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More Pronounced Deficits in Facial Emotion Recognition for Schizophrenia than Bipolar Disorder

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Abstract

Schizophrenia and bipolar disorder are typically separated in diagnostic systems. Behavioural, cognitive, and brain abnormalities associated with each disorder nonetheless overlap. We evaluated the diagnostic specificity of facial emotion recognition deficits in schizophrenia and bipolar disorder to determine whether select aspects of emotion recognition differed for the two disorders. The investigation used an experimental task that included the same facial images in an emotion recognition condition and an age recognition condition (to control for processes associated with general face recognition) in 27 schizophrenia patients, 16 bipolar I patients, and 30 controls. Schizophrenia and bipolar patients exhibited both shared and distinct aspects of facial emotion recognition deficits. Schizophrenia patients had deficits in recognizing angry facial expressions compared to healthy controls and bipolar patients. Compared to control participants, both schizophrenia and bipolar patients were more likely to mislabel facial expressions of anger as fear. Given that schizophrenia patients exhibited a deficit in emotion recognition for angry faces, which did not appear due to generalized perceptual and cognitive dysfunction, improving recognition of threat-related expression may be an important intervention target to improve social functioning in schizophrenia.

Schizophrenia and bipolar disorder are typically separated in diagnostic systems; however, there is considerable overlap between the two disorders with regard to symptoms, cognitive deficits, and brain abnormalities. Although cognitive deficits are not a part of the diagnostic criteria, these impairments are a prominent component in both disorders. Cognitive deficits are associated with worse real world functioning in both disorders [1] and facial emotion recognition deficits specifically are associated with worse social and work attainment [2–3]. Further delineation of facial emotion recognition deficits may be important to better understand real world functioning and potential rehabilitation of patients. The present study contrasted facial emotion recognition deficits in schizophrenia and bipolar disorder to determine what aspects of facial emotion recognition are aberrant in each disorder. A better understanding of facial emotional recognition deficits in the two severe mental disorders might assist with diagnostic clarification, as well as inform treatment development and selection.

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Facial emotion recognition deficits have been well documented in schizophrenia. Schizophrenia patients - first-episode, chronic, and putatively prodromal - have all been found to have difficulty recognizing basic facial emotions such as happiness, sadness, anger, and fear [4–6]. Two recent meta-analyses demonstrated large effect sizes (-0.70 to -0.91 *d*) for deficits in schizophrenia patients compared to controls for emotion recognition ability [7–8]. A number of studies have found behavioural deficits in unaffected adult relatives, further supporting the idea that the abnormality may mark genetic liability for the disorder [9–11]; however, this has not been a wholly consistent finding [e.g., 6], likely reflecting the heterogeneity amongst relative samples investigated. There is also still debate as to whether poor facial emotion recognition is a specific deficit [e.g., 5, 6] or part of generalized cognitive dysfunction [e.g., 12, 13] in schizophrenia, with evidence supporting both sides.

Like schizophrenia patients, bipolar patients have also been shown to demonstrate differences in facial emotion recognition compared to controls. Manic bipolar I patients have been found to have worse overall performance, specifically for the negative expressions, fear and disgust [14]. However, in the same study, euthymic bipolar II patients demonstrated enhanced fear recognition compared to manic and euthymic bipolar I patients [14]. A study of stable bipolar I patients also found that patients had more difficulty with all expressions combined compared to controls and specifically with misinterpreting expressions of sadness as fear [15]. In this study bipolar II did not differ from controls. Alternatively, a study found euthymic bipolar patients had enhanced recognition of disgust [16] and a study in euthymic bipolar I and II patients found no differences for any emotion compared to controls [17]. Furthermore, bipolar I and II depressed patients have been found to need to visualize more intense facial expressions before being able to first respond and correctly respond compared to controls [18]. Additionally, bipolar depressed patients were more able to recognize disgust expressions compared to unipolar depressed patients and controls. Last, at least one study has suggested that abnormal emotion recognition in manic or mixed bipolar disorder may be due to a specific deficit in processing facial emotions [19]. In summary, emotion processing deficits in bipolar disorder may be strongly influenced by mood state and bipolar type I or II; however, even stable bipolar patients have demonstrated impairments in facial emotion recognition, some of which appear selective for particular expressions [for review see 20].

Studies comparing schizophrenia and bipolar patients have revealed inconsistent findings. For example, Addington and Addington (1998) found that schizophrenia patients had impaired performance on an emotion recognition, emotion matching, and general facial recognition task, but bipolar patients only had difficulty on the emotion matching task compared to controls [21]. In contrast, Vaskinn and colleagues (2007) found that neither group showed deficits in facial emotion recognition (though schizophrenia patients showed differences compared to controls in auditory emotion perception) [22]. Nevertheless, studies comparing schizophrenia and bipolar patients generally find that schizophrenia patients have greater and more widespread deficits in facial emotion recognition [for review see 20].

Given the diversity of results, the present study aimed to determine the pattern of facial emotion recognition impairments in stable schizophrenia patients, bipolar I patients, and healthy controls. The work also tested for associations of facial emotion recognition with symptoms and intelligence functioning. The same face stimuli were used across a facial emotion recognition condition and an age recognition condition (used to control for processes associated with general facial recognition); therefore, the task controlled for physical aspects of stimuli that could impact performance. We hypothesized that schizophrenia patients would demonstrate more widespread deficits in facial emotion recognition compared to bipolar patients and that schizophrenia patients would demonstrate

a deficit in facial emotion recognition as compared to more general facial recognition processes.

