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ORIGINAL ARTICLE

Theory of mind and social inference in children and adolescents with bipolar disorder

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Background. Deficits in theory of mind (ToM), or the ability to infer what another person is thinking or feeling, have been reported in manic and euthymic adults with bipolar disorder. To date, there have been no investigations of ToM in pediatric bipolar disorder (PBD). The aim of the current study was to investigate this ability in PBD patients and healthy controls.

Method. PBD patients ($n=26$) and intellectually and demographically similar healthy comparison subjects ($n=20$) were administered two ToM tasks. In the Affective Story Task, subjects were read positive-, negative- and neutral-valenced stories, and were assessed on their ability to recognize that a misleading series of events could lead one character to develop a false belief about another character. On the Hinting Task, subjects were required to infer the real intentions behind subtle hints.

Results. The PBD group performed significantly more poorly than controls on the Hinting Task and the positive and negative conditions of the Affective Story Task. In the PBD group only, younger age, earlier illness onset and manic symptoms were associated with poorer ToM performance.

Conclusions. Consistent with past findings in adult bipolar disorder (BD), PBD youth performed more poorly than controls on ToM tasks. Data suggest that ToM ability may be more impaired in affectively charged contexts. Additionally, an earlier onset of illness among PBD youth may interfere with the development of social-cognitive skills. ToM disturbances may be a useful treatment target in PBD, with the aim of facilitating more accurate assessment of social cues and better interpersonal functioning.

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Key words: Pediatric bipolar disorder, social cognition, social inference, theory of mind.

Introduction

Many children and adolescents with pediatric bipolar disorder (PBD) exhibit persistent functional disability, including significant impairments in social and interpersonal functioning (Geller *et al*. 2002, 2004; see Pavuluri *et al*. 2005 for a review). Studies aimed at elucidating the mechanisms underlying interpersonal functioning impairments in PBD can aid in our understanding of the disorder, and help in the development of more effective treatment strategies (McClure *et al*. 2005*a*). Several recent investigations have demonstrated neurocognitive and neuropsychological impairments among PBD youth (Dickstein *et al*. 2004, 2007; Meyer *et al*. 2004; Doyle *et al*. 2005; McClure *et al*. 2005*b*; Pavuluri *et al*. 2006*a*). Investigations have also demonstrated impairments in social cognition in PBD, most notably on tasks of facial affect processing (McClure *et al*. 2003, 2005*a*; Rich *et al*. 2006). However, significantly less attention has been paid to aspects of social cognition in PBD that involve high-level cognitive processes such as social inference and attributions. For example, there have been no studies of theory of mind (ToM) in PBD, which is the ability to infer what another individual is thinking or feeling based on their verbal and/or non-verbal cues in the context of ongoing behavior and events.

ToM is central for successful social interaction. The ability to understand the intentions of others forms the basis for a correct understanding of the events, beliefs and behaviors that comprise everyday interpersonal interaction (Flavell, 1999; Tager-Flushberg & Sullivan, 2000). The precursors for developing ToM ability, including an appreciation of the intentionality and goal-directedness of human actions, are apparent in the first few months of life (Flavell, 1999; Wellman & Lagattuta, 2000). The development of ToM ability becomes more evident between the ages of 3 and 5 years with the understanding of deception, and continues to

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develop in more sophisticated forms throughout childhood and adolescence (Flavell, 1999; Flavell *et al*. 1999; Wellman & Lagattuta, 2000).

Impairments in ToM have been studied extensively in autism spectrum disorders, and are thought to be a core feature of the illness (see Baron-Cohen, 2000 for a review). ToM impairments have also been documented in other psychiatric disorders such as schizophrenia (Corcoran *et al*. 1995; Corcoran & Frith, 1996; Frith & Corcoran, 1996; Greig *et al*. 2004; Schenkel *et al*. 2005) and depression (Inoue *et al*. 2004). In schizophrenia, impaired ToM ability has been linked with poorer childhood social functioning, suggesting that ToM impairments in this population may begin early in the formative years of social development, prior to illness onset (Schenkel *et al*. 2005).

