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Visual and Auditory Perception of Emotion in Adolescents with Bipolar Disorder

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Abstract

This study sought to replicate the finding that adolescents with BPD have facial affect processing deficits and extended this line of inquiry to aural emotional processing (i.e., the ability to decode emotion expression from the speaker's voice quality). Because Attention Deficit/Hyperactivity Disorder (ADHD) has a high comorbidity with BPD (60-80% of children and adolescents with BPD also have ADHD), we contrasted the visual and aural recognition of emotion of five adolescents with BPD and no comorbid ADHD with nine adolescents who have ADHD alone and twelve who were psychiatrically healthy. The participants completed tasks of facial and vocal affect recognition, social functioning, and non-emotion based facial recognition. These pilot data revealed that adolescents with BPD may be deficient in vocal affect recognition. Our results suggest that those with BPD have more impoverished social skills, and that this difficulty is independent of the comorbid ADHD that many of these patients demonstrate.

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Introduction

Bipolar disorder (BPD) is a common psychiatric disorder that affects approximately 1.5% of the adult population (Kessler et al., 1994) and 1% of adolescents (Lewinsohn, Klein, & Seeley, 1995). This disorder is characterized by periods of elevated or irritable mood (mania) that may co-occur or alternate with periods of depression (American Psychiatric Association, 1994). In addition to mood disturbance, patients with BPD are known to display cognitive deficits across multiple domains of functioning. Given the key role of emotion regulation in BPD, the present study focused on the abilities of adolescents with bipolar disorder to perceive and process emotional material.

Overview of Cognitive Functioning in Bipolar Disorder

Before discussing the existing literature specific to emotional processing in BPD, it is important to emphasize that individuals with this disorder may experience difficulty across a number of cognitive domains, including memory (Basso, Lowery, Neel, Purdie, & Bornstein, 2002; Clark, Iversen, & Goodwin, 2001; Fleck et al., 2003; McClure, Treland, Snow, Dickstein et al., 2005; Robinson et al., 2006; Shear et al., 1999; van Gorp, Altshuler, Theberge, & Mintz, 1999), speeded verbal fluency (Dixon, Kravariti, Frith, Murray, & McGuire, 2004; Lebowitz, Shear, Steed, & Strakowski, 2001; Rossell, 2006; Wolfe, Granholm, Butters, Saunders, & Janowsky, 1987), attention (Bora, Vahip, & Akdeniz, 2006; Clark et al., 2001; Clark, Iversen, & Goodwin, 2002; Fleck, Shear, & Strakowski, 2005; Quraishi & Frangou, 2002; Robinson et al., 2006), and executive functioning (Dixon et al., 2004; Ferrier, Stanton, Kelly, & Scott, 1999; McGrath, Scheldt, Welham, & Clair, 1997; Quraishi & Frangou, 2002; Shear, DelBello, Rosenberg, & Strakowski, 2002). Some adults with BPD experience persistent cognitive deficits, although less pronounced, even during periods of euthymia (periods free of mood symptoms) (Altshuler, 1993; Bearden, Hoffman, & Cannon, 2001; Dixon et al., 2004; Ferrier et al., 1999;

Friedman, Culver, & Ferrell, 1977; Rossell, 2006; Rossi et al., 2000; Rubinsztein, Michael, Paykel, & Sahakian, 2000; Sapin, Berrettini, Nurnberger, & Rothblat, 1987; van Gorp et al., 1999).

The literature on cognitive deficits in children and adolescents with BPD is much more limited than in adults. However, the few studies are consistent with what has been demonstrated in the adult population. Specifically, studies of children and adolescents with BPD have revealed deficits in attention (Dickstein et al., 2004; Doyle et al., 2005; Pavuluri et al., 2006), learning and memory (Dickstein et al., 2004; Doyle et al., 2005; Kyte, Carlson, & Goodyer, 2006; McClure, Treland, Snow, Dickstein et al., 2005; Pavuluri et al., 2006), response flexibility (McClure, Treland, Snow, Schmajuk et al., 2005), processing speed (Doyle et al., 2005), and executive functioning (Kyte et al., 2006; Pavuluri et al., 2006). Thus, it is important for studies of emotional processing to place those specific skills in the context of other cognitive abilities that may be affected by the disorder.

Emotional processing in BPD

The literature on emotional processing in patients with bipolar disorder has focused primarily on the ability of patients to process facial affect (that is, the information that another person's facial expression conveys about his or her feelings). Emotions such as happiness, sadness, fear, anger, disgust, and surprise are labeled comparably across diverse cultures (Ekman & Oster, 1979), and correct labeling of these facial expressions is believed to be important for effective everyday functioning. For example, facial expressions can offer clues about a person's emotional condition at a specific point in time and how to best interact with that person. Social perception is important because it has been identified as a predictor of social competence; thus, deficits in this domain may lead to social dysfunction (Penn, Mueser, Spaulding, Hope, & Reed, 1995; Wallace, 1986).

Until recently, most of the information about facial affect recognition in adults with BPD has been drawn from studies designed to investigate schizophrenia that included patients with BPD only as a comparison group. Because the patients with BPD were not the primary focus of these studies, they were not always described comprehensively in terms of symptom severity or mood state. Thus, variability in sampling characteristics may have contributed to inconsistent findings regarding emotional processing skills in adults with BPD (Getz, Shear, & Strakowski, 2003). Nevertheless, results from a study designed to examine facial recognition and facial affect labeling in adults with BPD suggested that these individuals had impairment on a task that required recognition of facial affect but did not differ from psychiatrically healthy controls on a facial recognition task that did not have an affective component. That is, the patients could recognize faces but had difficulty decoding the affect displayed in the faces (Addington & Addington, 1998). A limitation of this study, however, was that the duration of the stimulus presentation for the two tasks was different, which may have contributed to the difference in task performance. Subsequently, a study from our laboratory that controlled for presentation time confirmed the previous results that adults with BPD performed significantly worse than controls on a facial affect task but were able to respond normally on a facial recognition task (Getz et al., 2003). These findings also have support from the neuroimaging literature. Specifically, manic adults with BPD had a negative bias towards expressions of sad emotions; that is, while they were manic, these patients had difficulty labeling sad affect correctly in others (Lennox, Jacob, Calder, Lupson, & Bullmore, 2004) and underestimated the intensity of sadness in others' facial expressions (Chen et al., 2006).