METHODS

Participants

Schizophrenia and bipolar I disorder subjects were recruited from the Minneapolis VA Medical Center outpatient clinics and community support programs for the mentally ill. Controls were recruited by posting announcements in the community. Participants were excluded if English was their second language, had mental retardation, current alcohol abuse, current drug abuse/dependence, past drug dependence within the last six months (with the exception of cannabis), a current or past central nervous system condition, history of head injury with skull fracture or loss of consciousness (over 30 minutes), and an age less than 18 or greater than 60. Controls were additionally excluded for a current major depressive episode, current or previous use of antipsychotic medications, or a personal or family history of psychosis or bipolar disorder. The Minneapolis VA Medical Center and University of Minnesota Institution Review Boards approved the protocol and all participants provided informed, written consent.

Diagnosis and Assessment

To obtain diagnostic information the Structured Clinical Interview for DSM-IV Disorders [23] and the Psychosis Module of the Diagnostic Interview for Genetic Studies [24] were completed with each participant. DSM-IV-TR diagnoses were determined after review of clinical interview materials by a trained research assistant or doctoral-level clinical psychologist. Patients' current symptomatology was assessed using the Scale for the Assessment of Negative Symptoms [SANS; 25] and the Scale for the Assessment of Positive Symptoms [SAPS; 26]. Three symptom dimensions for the SANS and SAPS, psychosis, formal thought disorder, and negative, were computed using Andreasen and colleagues' (1995) factor structure as a guide [27]. All participants had their overall symptomatology assessed using the Brief Psychiatric Rating Scale [BPRS; 28]. Average scores for five BPRS factors, thinking disorder, withdrawal, anxiety-depression, hostility-suspicion, and activity, were computed using Burger and colleagues' (1997) factor structure derived from a large sample of schizophrenia and bipolar patients [29]. Clinical information is presented in Table 1.

We specifically investigated the BPRS depression and elevated mood items in the bipolar I patients as a measure of their current mood state. Bipolar I patients as a group were mildly depressed (Mean=3.38, SD=2.03; on a scale of 1–7, with lower numbers indicating less psychopathology); however, 44% of the sample reported moderate or greater depression. Additionally bipolar I patients as a group demonstrated minimal elevated mood (Mean=1.31, SD=0.60), with no participants reporting moderate or greater elevated mood.

Additionally, all participants completed select subtests of the Wechsler Adult Intelligence Scale-III (WAIS-III): block design, digit span forward and backward, digit symbol coding, and vocabulary.

Facial Recognition Task

The facial recognition task consisted of two conditions - an emotion recognition condition and age recognition control condition. The Pennsylvania emotive faces were used and detailed image construction and validation has been reported elsewhere [30]. Each condition consisted of 60 faces and the *same faces* were presented in both conditions. Half of all the depicted faces represented each gender. Four races were represented in the images:

Caucasian (42 faces), African-American (12 faces), Asian (4 faces), and Hispanic (4 faces). In the emotion recognition condition, participants were presented with a face and asked to respond with a button press corresponding to the emotion expression from five possibilities: anger, fear, happy, neutral, and sad. Each face was presented until the participant responded. There were 10 faces in each emotion category and 20 neutral faces. In the age recognition condition, participants were asked to respond with a button press corresponding to what they judged to be the approximate age of the face from five age-range possibilities (Teens-25, 26-35, 36-45, 46-55, 56-Over). There were 12 faces in each age category. The age recognition condition was used as a comparison condition to control for aspects of facial perception, as well as task engagement, attention, and response selection demands. Conditions were presented sequentially with the emotion recognition condition presented first. Faces were chosen in random order within the task.

Statistical Analyses

From the facial recognition task we analyzed three dependent measures, accuracy (% correct), reaction time of responses (ms), and misattribution of emotion for incorrect responses (count). For all incorrect responses we calculated for each of the five emotions the number of times another specific emotion was misattributed (e.g., how many times an anger face was incorrectly labeled as fear). For the intelligence functioning we analyzed the raw values from the five WAIS-III measures rather than normed values as data was collected on a control group with the same recruitment criteria.

Given that the same faces were used in both conditions, we were able to compare emotion and age recognition performance for the same facial expressions using a 2 recognition condition (emotion, age) $\times$ 5 expression (anger, fear, happy, neutral, sad) $\times$ group mixed-model analyses of variance (ANOVAs) with behavioural accuracy and reaction time as dependent variables to test for overall group differences and test for specific hypotheses for between group differences. Significant effects from the mixed-model ANOVAs were followed up with ANOVAs to assess how groups differed within recognition and facial expression conditions. ANOVAs were used to compare the misattributions of emotions and intellectual functioning data. Greenhouse-Geisser correction was reported for all mixed-model ANOVA statistics. Partial eta-squared effect sizes (η^2) from SPSS were provided as appropriate. Spearman's rho was used for all correlations as it is more robust to violations of parametric assumptions.

RESULTS

Participants

Participant characteristics are presented in Table 1. The three groups differed in age ($F(2, 70)=5.93, p=0.004$), with post-hocs demonstrating schizophrenia patients were younger than controls ($p=0.001$) and bipolar patients ($p=0.04$). There were no significant differences for sex distribution ($\text{Chi-square}(2)=3.06, p=0.22$) or education ($F(2, 61)=0.42, p=0.66$). Although there were some associations of age and sex with task behavioral measures, none were of the nature that would negate group differences in emotion recognition.¹ Both patient

¹In schizophrenia patients, there were no associations between participant age and accuracy in any of the emotion or age recognition conditions. In bipolar patients, greater participant age was associated with lower accuracy when judging the emotion as neutral ($\rho=-0.52, p=0.04$). In controls, greater participant age was associated with lower accuracy when judging the emotion as fear ($\rho=-0.47, p=0.009$) and happy ($\rho=-0.41, p=0.02$). There were associations with greater participant age and greater reaction times when judging the emotion as neutral in schizophrenia patients ($\rho=0.40, p=0.04$) and controls ($\rho=0.46, p=0.01$). In controls, longer reaction times for age recognition during anger expressions were associated with greater age ($\rho=0.37, p=0.04$). There was no main effect of sex or sex by group interaction for any of the age or emotion recognition conditions for accuracy. For reaction times, there was a main effect of sex on emotion recognition of anger, fear, and sad expressions (p 's=0.02-0.05), with females being faster; however, no sex by group interactions on any emotion or age recognition conditions were present.