There have been only a few studies of ToM in adult bipolar disorder (BD), and findings demonstrate impairments among symptomatic (Kerr *et al*. 2003) and euthymic patients (Bora *et al*. 2005; Olley *et al*. 2005). Compared to healthy subjects, adult BD patients show poorer performance on measures of social inference (Bora *et al*. 2005), and on first- and second-order false-belief tasks (first order = to infer another person's mental state; second order = to infer one person's mental state about another person's mental state; Kerr *et al*. 2003; Olley *et al*. 2005).

To our knowledge, there have been no investigations that have directly examined ToM ability in PBD samples. This is surprising, given the significant impairments in social functioning that have been demonstrated among PBD youth (see Pavuluri *et al*. 2005 for a review). In particular, a number of investigations have demonstrated more problematic parent–child relationships in PBD samples, including greater parent–child conflict and less warmth (Geller *et al*. 2000, 2002; Schenkel *et al*. in press), as well as more problematic interactions with peers (Geller *et al*. 2000, 2002). Poor interpersonal functioning has been associated with impairments in ToM and social inference abilities in other psychiatric disorders such as schizophrenia and autistic spectrum disorders (Baron-Cohen & Belmonte, 2005; Schenkel *et al*. 2005; Shamay-Tsoory *et al*. 2007), and suggest abnormalities in the functional connectivity for brain regions subserving social cognition such as the amygdala, orbitofrontal cortex and medial frontal cortex (Baron-Cohen & Belmonte, 2005). These are the same systems that have been implicated in investigations of affective circuitry dysfunction in PBD youth (Chang *et al*. 2004; Pavuluri *et al*. 2007).

Although there have been no previous investigations that have directly examined ToM ability in PBD, McClure *et al*. (2005*a*) investigated social-cognitive impairments in PBD youth, and reported impaired performance on a measure of pragmatic language ability (i.e. the ability to formulate socially appropriate responses to interpersonal situations), and on tasks of positive and negative facial expression recognition. Consistent with these findings, we have demonstrated facial affect processing impairments in both acutely ill and euthymic PBD patients, with both groups tending to rate extreme emotional expressions as less intense compared to controls (Schenkel *et al*. 2007). Investigating ToM in acutely ill, unmedicated PBD patients is an important first step in identifying possible social-cognitive impairments in this population, and in helping to rule out the possibility that these impairments could be due to medication effects on perceptual and cognitive processes. Additionally, studies clarifying the nature of ToM difficulties in acutely ill PBD samples can help to pave the way for the development of pharmacological and psychosocial interventions that consider ToM as a treatment target.

The aim of the current study was to investigate false belief and social inference ability in an acutely ill PBD sample and matched healthy comparison subjects. Given the findings from adult bipolar samples, we hypothesized that youth with PBD would show impairments on ToM tasks. The second aim of the study was to examine ToM ability within the context of emotionally valenced (i.e. positive and negative) *versus* neutral scenarios.

Method

Subjects

PBD subjects were recruited from the Pediatric Mood Disorders Clinic at the University of Illinois at Chicago (UIC). The Institutional Review Board approved the study. Verbal or written assent was provided by all children in addition to written informed consent by their parents. The PBD ($n = 26$) and healthy comparison subjects recruited from the community ($n = 20$) were between the ages of 8 and 18 years. Both groups were not significantly different on age, sex, parental socio-economic status and intelligence as assessed by the two-subtest version of the Wechsler Abbreviated Scale of Intelligence (WASI; Wechsler, 1999). Inclusion criteria for the PBD group were a current diagnosis of BD type I, mixed ($n = 9$) or manic ($n = 5$) state, or BD type II, hypomanic ($n = 8$) or depressed ($n = 4$) state, and medication free for at least 1 week prior to testing. We included subjects who manifested at least two of the three core symptoms of PBD (i.e. elated mood, irritability and grandiosity). Subjects who presented with irritable mood in the absence of elated mood and/or grandiosity were not included (Leibenluft *et al*. 2003; Pavuluri *et al*. 2006*b*). In the PBD group, 15 subjects (58%) had a co-morbid diagnosis of attention