Despite the growing evidence that adults with BPD have affect processing deficits, there have been only a very few studies of these skills in children and adolescents with this disorder. Those data that are available suggest that adolescent BPD is indeed accompanied by deficits in

affect processing. Adolescents with BPD have been shown to be deficient in identifying facial affect (McClure, Pope, Hoberman, Pine, & Leibenluft, 2003; McClure, Treland, Snow, Schmajuk et al., 2005) and in completing a task requiring social cognition in the form of pragmatic judgment of language and response flexibility (McClure, Treland, Snow, Dickstein et al., 2005). A concern about this latter study is the inclusion of participants who were in variable mood states. The mixing of mood states is potentially problematic because adults experiencing a manic or mixed episode may present with different cognitive symptoms than those who are depressed or symptom free (Bearden et al., 2001; Dixon et al., 2004; Murphy & Sahakian, 2001; Murphy et al., 1999; Quraishi & Frangou, 2002; Sweeney, Kmiec, & Kupfer, 2000). A later study by McClure and colleagues (2005) again supported the idea that adolescents with BPD are deficient in identifying facial affect (McClure, Treland, Snow, Schmajuk et al., 2005). Because affect processing is fundamental to effective everyday functioning, it is important to confirm whether young patients with BPD experience the emotional processing deficits that are documented in adults with this disorder.

Although the existing literature in bipolar disorder has been focused on facial affect processing, effective emotional functioning also requires the accurate perception of emotion in a speaker's voice. Typically, people perceive a high frequency, fast, or bright voice as happy, while a low, slow, and soft voice is perceived as negative (Scherer, 1986). Data from our laboratory and others suggests that adults with schizophrenia, another serious mental illness associated with substantial cognitive deficits, demonstrate a deficit in decoding the emotional tones in speech (Pagulayan, Shear, & Farrell, 2004). To our knowledge, no study has examined these auditory processing abilities in childhood and adolescent BPD. Thus, the primary goal of this study is to examine both facial and vocal affect perception in adolescents with BPD.

Bipolar Disorder and Attention Deficit/Hyperactivity Disorder

A secondary goal of this study is to compare affect recognition and social functioning abilities in adolescents who have BPD without attention deficit/hyperactivity disorder (ADHD), and in those with ADHD alone. It has been reported that there is a high rate of comorbidity between BPD and ADHD; reportedly, 60-80% of children and adolescents who have BPD will also have comorbid ADHD (DelBello & Geller, 2001; Geller & Luby, 1997; West, McElroy, Strakowski, Keck, & McConville, 1995; Wozniak et al., 1995). Given the high comorbidity rate, it can be difficult to ascertain whether the deficits shown in patients with BPD are the result of BPD, the comorbid ADHD, or a combination of both disorders. Therefore, we aim to determine the relative degree of deficit in facial affect recognition or social functioning in adolescents with BPD alone and ADHD alone.

While the magnitude of affective processing deficits have not yet been compared in adolescents with BPD who do or do not have comorbid ADHD, this type of comparison has been conducted in other cognitive domains, such as executive functioning. A comparison of executive functioning in adolescents with BPD only, those with BPD and comorbid ADHD, and psychiatrically healthy controls demonstrated that the patients with comorbid ADHD were rated by caregivers as having more impaired executive functioning skills than the patients with BPD alone, who in turn were more impaired than the control group (Shear, DelBello, Rosenberg, Jak, & Strakowski, 2004). In a complementary study, adolescents with BPD and comorbid ADHD performed more poorly on executive functioning measures than did those with ADHD alone (Warner, DelBello, Shear, Fleck, & Strakowski, 2005).

The present study was designed analogously to these earlier executive functioning findings, to compare adolescents with BPD and those with ADHD in terms of affect recognition. Deficits in facial affect recognition and labeling have been demonstrated in both children and adolescents with ADHD (Corbett & Glidden, 2000; Ingram, 1996; Norvilitis, Casey, Brooklier,

& Bonello, 2000) and adults with ADHD (Rapport, Friedman, Tzelepis, & Van Voorhis, 2002). Rapport and colleagues also demonstrated that adults with ADHD have a deficit in the perception of emotion in speech prosody (Rapport et al., 2002). Therefore, it is important to learn whether adolescents with BPD show deficits in affect processing that are distinct from those attributable to ADHD.

Emotional Processing and Social Functioning

In terms of the relationship between emotional functioning measures and outcome, there is evidence that deficits in the labeling of affect are related to social functioning and social competence in serious mental illnesses other than BPD, such as schizophrenia. Poole, Tobias, and Vinogradov (2000) demonstrated a significant correlation between affect recognition and the Disorganized, Cognitive, and Positive Symptoms scales from the Positive and Negative Syndrome Scale (PANSS) as well as a significant correlation between affect recognition and Interpersonal Relations, Intrapsychic Foundations, and Community Participation subscales of the Quality of Life Scale (QLS). These correlations showed clinically meaningful relationships with affect recognition (Poole, Tobias, & Vinogradov, 2000). The relationship between affect recognition and the subscales of Interpersonal Relations, Intrapsychic Foundations, and Community Participation supports previous results that linked facial affect recognition to social relations (Mueser et al., 1996; Penn, Spaulding, Reed, & Sullivan, 1996). Similarly, a recent study from our laboratory found that facial affect recognition was a significant predictor of independent living on a social functioning scale in patients with schizophrenia (Pagulayan, Shear, Howe, Mohamed, & Foster, 2005).

Although the relationship between affect recognition and social functioning has been studied in other disorders, to our knowledge there are not yet published studies on this topic in adolescents with BPD. If a similar relationship between these factors exists in BPD, it could lead

to new information about the everyday functioning of individuals with this disorder and possible new methods of treatment, such as social skills training that includes an affect recognition component. Patients with schizophrenia have shown significantly improved affect recognition skills in response to affect recognition training, but the full impact of this improvement in daily social skills has not been studied (Frommann, Streit, & Wolwer, 2003). Together these studies suggest that affect processing skills have a strong impact on psychosocial functioning and, once identified, they may be at least partially remediable.