groups consisted of stable outpatients. As expected, schizophrenia patients had more positive, negative, and disorganization symptoms than bipolar patients and bipolar patients had more mood symptoms than schizophrenia patients. The percentage of patients on antipsychotics, antidepressants, mood stabilizers, antianxiety, antiparkinsons, and other psychotropic medications is presented in Table 1. Specifically, five bipolar I patients were on lithium and ten bipolar I patients were on anticonvulsants. Some patients were on more than one medication.

Facial Recognition Conditions Accuracy

Table 2 presents mean accuracy data for the five facial expressions and two recognition conditions. Overall group differences in emotion and age recognition performance for the same facial expressions were assessed using a 2 recognition condition (emotion, age) $\times$ 5 expression (anger, fear, happy, neutral, sad) $\times$ 3 group (schizophrenia, bipolar, control) mixed-model analysis of variance (ANOVAs) with behavioural accuracy as dependent variables. This analysis revealed a main effect of group ($F(2, 70)=3.10$, $p=0.05$), with schizophrenia patients generally performing worse than controls and bipolar patients ($p's=0.04$). A main effect of recognition condition was also found ($F(1, 70)=573.80$, $p<0.001$), demonstrating that the age recognition condition was more difficult than the emotion recognition condition. Last, a main effect of emotion expression was found ($F(3.31, 231.73)=39.04$, $p<0.001$), demonstrating that anger expressions were more easily identified than fear expressions; happy expressions were more easily identified than all other expressions; neutral expressions were more easily identified than anger and fear expressions; and sad expressions were more easily identified than anger and fear expressions. There was also a significant interaction between the recognition condition and emotion expression ($F(3.51, 249.59)=24.45$, $p<0.001$), reflecting that it was easier to identify the emotional expression of the face compared to the age of the face, with this pattern being more pronounced for some emotions. Last, a trend wise significance was found for the recognition condition by emotion expression by group interaction ($F(7.02, 245.59)=1.85$, $p=0.08$, $\eta^2=0.05$).

To explore the trend wise significant three way interaction and to test specific hypotheses about differences between the three groups, we conducted three 2 recognition condition $\times$ 5 expression $\times$ 2 group (schizophrenia versus control, bipolar versus control, or schizophrenia versus bipolar) mixed-model analyses of variance (ANOVAs) with behavioural accuracy as dependent variables.

Schizophrenia versus Control—To determine whether schizophrenia patients demonstrated a deficit in facial emotion recognition as compared to age recognition, and whether the emotion recognition deficit depended on the facial expression presented, we carried out a mixed-model ANOVA on response accuracy with group (schizophrenia, control) as a between subjects factor and recognition condition (emotion, age) and facial expression (anger, fear, happy, neutral, sad) as within subjects factors. The contrast yielded a main effect of group ($F(1, 55)=3.92$, $p=0.05$), with schizophrenia patients (Mean=60%, SD=15) generally performing worse than controls (Mean=64%, SD=15). There was also a main effect of recognition condition ($F(1, 55)=435.02$, $p<0.001$), with the age recognition condition (Mean=46%, SD=6) being more difficult than the emotion recognition condition (Mean=78%, SD=15). The ANOVA also revealed a main effect of facial expression ($F(3.30, 181.46)=30.20$, $p<0.001$), demonstrating that happy expressions were more easily identified than anger, fear, and neutral expressions; neutral expressions were more easily identified than anger and fear expressions; and sad expressions were more easily identified than anger and fear expressions. Additionally, an interaction between the recognition condition and facial expression was found ($F(3.60, 197.90)=18.72$, $p<0.001$), reflecting that it was easier

to identify the emotional expression of the face compared to the age of the face, with this pattern being more pronounced for some emotions. Importantly, there was the hypothesized three-way group by recognition condition by facial expression interaction ($F(3.60, 197.90)=3.22, p=0.02, \eta^2=0.06$) indicating that group differences between schizophrenia patients and controls varied depending on whether the participants needed to make an age or emotion judgment and the type of facial expression.

To more fully understand which facial expressions resulted in the greatest emotion recognition deficits in schizophrenia, separate ANOVAs with factors of recognition condition (emotion, age) and group were conducted on accuracy data for each of the five facial expressions. For the anger expression, there was a significant interaction between recognition condition and group (see Figure 1; $F(1, 55)=10.76, p=0.002, \eta^2=0.16$). Schizophrenia patients had reduced accuracy compared to controls when judging the facial emotion as an anger expression ($F(1, 55)=10.06, p=0.002, \eta^2=0.16$), but did not differ when judging the age of faces with an anger expression ($F(1, 55)=0.42, p=0.52, \eta^2=0.007$). No other recognition condition by group interactions were found for specific facial expressions (happy, fear, sad, neutral) between schizophrenia patients and controls, hence, no follow-up testing was conducted.

