the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1986), Hamilton Depression Rating Scale (HDRS) (Williams, 1988) and Young Mania Rating Scale (YMRS) (Young et al., 1978) at each time point by a trained assessor with no knowledge of task performance. Healthy control subjects ($n = 54$ initially, 32 with baseline and follow-up data) were recruited from the community who had no current psychotic or affective disorder, and who matched the patient groups on age, gender, and reading ability as assessed by the Wide Range Achievement Test-3rd Edition (Wilkinson, 1993). Full-scale IQ was measured using the Wechsler Abbreviated Scale of Intelligence (Wechsler, 1999). Demographic and illness-related characteristics of the final sample are presented in Table 1. Groups differed by IQ, $F(2,69) = 4.36$, $p < .01$, with schizophrenia patients having a lower IQ than healthy controls ($p < .01$). Specifying IQ as a covariate did not change the results of analyses, thus primary analyses are reported without IQ correction.

At study entry, some patients with SCZ and BP had previously been exposed to atypical antipsychotics (45.0%), antidepressants (30.0%), typical antipsychotics (15.0%), mood stabilizers/anticonvulsants (12.5%), and stimulants (12.5%), typically for brief periods of time in the months preceding their participation. No patient had taken a dose of any of these medications within three days of assessments, with the exception of BP (6.3%) and SCZ (12.5%) patients who were on maintenance antidepressant treatment started prior to study entry. Up to four weeks of prior cumulative lifetime antipsychotic treatment was allowed. The median lifetime cumulative duration of drug treatment for those patients who had previously received treatment was as follows: 2 weeks for antipsychotics, 24 weeks for antidepressants and, 6 weeks for mood stabilizers. After baseline assessments, which included emotion perception testing, participants began treatment with antipsychotic medications, the first line treatment being risperidone.

Five SCZ and 12 BP patients were lost to follow-up. There were no differences with respect to demographic variables (age, gender), IQ, oral reading, baseline clinical symptom ratings (PANSS, YMRS, HDRS), or emotion recognition accuracy between individuals who did not complete follow-up sessions and those who did (all p 's $> .14$). All remaining participants completed follow-up assessments an average of 6.8 weeks ($SD = 3.7$) after their initial testing. At the time of the second testing session, patients with SCZ were being treated with risperidone (79.2%), aripiprazole (12.5%), haloperidol (8.3%), or ziprasidone (4.2%). Patients with BP were treated with risperidone (86.7%) or olanzapine (6.7%), as well as mood stabilizers valproic acid (13.3%) and carbamazepine (6.7%). Four patients (12.5% SCZ, 6.7% BP) were continued on antidepressants and seven patients (29.2% SCZ) took anxiolytics as adjuncts. Dosing was by clinician judgment, but the clinical service generally treated with the lowest effective dose. The median daily dose of antipsychotic (typical and atypical) drugs in chlorpromazine equivalents (Andreasen et al., 2010) was 326.9 mg ($SD = 218.9$; range: 34.4–907.8 mg) for SCZ patients and 154.4 mg ($SD = 125.7$; range: 34.4–524.6 mg) for BP patients, with SCZ patients having been treated using a larger daily dose, $t(35) = 2.3$, $p = .03$.

Participants completed the computerized Penn Emotional Acuity Test (PEAT; Erwin et al., 1992), which is a measure of emotion recognition and discrimination that has been used in clinical samples (Gur et al., 1992; Sachs et al., 2004). The PEAT presents 40 faces, one at a time, each one displaying either a happy, sad, or neutral expression. Faces are balanced for

gender and presented randomly in two blocks, the first containing sad and neutral faces and the second happy and neutral faces. Participants were instructed to look carefully at each face and rate on a seven-point Likert scale the perceived facial expression for each face: *Very Sad, Moderately Sad, Mildly Sad, Neutral, Mildly Happy, Moderately Happy, and Very Happy*. The task began with a brief session involving five practice faces. Accuracy of facial affect judgments relative to test norms (Erwin et al., 1992) and response times (RT) were recorded for each trial.