Aims and Hypotheses

The primary goal of the present study was to compare the facial and vocal affective processing abilities of adolescents with bipolar disorder alone to adolescents with ADHD alone and those who are psychiatrically healthy. We hypothesized that adolescents with BPD and no comorbid ADHD would demonstrate a greater deficit than both adolescents with ADHD or healthy controls on tasks requiring the correct labeling of facial affect and the emotional valence of speech samples, and that both clinical groups would be impaired relative to the healthy control group. A second aim of this study was to examine the relationship between both facial and vocal affect processing and social functioning in adolescents with bipolar disorder and in those with ADHD. We hypothesized that greater deficits on tasks requiring the labeling of facial affect and the emotional valence of speech samples would correlate with a greater deficit in social functioning in all groups.

Method

Participants

Participants included 5 adolescents with a diagnosis of bipolar disorder I and no comorbid ADHD (average age of onset = 11.50 ± 3.71 years of age), 9 adolescents with a diagnosis of ADHD but no comorbid or first-degree relative with a mood or psychotic disorders

(average age of onset = 5.75 ± 1.72 years of age), and 12 healthy adolescents with no history of psychiatric illness in themselves or a 1st degree relative¹. All diagnoses were established via a semi-structured clinical interview using the Washington University at St. Louis Kiddie Schedule for Affective Disorders and Schizophrenia (WASH-U-KSADS). The adolescents with BPD were euthymic, defined by not meeting DSM-IV criteria for a manic, mixed, or depressive episode and having a rating of less than or equal to 12 on the Young Mania Rating Scale [(YMRS); (Young, Biggs, Ziegler, & Meyer, 1978)] and less than or equal to 28 on the Childhood Depression Rating Scale [(CDRS); (Poznanski, Cook, & Carroll, 1979)]. All participants were between the ages of 13 and 17 and were able to speak English fluently, able to provide written informed assent, and had a parent or legal guardian willing to provide written informed consent. We chose the age range of 13 to 17 in order to span much of adolescence while still falling into the normative ranges of our instruments and measures. Each participant's current medications were noted. The minority (40.00%) of the adolescents with BPD were currently taking medication (1 participant took Seroquel, another took Depakote), another 2 participants (40.00%) were currently participating in a clinical trial and were either taking Seroquel or a placebo, and the remaining 1 participant was not currently on medication. The majority (77.78%) of adolescents with ADHD were currently prescribed psychotropic medications, including Concerta, Strattera (1 participant), Ritalin (1 participant), Adderall, Focalin (1 participant), Medidate (1 participant) or a combination of these medications (3 participants); 2 participants were not currently taking any psychotropic medications. The majority (91.67%) of the healthy participants were not currently prescribed any psychotropic medications although one participant was prescribed amitryptiline

¹ Our small sample size of adolescents with BPD was unanticipated and was due to the difficulty of locating individuals who met all entry criteria. We did use a sample of convenience; patients from all groups were recruited from previously approved research protocols at the Division of Bipolar Disorders Research (DBDR) in the Department of Psychiatry at the University of Cincinnati. In our efforts to limit the possible explanations of the affect recognition deficits such as comorbid ADHD or a current mood episode, we limited our potential population to a very small proportion of the overall population of adolescents with BPD.

for headaches. Exclusion criteria for all groups included mental retardation (as estimated by the Wechsler Abbreviated Scale of Intelligence (WASI)), a history of serious closed head injury or other neurological illness or injury, and current substance abuse or lifetime substance dependence.

Data Collection Procedures

In order to recruit participants, the principal investigator contacted the clinical research coordinators at the DBDR and provided them with information about the inclusion and exclusion criteria, reimbursement, how to contact the principal investigator, and a request that they notify eligible individuals about the study. Potential participants were screened in person or over the phone. If it appeared that interested individuals met inclusion criteria, a meeting was scheduled with the principal investigator or a co-investigator. At that time, the purpose of the study was reiterated, the participant's legal guardian was asked to read and sign the informed consent form, and the participant was asked to provide written assent.

Once written informed consent was obtained, the principal investigator or a co-investigator obtained diagnostic and demographic information using the WASH-U-KSADS and demographic forms, administered by herself or by a trained research assistant. The principal investigator then administered the YMRS, CDRS-R, and Scale for the Assessments of Positive Symptoms [(SAPS); (Andreasen, 1984)] as symptom rating measures, the IQ estimate, the facial recognition task, the sentence repetition task, the attention task, and the social functioning measures. The affect labeling tasks were administered in a counterbalanced order. The adolescents were compensated \$40.00 for their time.

Instruments

Diagnostic and Symptom Measures

Washington University at St. Louis Kiddie Schedule for Affective Disorders and Schizophrenia [(WASH-U KSADS); (Geller, Warner, Williams, & Zimmerman, 1998)] was used to confirm the diagnosis of participants based on the criteria from the Diagnostic and Statistical Manual for Mental Disorders-IV [(DSM-IV); (American Psychiatric Association, 1994)]. Previous work using this instrument from our laboratory and others has indicated high reliability and validity. The WASH-U KSADS is a clinician-administered semi-structured diagnostic interview that includes a series of demographic items followed by questions assessing symptoms in the past month and during the participant's lifetime. The diagnostic evaluations were administered by the principal investigator or other trained research assistants from the DBDR.

Young Mania Rating Scale [(YMRS); (Young et al., 1978)] is an 11-item clinician-administered assessment that was used to obtain a measure of symptom severity of mania over the previous week with possible scores ranging from 0 to 60 and higher scores indicating more pronounced symptomatology. The reliability and validity of this instrument are acceptable (Fristad, Weller, & Weller, 1995; Young et al., 1978).

Childhood Rating Depression Scale-Revised [(CDRS); (Poznanski et al., 1979)] is used to rate the severity of depressive symptoms that have occurred over the previous week. This scale consists of 17 clinically relevant domains that are clinician-rated based on the participant's responses about his or her current behavior or functioning. The reliability and validity of this instrument are acceptable (Poznanski et al., 1979).