Bipolar versus Control—An ANOVA on response accuracy with group (bipolar, control) as a between subjects factor and recognition condition (emotion, age) and facial expression (anger, fear, happy, neutral, sad) as within subjects factors demonstrated no main effect of group ($F(1, 44)=0.21, p=0.65$). However, there was a main effect of recognition condition ($F(1, 44)=538.38, p<0.001$), with the age recognition condition (Mean=48%, SD=6) being more difficult than the emotion recognition condition (Mean=81%, SD=7). In addition, there was a main effect of facial expression ($F(2.88, 126.69)=24.08, p<0.001$), demonstrating that anger expressions were more easily identified than fear expressions; happy expressions were more easily identified than anger, fear, and neutral expressions; neutral expressions were more easily identified than fear expressions; and sad expressions were more easily identified than anger and fear expressions. Last there was an interaction between recognition condition and facial expression ($F(3.23, 142.10)=15.61, p<0.001$), reflecting that it was easier to identify the emotional expression of the face compared to the age of the face, with this pattern being more pronounced for some emotions. The three-way interaction of group by recognition condition by facial expression was absent ($F(3.23, 142.10)=1.00, p=0.40, \eta^2=0.02$), providing evidence that the content of the facial expression failed to differentially affect emotion recognition in bipolar patients as it did with schizophrenia patients.

We specifically investigated the pattern of response to the angry expression in bipolar patients compared to controls to compare with the results in schizophrenia patients. There was a significant interaction between recognition condition and group when contrasting bipolar patients and controls for faces with an anger expression ($F(1, 44)=5.82, p=0.02, \eta^2=0.12$). Bipolar patients were significantly better when judging age from an anger expression compared to controls ($F(1, 44)=5.48, p=0.02, \eta^2=0.11$), but not when judging the emotion as an anger expression ($F(1, 44)=0.43, p=0.51, \eta^2=0.01$).

Schizophrenia versus Bipolar—A third ANOVA on response accuracy with group (schizophrenia, bipolar) as a between subjects factor and recognition condition (emotion, age) and facial expression (anger, fear, happy, neutral, sad) as within subjects factors demonstrated no main effect of group ($F(1, 41)=3.21, p=0.08$). However, similar to the previous results, a main effect of recognition condition was present ($F(1, 41)=254.92, p<0.001$), with the age recognition condition (Mean=47%, SD=6) being more difficult than the emotion recognition condition (Mean=78%, SD=14). A main effect of facial expression

was also revealed ($F(3.40, 139.52)=26.39, p<0.001$), demonstrating that anger expressions were more easily identified than fear expressions; happy expressions were more easily identified than anger, fear, and neutral expressions; neutral expressions were more easily identified than anger and fear expressions; and sad expressions were more easily identified than anger and fear expressions. There was also an interaction between recognition condition and facial expression ($F(3.26, 133.65)=16.69, p<0.001$), reflecting that it was easier to identify the emotional expression of the face compared to the age of the face, with this pattern being more pronounced for some emotions. This direct contrast of schizophrenia and bipolar patients failed to reveal a three-way interaction of group, recognition condition, and facial expression ($F(3.26, 133.65)=0.80, p=0.51, \eta^2=0.02$) consistent with the facial recognition performance of bipolar patients falling between the schizophrenia patients and control subjects.

To compare the results in schizophrenia patients and controls within the angry expression, we specifically investigated the pattern directly contrasting schizophrenia and bipolar patients. Although there was no significant interaction between recognition and group for bipolar patients compared to schizophrenia patients ($F(1, 41)=1.09, p=0.30, \eta^2=0.03$), bipolar patients were better than schizophrenia patients in recognizing anger expressions ($F(1, 41)=3.92, p=0.054, \eta^2=0.09$). The two groups did not differ when judging age from the anger expressions ($F(1, 41)=2.94, p=0.09, \eta^2=0.07$).

Misidentification of Emotional Expressions

For the anger emotion recognition accuracy further analyses were conducted to determine patterns of misattribution. Schizophrenia patients mislabeled anger expressions as fear ($F(1, 55)=13.50, p=0.001, \eta^2=0.20$) and happy ($F(1, 55)=3.91, p=0.053, \eta^2=0.07$) more often than controls (see Figure 2). As discussed above, bipolar patients did not differ significantly from controls in correctly identifying anger expressions. However, bipolar patients also mislabeled more anger expressions as fear ($F(1, 44)=4.44, p=0.04, \eta^2=0.09$) compared to controls, similar to the pattern found in schizophrenia patients. There were no significant differences in misattribution of expressions to specific emotions when schizophrenia patients were compared to bipolar patients ($F's=0.13-2.45, p's=0.13-0.72$).

Further Analysis of Age Recognition Task

Given the lower accuracy rate on the age recognition task across groups (however, much greater than chance performance, which was 20%), further analysis was conducted to determine how many categories off the participants' responses were in cases of error. This was an alternative measure to assess for differences in basic facial recognition as it may be more sensitive to group differences as this was a more nuanced measure of error – indicating not just that there was an error in judging the age, but how large the error was. In cases of error, on average, the groups were approximately only one bracket off when discriminating the age of the faces (see Table 2; $F's=0.27-2.73, p's=0.11-0.61$). In summary, two measures of age recognition performance, accuracy and bracket's off, suggest that the groups do not differ on basic facial recognition.

Facial Recognition Conditions: Reaction Times

Three 2 recognition condition (emotion, age) by 5 expressions (anger, fear, happy, neutral, sad) by 2 group mixed-model ANOVAs demonstrated a recognition condition by group interaction in the bipolar versus control ($F(1, 44)=3.99, p=0.05, \eta^2=0.08$) and bipolar versus schizophrenia ($F(1, 41)=8.29, p=0.06, \eta^2=0.17$) comparisons, revealing that bipolar patients spent more time on the emotion recognition than age condition, whereas controls and schizophrenia patients did not demonstrate this pattern. There were no three way interactions

when comparing the groups ($F's < 1.08$, $p's > 0.36$); hence, no follow-up testing was conducted.