Table 1. *Demographic and clinical characteristics of healthy comparison and pediatric bipolar disorder (PBD) subjects*

	Healthy subjects	PBD subjects	*p* value
Variable, mean (S.D.)			
Age (years)	13.03 (3.39)	13.19 (3.21)	0.87 ($t=0.17$)
Socio-economic status[a]	1.61 (0.79)	1.66 (0.81)	0.45 ($t=0.77$)
YMRS	1.10 (2.00)	20.80 (9.27)	<0.0001 ($t=10.33$)
CDRS-R	19.20 (2.29)	52.00 (16.89)	0.0001 ($t=9.60$)
WASI IQ	111.90 (16.76)	107.29 (15.64)	0.36 ($t=0.93$)
Sex, *n* (%)			0.66 ($\chi^2=0.20$)
Male	11 (55)	16 (62)	
Female	9 (45)	10 (38)	
Race, *n* (%)			0.56 ($\chi^2=0.35$)
Caucasian	13 (65)	19 (73)	
Other	7 (35)	7 (27)	

WASI, Wechsler Abbreviated Scale of Intelligence; YMRS, Young Mania Rating Scale; CDRS-R, Children's Depression Rating Scale-Revised.

[a] Rated with the Hollingshead Index of Social Position (Hollingshead, 1975).

deficit hyperactivity disorder (ADHD). Healthy comparison subjects were euthymic, with Young Mania Rating Scale (YMRS; Young *et al*. 1978) scores of $\leqslant 8$ and Children's Depression Rating Scale-Revised (CDRS-R; Poznanski *et al*. 1985) scores of $\leqslant 40$. None of the subjects in the healthy comparison group met DSM-IV (APA, 1994) criteria for any major psychiatric disorder (see Table 1).

Each child and at least one of their parents were interviewed using the Washington University St Louis Kiddie Schedule for Affective Disorders and Schizophrenia (WASH-U-KSADS; Geller *et al*. 1998), along with a comprehensive clinical interview. Clinical information from all available sources was combined to provide a consensus clinical diagnosis. The WASH-U-KSADS interviews as well as the YMRS and CDRS-R were completed by trained masters or doctoral-level raters who had no knowledge of social cognition test performance. κ (WASH-U-KSADS) and intra-class correlation coefficients (ICCs) (YMRS and CDRS-R) for total scores on the clinical rating scales were maintained above the level of 0.90.

Exclusion criteria for the entire sample were active substance abuse, serious medical problems, IQ <70, diagnosis of autism or other pervasive developmental disorder, or the presence of another DSM-IV Axis I diagnosis that required psychiatric intervention of any kind, with the exception of ADHD.

Procedure

The Affective Story Task. This task was developed for the current study as a measure of ToM ability within the context of emotionally charged situations. It is a measure of false-belief understanding (i.e. one character's beliefs about the mental state of another character) and consists of positive-, neutral- and negative-valenced stories. Stories were matched on word length, complexity (i.e. details, dialogue, characters and events) and semantic structure. The positive, neutral and negative stories reflected content consistent with subjective experience characteristic of manic, euthymic or depressed states respectively. To ensure that results were not a function of specific stories, three stories from each condition were generated, and each subject received one story from each of the three conditions. Each story was read aloud to patients and the order of conditions was counterbalanced across subjects to control for order effects. Stories were gender specific; female subjects received the female story version and male subjects received the male story version. Subjects were assessed on their ability to recognize that a misleading series of events could lead one of the characters in the story to develop a false belief about another character's mental state. At the end of each story, subjects were asked a false-belief question that assessed whether they understood the potential for misunderstanding. Subject responses to the false-belief questions were scored dichotomously (correct *versus* incorrect) by doctoral-level research staff blind to the diagnostic group. In addition to assessing false-belief understanding, subjects were asked a 'control' question to assess story comprehension and understanding. Reliability of the responses to all of the false-belief questions (i.e. all subjects in all three conditions) was calculated by having two independent raters, who were unaware of subject group, rate each of the ToM and control responses.