Scale for the Assessment of Positive Symptoms [(SAPS); (Andreasen, 1984)] is a brief, clinician-administered assessment successfully used to rate the severity of psychotic symptoms

over the previous week. This measure assesses the presence and severity of positive symptoms of psychosis including hallucinations, delusions, and other aspects of thought disorder. The reliability and validity of this instrument are considered to be satisfactory (Andreasen, 1984).

Before administering the diagnostic and symptom measures in this battery, the principal investigator and co-investigators completed training and demonstrated a high degree of reliability ($\kappa > .90$) with a research psychologist or psychiatrist trained in the administration of the measure. For the neuropsychological measures, the principal investigator completed training with a psychologist.

Neuropsychological Measures

Because individuals with BPD are known to demonstrate cognitive deficits in domains other than emotional functioning, this battery included a small number of tasks that were selected to control for potential cognitive confounds that may have affected performance on the primary measures of interest. The neuropsychological measures are all well-validated, standardized clinical instruments.

Wechsler Abbreviated Scale of Intelligence [(WASI); (Wechsler, 1999)]. General intellectual functioning was estimated using the four-subtest form of the WASI (including the Vocabulary, Similarities, Block Design, and Matrix Reasoning subtests). This form of the WASI correlates highly with Full Scale IQ as estimated by the Wechsler Adult Intelligence Scale-III (WAIS-III) ($r = 0.92$) (Wechsler, 1999). This general intelligence estimate was used to ensure that the participants had the mental capacity to complete the affect processing task.

Benton Facial Recognition Test [(BFR);(Benton, Van Allen, Hamsher, & Levin, 1978)] was used to assess the ability to perceive and recognize unfamiliar faces. This assessment was used as a control condition to ensure that any measured deficits in facial affect recognition were not attributable to a more general difficulty in processing facial stimuli. We used the 54-item long form. This measure has suitable established validity (Benton et al., 1978).

Sentence Repetition Test [(BSR); (Spreeen & Benton, 1969)] was used to examine the ability of participants to repeat sentences heard aloud. A series of 22 sentences of increasing length and complexity was read to the participant and is to be repeated verbatim directly after each trial. This measure was also be used as a control condition to make certain that observed deficits in vocal affect labeling are not due to a broad deficit in processing auditory stimuli.

Connor's Continuous Performance Test [(CPT); (Connors, 1992)] was used to examined the sustained attention of the participants over a 14-minute time period. A series of letter are presented and the subject must depress the space bar for any letter of the alphabet except "X," which occurs 10% of the time. This assessment was used as a control condition to provide data about attentional deficits that may have distinguished the groups and that may have impacted the affective processing tasks.

Affect Recognition Tasks (Receptive Emotional Skills)

Diagnostic Analysis of Nonverbal Accuracy 2 [(DANVA2); (Nowicki & Duke, 1999)] was used to examine the ability to correctly recognize and label both facial affect and emotions present speech prosody . We used the FACES 2 Adult and Child subtests, which consisted of photographs of adults and photographs respectively, and also the PARALANGUAGE 2 Adult

and Child subtests, which use adult voices and child voices respectively. In the FACES subtests, a series of 24 images that depict people expressing each of four primary emotions (happiness, sadness, anger, and fear) are presented on a computer screen. Participants indicate by a key press which of the four emotions was depicted in the image. This measure has a reported internal consistency ranging from a coefficient alpha from 0.64 to 0.90 (FACES 2 Adult) and 0.69 to 0.81 (FACES 2 Child). In the PARALANGUAGE subtests, a series of 24 versions of the sentence “I am going out of the room now but I’ll be back later” that are spoken in intonations and rhythm to reflect each of four emotions are presented from computer speakers. Participants indicate which of the four emotions was depicted in the prosody of the sentence. For scoring, this assessment provides the number of errors made by each participant on each subtest, which we then converted to z -scores using the age-based normative data in the manual. This measure has a reported internal consistency ranging from a coefficient alpha from 0.70 to 0.78 (PARALANGUAGE 2 Adult) and 0.74 to 0.76 (PARALANGUAGE 2 Child). The DANVA2 manual offered age-based normative data in terms of the mean number of errors and standard deviations on each subtest for each age group. We used these means and standard deviations to calculate age-based z -scores for each participant’s performance on the four subtests in order to use a more standardized and interpretable index of performance on these tests.

Social Functioning

Social Skills Rating System [(SSRS); (Gresham & Elliot, 1990)] is a multiple-informant rating system using the child and parent to assess behaviors that affect parent-child relations, teacher-student relations, and peer relations. We used the secondary level student forms and parent forms to measure peer relations. (The secondary level forms are designed for participants in grades seven to twelve.) The parent form contains 52 items from two scales: Social Skills and

Problem Behaviors. The student form contains 39 items from only the Social Skills scale. The student form has an internal consistency coefficient of 0.83.

Statistical Analyses

The data distributions were first examined, and nonparametric analyses were used when the data did not meet the assumptions for normality or when the sample size prohibited parametric tests. Before approaching our analyses of the affect recognition and social functioning variables, we first examined our control variables, including facial recognition, sentence repetition, and sustained attention. We examined these variables first to determine if they had an impact on the variables of interest and to take them into account if necessary. Spearman rank correlations were conducted to examine the relationships of demographic variables (e.g. sex, race, education and age), symptom severity (assessed with the YMRS and the CDRS-R), and intellectual functioning (assessed with the WASI) with affective processing (assessed with the DANVA2) or social functioning (assessed with the SSRS), and these variables were incorporated into the final statistical models as appropriate.

For each of the four DANVA2 subtests, the raw number of errors and the corresponding z -score were highly correlated, with correlation coefficients ranging from 0.6237 (Child Faces in healthy participants) to 1.00 (each subtest in the adolescents with BPD) across all groups. As the two values were so highly correlated, we decided to use the z -scores from the DANVA2 subtests for our analyses because they are more readily interpreted than the number of errors made per test. The one exception to our use of the z -scores is a repeated measures ANOVA, which was used to compare the effects of stimulus (child or adult) and modality (facial or vocal), in which we analyzed the both the z -scores and the errors scores because they allowed us to compare the difference in the raw scores (i.e., to examine which conditions elicited more errors) and norm-

corrected performances to examine a different and more complete picture of the possible three-way interaction between stimulus, modality, and group.