Intellectual Functioning²

As a comparison to the groups' performance on the facial recognition task, we also examined participants' overall cognitive functioning using select WAIS-III subtests. Schizophrenia patients had lower raw scores on the vocabulary subtest than controls ($F(1, 53) = 25.58$, $p < 0.001$, $\eta^2 = 0.33$) and bipolar patients ($F(1, 39) = 4.84$, $p = 0.03$, $\eta^2 = 0.11$), whereas bipolar patients and controls did not differ ($F(1, 44) = 2.61$, $p = 0.11$, $\eta^2 = 0.06$). Both schizophrenia ($F(1, 35) = 9.40$, $p = 0.004$, $\eta^2 = 0.21$) and bipolar ($F(1, 33) = 19.89$, $p < 0.001$, $\eta^2 = 0.38$) patients had lower digit symbol coding raw scores compared to controls, whereas schizophrenia patients and bipolar patients did not differ ($F(1, 28) = 0.59$, $p = 0.45$, $\eta^2 = 0.02$). Schizophrenia patients had lower raw scores on block design ($F(1, 53) = 6.27$, $p = 0.02$, $\eta^2 = 0.11$) and digit span backward ($F(1, 35) = 4.71$, $p = 0.04$, $\eta^2 = 0.12$) than controls whereas bipolar patients did not differ from controls ($F's = 0.27 - 0.87$, $p's = 0.61 - 0.77$) or schizophrenia patients ($F's = 2.06 - 2.53$, $p's = 0.12 - 0.16$). No groups differed on Digit Span Forward ($F's < 0.001 - 1.61$, $p's = 0.21 - 0.98$). In summary, we found schizophrenia patients had lower scores on the vocabulary subtest compared to controls and bipolar patients and lower digit symbol coding, block design, and digit span backward compared to only controls. Bipolar patients had lower digit symbol coding scores compared to controls. These results suggest that schizophrenia patients also had more severe impairments in general cognitive domains compared to bipolar patients.

Relationship between Emotion Recognition Accuracy and Intellectual Functioning and Symptomatology

To more fully detail the relationship between facial emotion recognition, cognition, and behaviour, we evaluated the relationship between emotion and age recognition accuracy for the anger expression with WAIS subtests and symptoms. There were no significant relationships between emotion or age recognition and the five WAIS subtests in bipolar patients ($p's > 0.14$) or controls ($p's > 0.20$). In schizophrenia patients the only association found between WAIS subtests and anger recognition was that higher vocabulary raw scores were related to correct emotion recognition of anger expressions ($\rho = 0.43$, $p = 0.03$). Given the lack of significant associations between most of the intelligence measures and recognition of anger expressions in schizophrenia, further support is provided that the deficit in emotion processing appears to not be due to generalized perceptual or cognitive impairment.

There were no significant relationships between emotion and age recognition for anger expressions with psychosis, negative, and formal thought disorder symptom dimensions from the SANS and SAPS in schizophrenia ($p's > 0.07$) or bipolar patients ($p's > 0.18$). Additionally there were no relationships between the five factors from the BPRS and anger recognition accuracy in schizophrenia ($p's > 0.22$) or bipolar patients ($p's > 0.16$). This suggests that at least in this sample, there were no relationships between difficulties in identifying angry expressions and the observable symptoms of schizophrenia.

²Vocabulary and block design scores were missing for 2 schizophrenia patients. For Digit Symbol scores were available for 16 schizophrenia patients, 14 bipolar patients, and 21 controls. For Digit Span Forward and Backward scores were available for 16 schizophrenia patients, 15 bipolar patients, and 21 controls.

DISCUSSION

Schizophrenia and bipolar disorder exhibit similarities in symptom expression, cognitive deficits, and brain abnormalities; however, the pattern and severity of shared abnormalities can differ between the two disorders. The aim of this paper was to determine what aspects of facial emotion recognition are impaired in stable patients in each of the disorders using a novel emotion recognition task that compares emotion processing with more general facial processing. Similar to previous investigations and meta-analyses, schizophrenia patients showed deficits in facial emotion recognition [7–8]. Schizophrenia patients were found to have reduced accuracy in discriminating anger expressions compared to controls. In addition, when making errors in categorizing a facial expression as anger, schizophrenia patients misidentified the expression as fear and happy. The present findings are evidence that individuals with schizophrenia may have a particular deficit in recognizing negative emotions [e.g., 31]. Additionally, schizophrenia patients' difficulty recognizing anger emotions appears not to be due to generalized difficulties with face perception since no deficit was evident on a harder age recognition condition. However, because the emotion recognition and age recognition conditions did not necessarily have the same discriminability, there is not unequivocal evidence of a specific deficit.

In contrast to schizophrenia patients, bipolar patients did not demonstrate any differences compared to controls in overall recognition of anger expressions, yet, like schizophrenia patients, bipolar patients tended to misattribute anger expressions to fear. Two other studies have suggested fear recognition might be impaired in bipolar disorder. Lembke and Ketter (2002) found manic bipolar I patients mistook expressions of fear for surprise [14]. The patients studied by Lembke and Ketter (2002) also showed worse recognition of fear than the healthy subjects. The ability to identify fear expressions in the above study also depended on bipolar type and phase, with euthymic bipolar II disorder patients showing more accurate fear recognition than the manic and euthymic bipolar I disorder patients [14]. In the second study, Derntl and colleagues (2009) found that stable bipolar I patients misinterpreted the expression of sadness as fear [15]. Together these studies suggest that individuals with bipolar disorder may have a specific difficulty with correct recognition of fear. In contrast to this study, other studies have demonstrated abnormalities in emotion recognition across many facial expressions for bipolar disorder [e.g., 19], as well as no differences from controls in some instances [e.g., 17].

Comparison of schizophrenia with bipolar patients revealed schizophrenia patients had more difficulty recognizing anger expressions compared to bipolar patients. Although both groups misidentified fear as anger expressions, schizophrenia patients had additional deficits in emotion recognition as suggested by the previous literature [for review see 20]. Greater facial emotion recognition deficits in schizophrenia patients compared to bipolar patients found in this study may be a reflection of greater degree of brain abnormalities in regions associated with facial emotion recognition, such as in the amygdala and hippocampus, in schizophrenia patients [32–33].