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κ coefficients ranged from 0.89 to 0.93. Examples from the positive, neutral and negative story conditions are provided in the Appendix, Example 1.

The Hinting Task (*Corcoran et al. 1995*). This task is a measure of the ability to infer the 'real intentions' behind indirect comments. It consists of 10 short passages, each describing a social interaction between two characters that ends with one character 'dropping' a hint to the other. Subjects were required to infer the actual meaning of the hint. If a subject failed to give a correct answer, a more obvious hint was provided. An appropriate response to the first hint was scored with two points. If a correct response was given only after a more obvious hint, a score of one was given. If the subject failed to give a correct answer to either of the two hints, a score of zero was given. The maximum total score was 20 points. Passages from the original Corcoran *et al*. (1995) stories were adapted to the local vernacular, and some of the story content was altered to be more age appropriate for a pediatric sample. Passages were read aloud and repeated if necessary for adequate comprehension. An example is provided in the Appendix, Example 2.

Statistical analyses

On the Affective Story Task, data from subjects who did not answer correctly the control question for that story were excluded. Data from one healthy comparison subject in the positive story condition and one PBD subject in the negative story condition were excluded on this basis. Proportions of correct responses per group were compared across the three conditions. Fisher's p was used to compare dichotomous data from the three task conditions because Fisher's p is less influenced by imbalanced cells or small sample sizes than the χ^2 statistic. Associations between performance on the two ToM tasks and age and level of symptomatology were analyzed separately for each of the two diagnostic groups.

Results

On the Affective Story Task, the PBD group performed significantly more poorly than matched controls in the positive ($\chi^2=5.81$, $p<0.05$) and negative ($\chi^2=5.52$, $p<0.05$) story conditions, and there was a trend ($\chi^2=4.02$, $p=0.06$) towards poorer performance in the neutral condition (see Table 2 for the mean percentage correct in each group). Differences in performance between each of the affective conditions (i.e. positive and negative) and the neutral condition were computed separately for the PBD and control groups. PBD patients performed significantly more poorly in the negative story condition than in the positive story condition ($\chi^2=7.23$, $p<0.01$), and there was a trend towards poorer performance in the negative condition compared to the neutral condition ($\chi^2=3.60$, $p=0.09$). There were no significant differences between performance in the positive compared to the neutral condition ($\chi^2=1.89$, $p=0.21$). Among healthy comparison subjects, there were no significant differences between any of the three conditions ($p>0.05$).

Table 2. *Mean percentage correct* (*standard deviation*) *and significance values for the healthy comparison and pediatric bipolar disorder* (*PBD*) *subjects on the Affective Story Task and the Hinting Task*

	Healthy subjects	PBD subjects	p value
Affective Story Task			
Positive condition	95 (31)	64 (49)	<0.05
Negative condition	90 (31)	58 (51)	<0.05
Neutral condition	95 (22)	72 (46)	0.06
Hinting Task	90 (10)	70 (21)	<0.001

In the PBD group, increased symptoms of mania on the YMRS were associated with failure to answer the false-belief question correctly in the negative story condition of the Affective Story Task ($r=-0.44$, $p<0.05$). There were no significant associations between YMRS scores and performance on the positive ($r=-0.28$, $p=0.19$) or neutral ($r=-0.31$, $p=0.15$) story conditions among PBD youth. There were also no significant associations between increased symptoms of depression on the CDRS-R and performance on the positive ($r=-0.30$, $p=0.16$), negative ($r=12$, $p=0.58$) or neutral ($r=0.16$, $p=0.46$) conditions. Among controls, there were no significant associations between YMRS and CDRS-R scores and performance on the Affective Story Task. Performance on the Affective Story Task was not associated with age or age at first diagnosis (PBD only) for PBD youth or controls (p's >0.05). Age was also not correlated with YMRS or CDRS-R scores in either group (p's >0.05).