The first hypothesis was that adolescents with BPD would perform worse than adolescents with ADHD or healthy participants on tasks of facial and vocal affect processing and that the adolescents with ADHD would perform worse on the same tasks than healthy participants. This hypothesis was tested using Kruskal-Wallis tests for the adult and child facial and vocal affect labeling z -scores as the dependent variables and the independent variable of group membership. If the Kruskal-Wallis was significant, we followed it with a Mann-Whitney U test to determine which specific group differences were significant.

The second hypothesis was that greater deficits in facial and vocal affect labeling would correlate with more impaired social functioning. We compared the groups on measures of parent ratings of their children's social skills, student ratings of their social skills, and parent ratings of their children's problem behaviors using the Kruskal-Wallis and Mann-Whitney U tests, and then correlated these measures with measures of affect recognition using Spearman correlations.

Results

Demographic Variables

See Table 1 for descriptive statistics of the demographic variables. There was a significant difference in mean age ($H(2) = 7.78, p = 0.02$) between the three groups. The mean age for adolescents with BPD was higher than the mean age for adolescents with ADHD ($U = 5.50, p = 0.02$) and healthy participants ($U = 5.50, p < 0.01$). The mean ages for the ADHD and HP groups were not significantly different from each other. This mean difference reflected the fact that all of the BPD participants were 16 or 17 years of age, whereas the other two groups included individuals as young as age 13. On the ratings of psychiatric symptom severity, the

mean ratings on both the YMRS ($H(2) = 9.10, p = 0.01$) and CDRS-R ($H(2) = 7.067, p = 0.03$) were, as expected, significantly higher (YMRS: $U = 3.30, p < 0.01$; CDRS: $U = 6.50, p = 0.01$) for the adolescents with BPD than the healthy participants. Neither the BPD nor the HP group was significantly different from the adolescents with ADHD.

Table 1

Demographic information by variable and group

Variable	M	SD	Median	Range	Variable	Percentage
Age					Sex	% Male
ADHD (N = 9)	14.89	1.27	15.00	13.00-17.00	ADHD	55.56%
BPD (N = 5)	16.60	0.55	17.00	16.00-17.00	BPD	20.00%
HP (N = 12)	14.67	1.23	14.50	13.00-17.00	HP	58.33%
Education					Race	% Caucasian
ADHD	8.78	1.30	8.00	7.00-11.00	ADHD	88.89%
BPD	10.40	0.89	11.00	9.00-11.00	BPD	100%
HP	8.83	1.79	9.00	6.00-12.00	HP	83.33%
SES*						
ADHD	5.56	0.88	6.00	4.00-7.00		
BPD	4.00	1.87	4.00	2.00-7.00		
HP	5.50	1.45	6.00	2.00-7.00		
YMRS						
ADHD	2.89	2.67	2.00	0.00-7.00		
BPD	5.80	3.77	5.00	2.00-12.00		
HP	1.08	1.24	1.00	0.00-4.00		
CDRS						
ADHD	20.56	3.56	19.00	17.00-26.00		
BPD	23.00	3.54	24.00	18.00-27.00		
HP	18.17	1.11	18.50	17.00-20.00		
SAPS						
ADHD	0.22	0.44	0.00	0.00-1.00		
BPD	0.00	0.00	0.00	0.00-0.00		
HP	0.00	0.00	0.00	0.00-1.00		

**SES Levels: Household Income: 1 = \$0 - \$10,000; 2 = \$10,001 - \$20,000; 3=\$20,001 - \$35,000; 4 = \$35,001 - \$50,000; 5 = \$50,001 - \$75,000; 6 = \$75,001 - \$100,000; 7 = > \$100,000

The only demographic variable associated with affect recognition was education, with years of education significantly correlated with the errors on the Child Paralanguage subtest of the DANVA2. This relationship was only significant in the group with BPD ($\rho = -0.89, p = 0.04$) and the healthy participants ($\rho = -0.68, p = 0.01$).

Control Variables

Descriptive statistics of the cognitive control variables can be found in Table 2. In our investigation of the cognitive control variables, we found group differences on a task of facial recognition ($H(2) = 10.26, p < 0.01$); the adolescents with ADHD performed significantly worse on a task of facial recognition than the healthy participants ($U = 11.50, p < 0.01$). In the healthy participants, better scores on the BFR were significantly associated with fewer errors on the Adult Paralanguage subtest of the DANVA2, ($\rho = -0.64, p = 0.03$). In contrast, this relationship was significant in a counter-intuitive direction in the adolescents with BPD ($\rho = .89, p = 0.04$), meaning that in this group, higher scores on the BFR were significantly associated with more errors on the Adult Paralanguage subtest.

Table 2

Means, standard deviations, medians and ranges of the control variables

Variable	M	SD	Median	Range
IQ				
ADHD	105.78	6.16	106.00	93.00-115.00
BPD	101.40	15.34	107.00	85.00-120.00
HP	108.58	12.82	109.00	85.00-132.00
Facial Recognition				
ADHD	39.44	2.40	39.00	36.00-43.00
BPD	42.60	3.71	44.00	36.00-45.00
HP	44.91	3.58	45.00	38.00-49.00
Sentence Repetition				
ADHD	13.67	0.71	14.00	12.00-14.00
BPD	12.80	1.10	12.00	12.00-14.00
HP	13.67	0.65	14.00	12.00-14.00
CPT Hit Reaction Time				
ADHD	49.12	13.47	44.24	36.26-76.35
BPD	48.74	10.92	50.96	32.80-61.04
HP	41.85	5.11	40.52	34.07-48.09
CPT Detectability (d')				
ADHD	56.53	4.24	57.01	49.67-62.80
BPD	47.17	3.81	48.49	41.20-51.27
HP	48.33	7.26	48.44	38.96-59.81
CPT Response Style (β)				
ADHD	48.44	5.24	47.72	41.76-58.92
BPD	48.08	3.95	46.39	44.42-53.47
HP	46.44	3.02	45.99	42.60-52.33

The adolescents with ADHD also performed significantly worse ($H(2) = 9.55, p < 0.01$) than the adolescents with BPD ($U = 1.00, p < 0.01$) and healthy participants ($U = 18.50, p = 0.01$) on the

detectability (d') t-score of a sustained attention task. There were no correlations between any of the cognitive control variables and performances on the affect recognition subtests of the DANVA2 that were significant and consistent across all three groups.