Schizophrenia patients also demonstrated more impairment on intelligence sub-domains than bipolar patients and controls, but bipolar patients did demonstrate impairments on digit symbol coding. Therefore, the lack of greater facial emotion recognition deficits in bipolar patients does not reflect a sample-specific issue of a very healthy bipolar sample without any impairment.

Last, we found bipolar patients took more time evaluating faces in the emotion recognition condition as opposed to the age recognition condition compared to schizophrenia patients and controls. One explanation for bipolar patients' longer reaction times could be the

psychomotor slowing associated with lithium or anticonvulsant medications many patients were on [34–36]. Alternatively, this finding of better performance and longer response times may indicate better strategy on the part of the bipolar patients (as they were compared to schizophrenia patients who were also on psychoactive medications). This finding may have clinical implications for treatment development in schizophrenia as it suggests that schizophrenia patients may have a different strategy when viewing faces compared to bipolar patients, which may result in lower accuracy. Currently, specific training on facial emotion recognition has been found to be effective in remediating facial emotion recognition deficits compared to both treatment as usual and cognitive remediation training in schizophrenia [37]. Given that facial emotion recognition is associated with lower work functioning in schizophrenia patients [e.g., 3], research in this area could lead to reducing the human and economic burden of the disorder.

Limitations of this study include the modest sample size, particularly in the bipolar group. This could have resulted in reduced power to detect group differences. However, analysis of effect size, which provides an estimate of magnitude of differences between groups, suggested that the effect size for the 2 recognition condition by 5 emotion expression by 3 group interaction was small for the bipolar patients compared to controls. Another limitation of this study was the differing age distributions between samples; however, tests indicated that these differences between groups failed to account for important group effects. Additionally, the patient groups were not equated for psychiatric symptoms; as expected schizophrenia patients had more positive, negative, and disorganization symptoms and bipolar patients had more mood symptoms. We tested the association between symptoms and facial emotion recognition within the groups and found no significant relationships; therefore, differences in symptoms are unlikely to account for group differences. This study evaluated five major facial emotion expressions; however, a fuller range of emotions, including disgust and surprise, could provide additional insight into expression-specific aspects of face processing. Last, although results are consistent with a specific deficit in facial emotion recognition, the present data are not absolutely conclusive due to the two tasks not being matched on discriminatory power. In an attempt to enhance the discriminatory power of the age recognition task we investigated the number of age brackets (decades) participants were off when making errors in age judgment. There were no differences between groups in the size of the errors made in age recognition, suggesting that groups did not differ in basic facial processing, with apparent increase in task discriminatory power.

This present study has a number of strengths, including the use of the exact same facial stimuli depicting five emotion expressions in emotion processing and control conditions. Therefore, the task controlled for any superficial characteristics that could impact performance. This investigation adds to what is known about emotion recognition by assessing the diagnostic specificity in schizophrenia and bipolar disorder, illuminating shared and unique aspects to each disorder.

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References

1. Green MF. Cognitive impairment and functional outcome in schizophrenia and bipolar disorder. *J Clin Psychiatry*. 2006; 67(Suppl 9):3–8. discussion 36–42. [PubMed: 16965182]
2. Fett AK, Viechtbauer W, Dominguez MD, Penn DL, van Os J, Krabbendam L. The relationship between neurocognition and social cognition with functional outcomes in schizophrenia: A meta-analysis. *Neurosci Biobehav Rev*. 2010
3. Kee KS, Green MF, Mintz J, Brekke JS. Is emotion processing a predictor of functional outcome in schizophrenia? *Schizophrenia Bull*. 2003; 29:487–97.
4. Addington J, Penn D, Woods SW, Addington D, Perkins DO. Facial affect recognition in individuals at clinical high risk for psychosis. *British Journal of Psychiatry*. 2008; 192:67–8. [PubMed: 18174514]
5. Schneider F, Gur RC, Koch K, Backes V, Amunts K, Shah NJ, et al. Impairment in the specificity of emotion processing in schizophrenia. *American Journal of Psychiatry*. 2006; 163:442–7. [PubMed: 16513865]
6. Goghari VM, MacDonald AW 3rd, Sponheim SR. Temporal lobe structures and facial emotion recognition in schizophrenia and non-psychotic relatives. *Schizophrenia Bull*. 2010 In press. Available Online.
7. Chan RC, Li H, Cheung EF, Gong QY. Impaired facial emotion perception in schizophrenia: a meta-analysis. *Psychiatry Res*. 2010; 178:381–90. [PubMed: 20483476]
8. Kohler CG, Walker JB, Martin EA, Healey KM, Moberg PJ. Facial emotion perception in schizophrenia: a meta-analytic review. *Schizophr Bull*. 2010; 36:1009–19. [PubMed: 19329561]
9. Alfimova MV, Abramova LI, Barhatova AI, Yumatova PE, Lyachenko GL, Golimbet VE. Facial affect recognition deficit as a marker of genetic vulnerability to schizophrenia. *Span J Psychol*. 2009; 12:46–55. [PubMed: 19476218]
10. Leppanen JM, Niehaus DJ, Koen L, Du Toit E, Schoeman R, Emsley R. Deficits in facial affect recognition in unaffected siblings of Xhosa schizophrenia patients: evidence for a neurocognitive endophenotype. *Schizophr Res*. 2008; 99:270–3. [PubMed: 18055176]
11. Eack SM, DEM, Montrose DM, Miewald J, Gur RE, Gur RC, et al. Social cognition deficits among individuals at familial high risk for schizophrenia. *Schizophr Bull*. 2009
12. Salem JE, Kring AM, Kerr SL. More evidence for generalized poor performance in facial emotion perception in schizophrenia. *Journal of Abnormal Psychology*. 1996; 105:480–3. [PubMed: 8772021]
13. Kerr SL, Neale JM. Emotion perception in schizophrenia: specific deficit or further evidence of generalized poor performance? *Journal of Abnormal Psychology*. 1993; 102:312–8. [PubMed: 8315144]
14. Lembke A, Ketter TA. Impaired recognition of facial emotion in mania. *American Journal of Psychiatry*. 2002; 159:302–4. [PubMed: 11823275]
15. Derntl B, Seidel EM, Kryspin-Exner I, Hasmann A, Dobmeier M. Facial emotion recognition in patients with bipolar I and bipolar II disorder. *Br J Clin Psychol*. 2009; 48:363–75. [PubMed: 19220936]
16. Harmer CJ, Grayson L, Goodwin GM. Enhanced recognition of disgust in bipolar illness. *Biol Psychiatry*. 2002; 51:298–304. [PubMed: 11958780]
17. Venn HR, Gray JM, Montagne B, Murray LK, Michael Burt D, Frigerio E, et al. Perception of facial expressions of emotion in bipolar disorder. *Bipolar Disorder*. 2004; 6:286–93.
18. Schaefer KL, Baumann J, Rich BA, Luckenbaugh DA, Zarate CA Jr. Perception of facial emotion in adults with bipolar or unipolar depression and controls. *J Psychiatr Res*. 2010; 44:1229–35. [PubMed: 20510425]
19. Getz GE, Shear PK, Strakowski SM. Facial affect recognition deficits in bipolar disorder. *Journal of the International Neuropsychological Society*. 2003; 9:623–32. [PubMed: 12755174]
20. Rocca CC, Heuvel E, Caetano SC, Lafer B. Facial emotion recognition in bipolar disorder: a critical review. *Revista Brasileira de Psiquiatria*. 2009; 31:171–80. [PubMed: 19578691]
21. Addington J, Addington D. Facial affect recognition and information processing in schizophrenia and bipolar disorder. *Schizophr Res*. 1998; 32:171–81. [PubMed: 9720122]