2.2. Statistical Plan

The distribution of accuracy scores at both assessment times was not normally distributed by visual inspection and violated the Shapiro-Wilks test. Thus, between-group analyses were carried out using both non-parametric and parametric statistical tests. There were no differences in the pattern of findings, therefore results of parametric analyses are presented for simplicity. RT data were normalized using a square-root transformation. Given that several patients and controls were lost to follow-up, initial analyses focused solely on baseline data during acute psychosis, at which point the emotion recognition measure was completed by a larger number of patients. Accuracy and RT were analyzed using 3 (Group) $\times$ 2 (Time Points) $\times$ 7 (Emotion) repeated-measures MANOVA with Tukey post-hoc comparisons. Potential biases in emotion perception were evaluated by coding responses (i.e., error types) as more positive or negative in intensity relative to the psychometrically determined normative response (Erwin et al., 1992) and compared within- and between-groups using repeated-measures MANOVA.

3. Results

3.1. Acute Psychotic Illness Phase

Figure 1 (top) displays standardized emotion recognition accuracy for SCZ and BP groups compared to healthy controls. At baseline, groups differed in recognizing moderately sad, $F(2,108) = 5.38, p = 0.01$, mildly happy, $F(2,108) = 9.97, p < 0.001$, and moderately happy facial expressions, $F(2,108) = 9.00, p < 0.001$.

Post-hoc analysis indicated that compared to controls, BP patients were less accurate recognizing moderately sad ($p = 0.01$) and mildly/moderately happy (p 's < 0.01) facial expressions. BP patients interpreted moderately sad, $F(1,80) = 6.38, p = .13$, moderately happy, $F(1,80) = 8.83, p = .004$, and mildly happy $F(1,80) = 6.74, p = .01$, facial expressions as more intense than controls. For BP patients, mood symptom ratings were not significantly correlated with emotion recognition accuracy.

While acutely psychotic, SCZ patients demonstrated difficulty recognizing mild and moderately happy ($p < 0.02$) faces. These patients were more likely than controls to underestimate the intensity of the emotional expression and/or perceive the face as the opposite valence for both mild, $F(1,81) = 17.39, p < 0.001$, and moderately happy expressions, $F(1,84) = 14.65, p < .001$. SCZ patients' recognition of moderately happy faces was correlated with severity of positive symptoms on the PANSS ($r = .41, p = .03$).

At baseline, SCZ and BP did not significantly differ from each other on any emotion category. Effect sizes, however, indicated that BP patients during acute psychotic illness had somewhat greater difficulties than SCZ patients recognizing milder intensities of positive emotions (Figure 2). The same was true for milder negative emotions, except in the case of very sad facial expressions, where SCZ patients were somewhat less accurate than BP patients.

3.2. Follow-Up Assessment After Treatment of Acute Symptoms

Both patient groups achieved significant clinical benefit over the course of acute treatment (Table 1). Figure 1 (bottom) displays standardized emotion recognition accuracy for each group at the follow-up assessment. Patients with BP continued to have problems recognizing mild/moderately happy expressions (p 's < 0.01) after acute symptom treatment compared to controls. For BP patients at follow-up, emotion recognition accuracy was not significantly associated with mood state (depression/mania) or positive/negative symptom severity.

At follow-up, SCZ patients continued to have the difficulty recognizing moderately happy faces that they did at baseline ($p = 0.01$). Contrary to their initial bias to underestimate the intensity of this emotional expression, they showed a trend in rating happiness as more intense (Group $\times$ Emotion, $F(1,54) = 5.13$, $p = 0.06$). In addition, compared with controls, they were worse at recognizing mildly and moderately sad expressions at follow-up (p 's < 0.05). Whereas they underestimated emotional intensity when they misperceived mildly sad expressions (Group $\times$ Emotion, $F(1,54) = 6.26$, $p = 0.02$), they showed no systematic positive or negative bias when misperceiving moderately sad faces (Group $\times$ Emotion, $F(1,54) < 0.1$, $p = 1.0$). Difficulty recognizing mildly sad faces for SCZ patients at follow-up was associated with more severe negative symptoms ($r = -0.44$, $p = 0.04$).

On follow-up, SCZ and BP patients did not significantly differ from each other on any emotion category. Inspection of effect sizes after acute symptom treatment revealed that BP remained less accurate than SCZ in recognizing expressions of positive emotion (Figure 2). Additionally, SCZ patients showed somewhat more pervasive difficulties recognizing negative emotions than during acute illness, although these differences were not statistically significant.

After acute symptom treatment, higher doses of antipsychotic medications for SCZ patients were associated with greater difficulties in recognizing mildly sad ($r = -0.49$, $p = 0.01$) and neutral facial expressions ($r = -0.56$, $p < .01$). For BP patients, antipsychotic dosages were unrelated to accuracy of emotion judgments regardless of emotion category (all p 's > 0.16).