Affect Recognition

Table 3 includes the descriptive statistics for the affect recognition variables. We began by examining group differences in z -scores across the four DANVA subtests using a Kruskal-Wallis test with follow-up comparisons using Mann-Whitney U tests. Of these affect recognition tasks, only the z -scores ($H(2) = 6.55, p = 0.04$) from the Adult Paralanguage subtest demonstrated significant group differences. The adolescents with BPD performed significantly worse ($U = 7.000, p = 0.02$) than the healthy participants on this subtest. Wilcoxon Signed Rank tests demonstrated that although there was a significant difference in the number of errors on male (42 Stimuli over all four subtests) versus female (54) stimuli, including both facial and vocal stimuli and with participants making more errors on the female stimuli ($z = -2.85, p < 0.01$), this difference disappeared when the groups were compared on the percentage of errors on male versus female stimuli (number of errors on male stimuli divided by the total number of male stimuli).

Table 3

Descriptive statistics of the z-scores and number of errors per subtest of the DANVA2 subtests.

Variable	<i>M</i>	<i>SD</i>	Median	Range	Variable	<i>M</i>	<i>SD</i>	Median	Range
Adult Faces z-scores					Adult Paralanguage Errors				
ADHD	-0.20	0.78	-0.52	-1.39-1.13	ADHD	6.22	2.44	6.00	3.00-10.00
BPD	-0.17	1.35	-0.52	-1.39-2.09	BPD	9.00	3.39	8.00	5.00-13.00
HP	-0.19	0.84	-0.11	-2.02-0.78	HP	5.08	2.35	5.00	2.00-11.00
Child Faces z-scores					Child Paralanguage Errors				
ADHD	-0.16	0.57	-0.38	-0.90-0.52	ADHD	4.00	1.22	4.00	2.00-5.00
BPD	0.14	0.62	0.05	-0.43-1.00	BPD	5.60	4.04	5.00	0.00-10.00
HP	-0.55	0.52	-0.61	-1.54-0.05	HP	4.50	2.39	5.00	1.00-8.00
Adult Paralanguage z-scores									
ADHD	-0.21	0.78	-0.42	-1.38-1.03					
BPD	0.84	1.00	0.44	-0.44-1.91					
HP	-0.70	0.89	-0.59	-2.49-1.19					
Child Paralanguage z-scores									
ADHD	-0.09	0.41	-0.03	-0.78-0.27					
BPD	0.45	1.22	0.27	-1.24-1.78					
HP	-0.10	0.83	-0.16	-1.55-1.09					
Adult Faces Errors									
ADHD	3.78	1.86	3.00	1.00-7.00					
BPD	3.80	3.11	3.00	1.00-9.00					
HP	4.08	1.44	4.00	1.00-6.00					
Child Faces Errors									
ADHD	2.56	1.24	2.00	1.00-4.00					
BPD	3.20	1.30	3.00	2.00-5.00					
HP	2.00	0.95	2.00	1.00-3.00					

We used a 2 (child and adult) X 2 (facial and vocal) repeated measures analysis of variance (ANOVA) to investigate the effects of modality, stimulus, and any potential interactions in our sample. The 2 X 2 ANOVA using the raw scores revealed a main effect of stimulus ($F(1) = 15.41, p < 0.01$) and a main effect of modality ($F(1) = 24.12, p < 0.01$). There was also a near significant three-way interaction of stimulus*modality*group ($F(2) = 3.24, p = 0.057$). See Figure 1 for a representation of this interaction. Follow-up comparisons using the Wilcoxon Signed Ranks test showed that the participants made significantly more errors on the Adult Faces subtest than the Child Faces subtest ($z = -3.04, p < 0.01$) and on the Adult Paralanguage subtest relative to the Child Paralanguage subtest ($z = -2.38, p = 0.02$). The participants also made more errors on the Paralanguage subtests than the Faces subtests, both in child ($z = -3.46, p < 0.01$) and adult ($z = -2.84, p < 0.01$) stimuli.

Figure 1. Number of errors on the DANVA2 subtests by group and subtest.

To clarify further the nature of these results and interaction, and to continue our examination of the four affect recognition tasks, we compared these tasks in just the healthy participants. A 2 (stimulus) X 2 (modality) repeated measures ANOVA on the healthy participants group showed that the number of errors on each of the four DANVA2 subtests were significantly different according to both stimulus and modality. The healthy participants made significantly more errors on the adult subtests than the child subtests (stimulus: $F(1) = 8.56, p = 0.01$) and also made significantly more errors on the vocal or paralanguage subtests than the facial subtests (modality: $F(1) = 8.48, p = 0.01$). We then compared the z -scores of the healthy participants on these tasks; the participants' z -scores were not significantly different according to stimulus ($p > 0.05$) or modality ($p > 0.05$) alone, however there was a significant interaction between stimulus and modality ($F(1) = 10.00, p < 0.01$). A 2 (child and adult) X 2 (facial and vocal) repeated measures ANOVA analysis on the average z -scores of the subtests across all three participant groups demonstrated a significant three-way interaction of stimulus*modality*group ($F(2) = 3.46, p = 0.049$) but no significant group differences on either stimulus ($p > 0.05$) or modality ($p > 0.05$). See Figure 2 for a depiction of this interaction.

Figure 2. Average z -score on the DANVA2 subtests by group and subtest.

Follow-up repeated measures comparisons between each set of participant groups (ADHD and BPD, ADHD and HP, and BPD and HP) to this interaction showed that the only significant interaction term between stimulus*modality* group was between the adolescents with BPD and the healthy participants ($F(1) = 9.64, p < 0.01$). This same repeated measures ANOVA also showed group differences between the adolescents with BPD and the healthy participants on the z -scores of the Child Faces ($F(1) = 5.58, p = 0.03$) and Adult Paralanguage subtests ($F(1) = 8.53, p = 0.01$). Follow-up t -tests to the ANOVA revealed that the adolescents with BPD performed significantly worse on the Child Faces ($t = 2.36, p = 0.03$) and Adult Paralanguage subtests ($t = 2.92, p = 0.01$). Neither this pattern nor any other significant differences were shown in the comparisons between any other sets of groups.