22. Vaskinn A, Sundet K, Friis S, Simonsen C, Birkenaes AB, Engh JA, et al. The effect of gender on emotion perception in schizophrenia and bipolar disorder. *Acta Psychiatr Scand*. 2007; 116:263–70. [PubMed: 17803756]
23. First, MB.; Spitzer, RL.; Gibbon, M.; Williams, JBW. Structured Clinical Interview for DSM-IV Axis I Disorders, Clinician Version (SCID-CV). Washington, D.C: American Psychiatric Press; 1996.
24. Nurnberger JI Jr, Blehar MC, Kaufmann CA, York-Cooler C, Simpson SG, Harkavy-Friedman J, et al. Diagnostic interview for genetic studies. Rationale, unique features, and training. NIMH Genetics Initiative. *Archives of General Psychiatry*. 1994; 51:849–59. [PubMed: 7944874]
25. Andreasen, NC. Scale for the Assessment of Negative Symptoms (SANS). Iowa: University of Iowa; 1981.
26. Andreasen, NC. Scale for the Assessment of Positive Symptoms (SAPS). Iowa: University of Iowa; 1983.
27. Andreasen NC, Arndt S, Alliger R, Miller D, Flaum M. Symptoms of schizophrenia. Methods, meanings, and mechanisms. *Arch Gen Psychiatry*. 1995; 52:341–51. [PubMed: 7726714]
28. Ventura J, Lukoff D, Nuechterlein KH, Liberman RP, Green MF, Shaner A. Manual for the expanded Brief Psychiatric Rating Scale. *International Journal of Methods in Psychiatric Research*. 1993; 3:221–4.
29. Burger GK, Calsyn RJ, Morse GA, Klinkenberg WD, Trusty ML. Factor structure of the expanded Brief Psychiatric Rating Scale. *Journal of Clinical Psychology*. 1997; 53:451–4. [PubMed: 9257222]
30. Gur RC, Sara R, Hagendoorn M, Marom O, Hughett P, Macy L, et al. A method for obtaining 3-dimensional facial expressions and its standardization for use in neurocognitive studies. *Journal of Neuroscience Methods*. 2002; 115:137–43. [PubMed: 11992665]
31. Brune M. Emotion recognition, 'theory of mind,' and social behavior in schizophrenia. *Psychiatry Research*. 2005; 133:135–47. [PubMed: 15740990]
32. Brown GG, Lee JS, Strigo IA, Caligiuri MP, Meloy MJ, Lohr J. Voxel-based morphometry of patients with schizophrenia or bipolar I disorder: a matched control study. *Psychiatry Res*. 2011; 194:149–56. [PubMed: 21924872]
33. Dutt A, Ganguly T, Shaikh M, Walshe M, Schulze K, Marshall N, et al. Association between hippocampal volume and P300 event related potential in psychosis: Support for the Kraepelinian divide. *Neuroimage*. 2012; 59:997–1003. [PubMed: 21924362]
34. Kaskey GB, Salzman LF, Ciccone JR, Klorman R. Effects of lithium on evoked potentials and performance during sustained attention. *Psychiatry Res*. 1980; 3:281–9. [PubMed: 6936723]
35. Elsass P, Mellerup ET, Rafaelsen OJ, Theilgaard A. Effect of lithium on reaction time--a study of diurnal variations. *Psychopharmacology (Berl)*. 1981; 72:279–82. [PubMed: 6784147]
36. Brodie MJ, McPhail E, Macphee GJ, Larkin JG, Gray JM. Psychomotor impairment and anticonvulsant therapy in adult epileptic patients. *Eur J Clin Pharmacol*. 1987; 31:655–60. [PubMed: 3830252]
37. Wolwer W, Frommann N, Halfmann S, Piaszek A, Streit M, Gaebel W. Remediation of impairments in facial affect recognition in schizophrenia: efficacy and specificity of a new training program. *Schizophr Res*. 2005; 80:295–303. [PubMed: 16125367]

Figure 1.
Accuracy for facial emotion and age recognition conditions for anger expressions.