3.3 Changes from Acute Illness to Relative Clinical Stabilization

Between baseline and follow-up assessments, there were no significant improvements or decrements in emotion recognition accuracy (Time $\times$ Emotion, $F(1,69) = 2.81$, $p = 0.10$), no changes in accuracy for one group over another after acute treatment (Time $\times$ Group, $F(2,69) = 0.12$, $p = 0.89$), and no significant improvement for any one group for any specific emotion (Time $\times$ Group $\times$ Emotion, $F(12,130) = 0.49$, $p = 0.92$).

From acute illness to follow-up testing, examination of effect sizes across time suggested that SCZ patients became slightly worse on recognizing mildly/moderately sad expressions and also slightly improved on recognizing mildly/moderately happy expressions. For BP patients, slight improvements in recognizing mild/moderately happy and sad facial expressions were found, although they were not associated with resolving clinical symptoms (mania/depression or positive/negative symptoms).

3.4. Reaction Times

At baseline, both patient groups responded slower on trials than healthy controls (p 's < 0.01). After acute treatment, patients with BP ($p = 0.048$) but not SCZ ($p = 0.27$) continued to respond slower than controls. Collapsing across groups, RT's became faster between baseline and follow-up assessments, $F(1,69) = 17.14$, $p < 0.001$, although no group showed a greater decrease in RT at the second assessment (Time $\times$ Group, $F(2,69) = 2.92$, $p = 0.06$).

4. Discussion

The present study sought to clarify the state of facial emotion recognition deficits in psychotic BP and SCZ early in the course of illness, including their potential differences in severity across disorders, and their differential change after acute treatment. Patients were examined early in their course of illness when they were acutely ill and not yet receiving active treatment, and again after treatment with antipsychotic medication.

During acute psychotic illness, both patient groups showed difficulties recognizing positive emotions compared to healthy controls. Specifically, BP patients were less accurate than controls in recognizing mild and moderately happy expressions and SCZ patients had difficulty recognizing moderately happy expressions. In comparing the two disorders during acute illness, the patterns of effect size differences suggested that BP patients tended to show greater difficulty recognizing positive emotions, although these differences were not statistically significant. Conversely, patients with SCZ appeared to be less accurate recognizing intensely negative facial emotion but not milder intensities. Whereas both patient groups did not differ from healthy controls in recognizing neutral facial expressions, examination of effect sizes of differences from controls suggested that SCZ patients tended to be more accurate than those with BP.

Despite significant symptomatic improvements for both patient groups, no significant changes in emotion recognition were observed from acute psychotic illness to relative clinical stabilization, irrespective of emotional valence. When acute symptoms were treated, both BP and SCZ patients continued to have deficits recognizing positive emotions compared to healthy controls, although BP again tended to be less accurate based on inspection of the magnitude of effect sizes of their deficits. A bias for patients with BP to rate positive expressions as more intensely positive no longer appeared at follow-up. Additionally, difficulties emerged after treatment of acute symptoms for SCZ in recognizing mild and moderately sad faces, deficits which were not apparent during acute illness. During follow-up testing, SCZ patients showed a trend-level tendency to perceive moderately happy faces as more intensely positive, which was contrary to baseline assessments during which they underestimated the emotional intensity of these faces. These findings raise the possibility of secondary negative symptoms associated with antipsychotic medications (Artaloytia et al., 2006) that may have impacted emotion perception in SCZ after treatment of acute symptoms. This seems most plausible given that performance was worse after treatment for acute psychosis, but whether this might be a result of a greater susceptibility to such effects in SCZ or the higher treatment dosages remains a question for future work.

Antipsychotic medication dose was not associated with emotion recognition accuracy in BP; however, in SCZ, higher doses were correlated with poorer recognition of mildly sad and neutral facial expressions. Notably, this effect was observed when treatment dosing was relatively low. These findings are in line with the results of a meta-analysis which examined emotion recognition in SCZ and determined that higher medication doses were moderately correlated with a greater degree of emotion recognition deficits (Kohler et al., 2010). It is perhaps plausible that patients with more severe illness were prescribed higher dosages of antipsychotic medication during acute illness, and these patients may have been more likely to have greater deficits in emotion recognition because of their illness rather than its treatment. Treatment dosing was not related to pre-treatment illness severity, but such effects are still possible. A potential effect of dopamine blockade on hedonic tone (Berridge and Robinson, 1998) might be related to these effects.