Social Functioning

See Table 4 for the descriptive statistics from the SSRS, the measure of social functioning. Significant group differences were shown on the parent ratings of both social skills ($H(2) = 14.01, p < 0.01$) and problem behaviors ($H(2) = 14.59, p < 0.01$) but not on the study participants' ratings of their own social skills. To reiterate, the parents rated both social skills and problem behaviors, but the adolescents were asked only to rate social skills.

Table 4

Descriptive statistics of the standard scores of the SSRS subscales

Variable	M	SD	Median	Range
Social Skills (Parent)				
ADHD	91.67	14.00	91.00	67.00-120.00
BPD	77.00	4.24	75.00	74.00-84.00
HP	108.42	12.62	109.50	88.00-130.00
Social Skills (Student)				
ADHD	102.22	19.72	100.00	76.00-130.00
BPD	99.00	9.97	97.00	88.00-115.00
HP	108.75	11.43	106.00	95.00-130.00
Problem Behaviors (Parent)				
ADHD	102.89	10.11	102.00	86.00-124.00 103.00-
BPD	118.20	9.60	120.00	128.00
HP	90.33	6.84	89.50	85.00-109.00

On the parents' ratings of their children's social skills, the adolescents with BPD were described as having significantly poorer social skills ($U = 5.50, p = 0.02$) than the adolescents with ADHD. The adolescents with ADHD had significantly poorer social skills ($U = 19.50, p = 0.01$) than the healthy participants. The parents' ratings of their children's problem behaviors showed a similar pattern. The adolescents with BPD had significantly more problem behaviors ($U = 6.50, p =$

0.03) than the adolescents with ADHD who had significantly more problem behaviors ($U = 15.00, p < 0.01$) than the healthy participants. When we explored the correlations between the affect recognition measures and the social functioning measures individually, by group, we did not find any significant correlations between these variables that were present in more than one group and that were not due to spurious causes. Scatter plots of the significant correlations were examined to see if the relationship did indeed follow a pattern or if the correlation was due to an outlier or other influence. The correlation coefficients ranged from $-.80$ to $.90$ between the z -scores of the DANVA2 subtests and the subscales of the SSRS.

Discussion

This study evaluated affect recognition and social functioning in adolescents with BPD in comparison to adolescents with ADHD and healthy participants. We examined the recognition of affect presented facially and vocally and using both adult and child stimuli. An analysis of the raw numbers of errors across the four DANVA subtests suggested that participants in each group made significantly more errors when emotional information was presented through adult stimuli than through child stimuli and also had more difficulty recognizing emotion presented vocally than facially. This finding has important methodologic implications for the interpretation of existing studies and the design of future work because it suggests that the presence or absence of affect recognition deficits in a certain group may be due not totally to group membership but to the type of stimuli or modality used; it also limits the generalizability of the study. Further analyses of the four subtests show that the differences in performance of the healthy participants on effects of stimulus and modality that were present in number of errors of the DANVA2 subtests disappear after converting the error scores to z -scores using the age-based norms. In other words, use of the normative data is effective in reducing statistical inter-subtest

discrepancy in difficulty and our results offers additional validation of the normative data for the subtests of the DANVA2.

A repeated measure ANOVA between all three participant groups and using the z -scores of the four DANVA2 subtests indicated a significant group difference on the Adult Paralanguage subtest of the DANVA2 as well as a significant interaction between stimulus*modality*group. The only groups between which this interaction was significant were the adolescents with BPD and the healthy participants, which implies that the effects of modality and stimulus were greater in the adolescents with BPD than in the healthy participants.

In terms of group differences in affective processing, the adolescents with BPD were impaired on the z -scores of the Adult Paralanguage subtest of the DANVA2 in comparison to the healthy participants, and these results partially support our hypothesis that adolescents with BPD would perform worse on tasks of affect recognition than adolescents with ADHD and healthy participants. Although we did not demonstrate the facial affect recognition deficit suggested in the BPD literature (McClure et al., 2003; McClure, Treland, Snow, Schmajuk et al., 2005), we did demonstrate a deficit in vocal affect recognition. In addition, this deficit was present in the absence of comorbid ADHD. Though it was not significant, the adolescents with BPD did perform worse on this subtest than the adolescents with ADHD. These results suggest that the deficit is the result of the BPD and not comorbid ADHD or a combination of both disorders.

The pattern of our results is similar to those documented in individuals with traumatic brain injury, who performed better on the child stimuli tasks than on the adult stimuli tasks and better on the facial than the vocal affect tasks (Spell & Frank, 2000). A study in adolescents with ADHD using the DANVA also demonstrated group differences on the paralanguage task of the DANVA but not on the facial expressions subtest (Hall, Peterson, Webster, Bolen, & Brown,

1999). Thus, it appears that the paralinguistic task is more challenging in general than is the facial affect task and may, therefore, be a more sensitive test of affective processing skill.

The results of our study are inconsistent with the current literature in affect recognition and ADHD (Corbett & Glidden, 2000; Norvilitis et al., 2000; Rapport et al., 2002), because we did not demonstrate group differences between the adolescents with ADHD and the healthy participants on these tasks. One possible reason for this discrepancy could be that our affect recognition task did not adequately challenge the participants, and the ceiling effect limited our variability and power to identify group differences.

Because the groups did not differ on the Child Faces, Adult Faces, and Child Paralinguistic affective measures, it was not necessary to incorporate a consideration of the various cognitive control measures (intellectual functioning, facial recognition, sentence repetition, sustained attention) into our analyses. However, for completeness of the discussion, we note that there were group differences on the detectability *t*-score of the sustained attention task and on the facial recognition task. Specifically, the adolescents with ADHD differed from healthy participants and adolescents with BPD on the detectability score of a continuous performance task and with the healthy participants on a task of facial recognition, which demonstrates that they were indeed experiencing attentional fluctuations that are expected given their diagnosis. It is also possible that as a whole, the participants in our BPD were generally older than the participants in both other groups, and are therefore expected to perform better on these tasks by virtue of their age. It should also be noted that the detectability scale and the facial recognition scores were not significantly correlated with any of the affect recognition or social functioning measures. Although number of years of education was significantly correlated with the *z*-scores on the Child Paralinguistic subtest; there were no group differences to investigate on

this subtest, even when the demographic, symptomatic, and cognitive control measures were taken into account.