Figure 2.

Number of misattributions for anger expressions in the facial emotion recognition condition.

*Schizophrenia patients differ from controls

**Schizophrenia and bipolar patients differ from controls

Table 1

Participant characteristics.

	Schizophrenia	Bipolar	Control
N	27	16	30
Age	38.9 (12.3) ^{ac}	46.2 (11.3)	48.8 (9.7)
Gender (% male)	70%	81%	57%
Education (Years Completed)	14.1 (2.7)	14.8 (2.7)	14.8 (3.7)
BPRS Total	46.4 (13.0) ^{ac}	39.4 (8.9) ^c	29.6 (5.1)
BPRS Thinking Disorder	2.42 (1.35) ^{ac}	1.25 (0.28)	1.07 (0.26)
BPRS Withdrawal	1.53 (0.67) ^{ac}	1.05 (0.58)	0.82 (0.25)
BPRS Anxiety-Depression	1.95 (0.57) ^b	2.36 (0.83) ^c	1.63 (0.62)
BPRS Hostility-Suspicion	2.09 (0.86) ^{ac}	1.60 (0.57)	1.23 (0.31)
BPRS Activity	1.36 (0.45) ^a	1.48 (0.64) ^c	1.09 (0.18)
SANS Total	26.6 (3.0) ^b	14.07 (4.0)	-
SAPS Total	16.50 (15.0) ^b	3.2 (3.7)	-
Psychosis Factor	2.25 (1.64) ^b	0.20 (0.37)	-
Positive Thought Disorder Factor	1.12 (1.53)	0.60 (0.99)	-
Negative Factor	1.81 (1.08) ^b	0.88 (1.0)	-
Antipsychotic (Atypical, Typical ^d , % on)	89 (96, 13)	44 (100, 0)	0
Antidepressants (% on)	44	44	10
Mood Stabilizer (% on)	37	75	0
Antianxiety (% on)	22	6	0
Antiparkinson (% on)	19	6	3
Other Psychiatric (% on)	22	31	13

BPRS = Brief Psychiatric Rating Scale: 24 items, scores can range from 24–168; Symptom dimensions computed from BPRS [29]: Thinking disorder (the average for grandiosity, hallucinations, unusual thought content, conceptual disorganization, and bizarre behavior items); Withdrawal (the average for disorientation, blunted affect, emotional withdrawal, motor retardation, and self-neglect items); Anxiety-Depression (the average for somatic concern, anxiety, depression, guilt, and suicidality items); Hostility-Suspicion (the average for hostility, suspiciousness, and uncooperativeness items); and Activity (the average for tension, excitement, mannerisms and posturing, distractibility, and motor hyperactivity items); SANS = Scale for Assessment of Negative Symptoms: 20 items, scores can range from 0–100; SAPS = Scale for Assessment of Positive Symptoms: 30 items, scores can range from 0–150. Symptom dimensions computed from SANS and SAPS using Andreasen and colleagues [27] as a guide: Psychosis symptoms (the average global score for delusions and hallucinations); Formal Thought Disorder (the global score for positive formal thought disorder); and Negative symptoms (the average global score for alogia, affective flattening, avolition-apathy, and anhedonia-asociality).

^aSchizophrenia patients and controls differ

^bSchizophrenia and bipolar patients differ

^cBipolar patients and controls differ

^dSome patients were on both an atypical and typical antipsychotic medication

Table 2

Accuracy (percentage correct; 20% is chance performance) and reaction time (ms) for facial recognition conditions.

Facial Recognition	Schizophrenia (n=27)	Bipolar (n=16)	Control (n=30)	Schizophrenia (n=27)	Bipolar (n=16)	Control (n=30)
Emotion Recognition	Accuracy			Reaction Time		
Facial Expression:						
Anger	60 (27) ^{ab}	75 (15)	78 (12)	3929 (2082)	4212 (1498)	4037 (1813)
Fear	56 (22)	62 (14)	66 (14)	4091 (2348)	4756 (2362)	3782 (1930)
Happy	91 (19)	98 (4)	94 (12)	2652 (1051)	3015 (1361)	2625 (1218)
Neutral	84 (22)	80 (22)	81 (20)	3223 (1742)	3602 (1842)	3134 (1869)
Sad	82 (19)	91 (10)	90 (13)	3311 (1545)	3031 (1223)	2822 (1239)
Age Recognition	Accuracy			Reaction Time		
Facial Expression:						
Anger	44 (14)	51 (11)	41 (14)	3762 (1861)	3289 (1234)	3264 (1331)
Fear	43 (13)	43 (11)	45 (13)	3932 (2055)	3141 (1141)	3232 (1142)
Happy	45 (14)	49 (11)	48 (15)	3760 (2203)	2981 (990)	3371 (1122)
Neutral	48 (11)	51 (11)	51 (9)	3655 (1809)	3128 (1070)	3239 (1276)
Sad	45 (15)	49 (13)	48 (14)	3510 (2476)	3215 (1689)	2983 (1273)
# of Categories (i.e., age brackets) off for Incorrect Responses in the Age Recognition Condition						
All Facial Expressions Combined	1.22 (0.14)	1.15 (0.08)	1.17 (0.11)	-	-	-

^a Schizophrenia patients and controls differ;

^b Schizophrenia and bipolar patients differ – as described in the text.