Despite some changes after treatment, our overall pattern of findings suggest that psychotic BP and SCZ patients have reasonably consistent valence-specific deficits in facial emotion

recognition that persist in a trait-like fashion independent of acute illness. There has been an increased interest over recent years in comparing emotion recognition abilities in BP and SCZ, although few studies have directly examined whether these groups differ according to their recognition of positive versus negative emotional valences. Several previous studies observed that while both BP and SCZ patients may have deficits in emotion recognition, these deficits may be more pervasive (i.e., affecting a wider range of emotions) and severe in SCZ than in BP (Addington and Addington, 1998; Baez et al., 2013; Derntl et al., 2012; Lee et al., 2013; Rowland et al., 2013; Wynn et al., 2013). The few studies that differentially evaluated positive versus negative emotional valences in these patient groups, however, found isolated deficits in recognizing negative emotions in SCZ (Baez et al., 2013; Goghari and Sponheim, 2013), although emotion processing deficits in the two disorders may also share a common neurophysiological abnormality (Ibañez et al., in press). The results of the current study extend previous findings by showing that the difficulty identifying negative emotions in faces may extend to more subtle expressions of these emotions and that this difference might in part be treatment related. Additionally, given that most prior studies evaluated medicated and clinically stable patients with prolonged histories of psychotic illness, these findings are among the first to suggest that emotion recognition deficits in BP and SCZ are evident even at the first episode of psychotic illness, before chronic disability and persistent interpersonal problems or social isolation might themselves contribute to difficulty perceiving facial emotion cues accurately.

Although mood-state dependent biases in emotion perception are sometimes reported in acutely manic/hypomanic BP patients, no difficulty recognizing negative emotions, nor a heightened detection of positive emotions, was observed in the present study. Contrary to expectations, BP patients had difficulty recognizing milder intensities of positive emotional expressions and were not more likely than controls to misperceive these emotions as more intensely positive. These results run counter to studies which suggest that acutely ill BP patients may show enhanced recognition of happy facial expressions and poorer recognition of sad expressions (Lembke and Ketter, 2002; Lennox et al., 2004), although studies have not consistently reported this finding (Rocca et al., 2009). Additionally, manic/hypomanic symptoms were not significantly related to either positive or negative emotion recognition accuracy for BP patients during acute illness or relative clinical stabilization. Negative symptoms, however, were related to less accurate detection of sad expressions at baseline and follow-up assessment for SCZ, which is consistent with previous findings (Kohler et al., 2010), and shows that such a relationship exists even early in the course of psychotic illness.

These findings confirm and extend prior cross-sectional studies of acutely ill and clinically stabilized pediatric BP patients which showed similar findings suggestive of trait-like deficits in emotion recognition (Schenkel et al., 2007). Whereas acute psychosis and mood symptoms may be effectively treated by antipsychotic medications, it appears that emotion processing deficits may endure beyond acute illness through to periods of relative clinical stability. This is an especially important observation in the BP group, where emotion processing deficits were not only most pronounced (i.e., evident on positive and perhaps neutral expressions), but also persisted despite a marked reduction in mood symptom severity following treatment of acute symptoms. These results are consistent with previous studies showing an absence of significant improvements in emotion recognition for BP (without a history of psychosis) treated with mood-stabilizing medications (Haldane et al., 2008; Jogia et al., 2008) and other work which found no differences in emotion recognition for BP patients taking antipsychotic versus mood-stabilizing medications (Derntl et al., 2009). Together, available findings suggest that emotion processing deficits in BP persist despite considerable change in mood state, suggesting a trait-like deficit in emotion recognition that may not improve with acute pharmacologic treatment and relative clinical stabilization.

Certain limitations should be considered as they relate to interpreting the findings of the present study. First, whereas facial emotion recognition deficits showed no improvement after recovery from an acute episode of illness, it is possible that other forms of emotion processing may change in relation to state of illness and be responsive to pharmacologic treatments. Further studies across a range of dimensions of affective function (e.g., emotion reactivity, recognition of affective prosody) are needed to fully characterize the state and trait aspects of deficits in this broad domain. Second, while the use of first episode patients with psychotic illness is important in indicating that deficits are present early in the course of illness, whether deficits in this domain evolve differently in SCZ and BP remains to be determined. It is important for research to evaluate differences between SCZ and BP later in adulthood to evaluate potential changes in this domain of deficit over the course of illness. Third, the possible effects of non-antipsychotic drugs and prior psychotropic drug use on emotion information processing in these disorders should be clarified in subsequent research. Fourth, the affective changes seen in BP with a history of psychosis should be further examined to determine whether these extend to BP patients with no history of psychosis. Finally, preliminary findings suggest that SCZ and BP patients may show differential emotional responses to faces versus other images or words (Aminoff et al., 2011; Ibañez et al., 2012; Pan et al., 2013). It will be essential to determine the specificity of the current findings to facial expressions as compared to other emotional visual stimuli.