Our study adds to the existing literature about adolescents with BPD and partially supports the evidence that those adolescents have deficits in affect recognition. Previous studies have demonstrated this deficit in a group of adolescents that combined varying mood states (manic and depressed episodes and those in periods free of mood symptoms) (McClure et al., 2003; McClure, Treland, Snow, Schmajuk et al., 2005). Our study expands the available knowledge about adolescents with BPD by examining solely adolescents with BPD who were not in an active mood state at the time of the testing. If adolescents with BPD show this deficit while their other symptoms are in remission, it is likely that they will also show the deficit in periods when their mood and other symptoms are present in a larger extent, and possibly to a greater degree.

The results of our study also reveal some noteworthy group differences on tasks of social functioning. We demonstrated that, according to their parents, the adolescents with BPD had fewer social skills and more behavioral problems than their peers with ADHD or healthy participants. The adolescents with ADHD also demonstrated significantly fewer parent rated social skills and more problem behaviors than the healthy participants. Our findings do replicate the suggestion in the literature that individuals with BPD have deficits in their social functioning (Dion, Tohen, Anthony, & Waternaux, 1988; Grossman, Harrow, Goldberg, & Fichtner, 1991), even while their overall functioning was rated as “stable” by a treating doctor (Dickerson, Sommerville, Origoni, Ringel, & Parente, 2001). Our findings are also consistent with the literature on social functioning in adolescents with BPD, which suggests that a deficit in social functioning does exist, even at a young age (Biederman et al., 2005; Goldstein, Miklowitz, & Mullen, 2006). In one such study, both the Global Assessment of Functioning (GAF) and

performance on another social functioning inventory were impaired in this population (Biederman et al., 2005). It is important to note that irritability is a very common symptom of adolescents with BPD (Biederman et al., 2005; Wozniak et al., 1995) and it may also play a role in their social functioning.

These group differences did not carry over to the self-report form of our social functioning measure, suggesting that none of the participant groups rated themselves as having poorer social skills; in fact, each group's average self-report score fell into the average range of number of social skills. Although the mean parent and student ratings of social skills were most similar in the healthy volunteer group, the correlations between these variables were still non-significant. Previous studies have shown that individuals with depression and individuals with BPD may tend to over-estimate their own social skills and level of social functioning as compared to third-party ratings of their social functioning (Getz, 2004; Lewinsohn, Mischel, Chaplin, & Barton, 1980). Similarly, it is possible that the adolescents with BPD and the adolescents with ADHD over-estimated their own social skills as compared to their parents' ratings.

Future Directions

A clear limitation of our study is the small sample size in the BPD group. A larger sample could have increased our power to find smaller effects as well as given us a more representative group of the population of adolescents with bipolar disorder. In our desire to perform a study with a "pure" sample of adolescents with BPD and no comorbid ADHD who were currently not in an active mood state, we made it challenging to obtain a large sample size. Given the high 60-80% rate of comorbidity between BPD and ADHD in adolescents (DelBello & Geller, 2001; Geller & Luby, 1997; West et al., 1995; Wozniak et al., 1995), it follows that the particular participant group we used would be in the minority of adolescents with BPD. Future inclusion of

adolescents with BPD and comorbid ADHD may provide a more realistic portrayal of the actual deficits individuals with BPD experience. The additional limitation of excluding adolescents with BPD currently in an active mood state also limited our possible sample size. Related studies in our division and those existing in the literature that focused on adolescents currently in an active mood state showed greater success with recruitment and larger sample sizes. In future studies, I might design the study to include adolescents with BPD and comorbid ADHD and would also accept individuals in an active mood state, although I would consider limiting it to one particular mood state. The methodologic reasoning for designing our study as we did was to determine if adolescents with BPD demonstrated a deficit in affect recognition while they were not in an active mood state that was present in the absence of comorbid ADHD. We aimed to show a deficit in affect recognition that was greater than the deficit described in the literature in adolescents with ADHD and that was not attributable to having a comorbid diagnosis of ADHD. We designed this study with the belief that if we could show a deficit while participants were not in an active mood state, it would be possible to replicate our finding in adolescents currently in an active mood state and that our findings could also be generalized to the population of adolescents with BPD.

Another limitation of our study was the relative ease of our affect recognition task. It is possible that a ceiling effect of the task not challenging the majority of the participants limited how well the participants could perform on the task and in doing so limited the variance of performance. If an assessment is unable to test the full scope of a participant's ability on a task, it will attenuate the overall variance of the responses and scores on the assessment. It becomes more difficult to determine statistical significance between groups' performance if the overall variance is small because the group means will fall more closely together than on a task with a larger overall variance. That we also failed to show a significant difference between the

adolescents with ADHD and the healthy participants that has been shown in the literature (Corbett & Glidden, 2000; Ingram, 1996; Norvilitis et al., 2000) suggests that our tasks may not have challenged the adolescents with ADHD to the extent needed to demonstrate this deficit. This line of thinking is supported by the fact that only the most difficult subtest of the DANVA2, Adult Paralanguage, began to show significant group differences. If the other subtests were as challenging, it is possible that we could have shown more and greater significant differences between the adolescents with BPD, the adolescents with ADHD, and the healthy participants.

If future studies in individuals with bipolar disorder are able to demonstrate a relationship between affect recognition or identification and social functioning deficits, similar to the relationship that has been shown in individuals with schizophrenia (Mueser et al., 1996; Pagulayan et al., 2005; Penn et al., 1996; Poole et al., 2000), it may possible to focus interventions on areas which contribute to these deficits. A greater understanding of the correlates of this social dysfunction could have substantial implications for the treatment of mental illness, as current programs could be modified to target behaviors or skills that are contributing to this impairment. If it is found that receptive emotional skills, such as identifying facial and vocal affect, are related to the varying domains of social functioning, then this information could be incorporated into current rehabilitation efforts. Improved social functioning in BPD could greatly contribute to enhancing the quality of life of patients with this severe and chronic form of mental illness.

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