In summary, this is the first study to compare emotion recognition deficits in SCZ and BP during acute psychotic illness and after treatment of acute symptoms with antipsychotic medication. Both patient groups showed trait-like deficits in emotion recognition that persisted relatively independent of mood state, with SCZ showing more consistent deficits recognizing negative emotions, and BP having somewhat more difficulty recognizing positive emotions. Whereas the contributions of mood-state and symptom related effects on emotion perception were not supported in BP, negative symptoms were associated with more severe deficits recognizing neutral and positive expressions in SCZ. Together, these findings suggest that valence-specific deficits in emotion recognition for patients SCZ and BP may exist early in the course of psychotic illness and persist despite acute symptom resolution.

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Figure 1.

Emotion recognition accuracy for first-episode patients with schizophrenia, psychotic bipolar disorder and healthy controls, during a phase of acute psychotic illness (top) and after treatment of acute symptoms (bottom).

Note: Data are z-transformed relative to the healthy control group.

Figure 2.

Effect size of differences between patients with schizophrenia and psychotic bipolar disorder in emotion recognition accuracy during acute psychotic illness (blue) and after treatment of acute symptoms (green).

Note: Positive values reflect greater emotion recognition accuracy for patients with schizophrenia compared to bipolar disorder. Negative values reflect greater accuracy for patients with bipolar disorder compared to schizophrenia.

Demographic and illness-related characteristics of healthy controls, patients with schizophrenia, and patients with psychotic bipolar disorder.

Table 1

	HC (n = 32)	SCZ (n = 24)	BP (n = 16)	Test Statistic	p	Post-hoc-test
Age (years)	25.78 (6.81)	22.58 (5.69)	23.63 (6.27)	$F = 1.84$	0.17	
Male: Female	11:21	19:5	9:7	$\chi^2 = 11.1$	<0.01	
WASI Full-Scale IQ	102.66 (12.12)	90.67 (17.43)	99.31 (17.11)	$F = 4.36$	0.02	SCZ < HC
WRAT-3	99.34(9.85)	93.00 (13.72)	92.56 (14.04)	$F = 2.52$	0.09	
Race						
White (non-Hispanic)	13	3	3			
Black (non-Hispanic)	15	15	9			
Asian-Pacific Islander	1	1	2			
Hispanic	2	4	2			
Other	1	1	0			
PANSS Positive						
Baseline		22.25 (4.20)	24.50 (4.55)	$F = 2.58$	0.18	
Follow-up		15.61 (5.12)	17.94 (5.27)	$F = 1.90$	0.18	
% Change		-29.84%	-26.67%			
PANSS Negative						
Baseline		19.17 (5.44)	10.88 (3.61)	$F = 28.6$	<0.001	SCZ > BP
Follow-up		15.52 (5.96)	10.50 (2.50)	$F = 10.1$	<0.01	SCZ > BP
% Change		-19.04%	-3.49%			
HDRS						
Baseline		25.88 (9.90)	28.50 (7.95)	$F = .78$	0.38	
Follow-up		14.70 (8.17)	15.75 (6.85)	$F = .18$	0.68	
% Change		-42.20%	-44.74%			
YMRS						
Baseline		12.00 (5.96)	28.20 (11.11)	$F = 16.5$	<0.001	BP > SCZ
Follow-up		8.00 (6.03)	15.11 (9.84)	$F = 5.77$	0.03	BP > SCZ
% Change		-33.33%	-46.42%			

Note: Data are presented for patients and controls with data for baseline and follow-up assessments. HC = Healthy Control; SCZ = Schizophrenia; BP = Bipolar Disorder I with Psychosis; WASI = Wechsler Abbreviated Scale of Intelligence; WRAT-3 = Wide Range Achievement Test-3; PANSS = Positive and Negative Syndrome Scale; HDRS = Hamilton Depression Rating Scale; YMRS = Young Mania Rating Scale.