On the Hinting Task, the PBD group scored significantly lower than controls [$t(37)=4.37$, $p<0.001$]. Among PBD patients, poorer Hinting Task performance was correlated significantly with younger age ($r=0.66$, $p<0.001$) and an earlier age at first diagnosis ($r=0.58$, $p<0.01$). By contrast, among healthy comparison subjects, there was no significant relationship between age and performance on this task ($r=0.08$, $p=0.74$). Among PBD patients, higher YMRS scores were associated with poorer performance on the Hinting Task ($r=0.57$, $p<0.01$). There were no significant relationships between CDRS-R scores and

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Hinting Task performance in the PBD group ($r = -0.04$, $p = 0.84$).

To examine the effects of co-morbid ADHD status on ToM among PBD youth, a series of analyses were performed examining differences between PBD youth with co-morbid ADHD *versus* those without ADHD. There were no significant group differences between PBD + ADHD and PBD-only subjects on any of the Affective Story Task conditions [positive ($\chi^2 = 0.26$, $p = 0.61$), negative ($\chi^2 = 1.33$, $p = 0.25$), neutral ($\chi^2 = 0.53$, $p = 0.47$)]. However, significant differences were observed on the Hinting Task [$t(24) = 2.70$, $p < 0.05$], with the PBD + ADHD group performing significantly more poorly (mean = 12.33, S.D. = 4.13) than the PBD-only group (mean = 16.27, S.D. = 2.94). PBD + ADHD youth also had significantly higher symptoms of mania on the YMRS [$t(25) = 4.40$, $p < 0.001$] compared to PBD-only youth. There were no significant differences on CDRS-R scores between the PBD + ADHD and PBD-only groups.

Differences on the ToM tasks between BD types I and II were also examined. There were no significant differences between BD I and II youth on the positive ($\chi^2 = 0.65$, $p = 0.68$) or negative ($\chi^2 = 0.47$, $p = 0.69$) Affective Story Task conditions, and there was a trend towards poorer performance among BD I youth in the neutral condition ($\chi^2 = 3.48$, $p = 0.09$). On the Hinting task, the BD I group (mean = 12.50, S.D. = 4.75) performed significantly more poorly than the BD II group (mean = 15.75, S.D. = 2.38) [$t(24) = 2.25$, $p < 0.05$]. There was a trend towards greater manic symptomatology on the YMRS in the BD I group [$t(24) = 1.84$, $p = 0.08$]. There were no significant differences between youth with BD I and BD II on the CDRS-R [$t(24) = 1.23$, $p = 0.23$].

Discussion

Evidence for ToM deficits in PBD

This is the first investigation of ToM ability in patients with PBD. Consistent with past findings in adult BD populations (Kerr *et al*. 2003; Bora *et al*. 2005), PBD youth performed significantly more poorly on measures of false belief and social inference ability compared to matched healthy subjects. Data from this study also suggest that ToM ability in PBD is more impaired in affectively valenced situations, perhaps especially in negatively valenced contexts, which is consistent with past investigations demonstrating more impaired cognitive functioning among PBD patients when placed in emotionally challenging circumstances (Rich *et al*. 2005).

Like other psychiatric disorders such as schizophrenia (Uhlhaas *et al*. 2006), deficits in ToM were noted to be related to acute symptom severity. Although these results could be interpreted as secondary to poor attention due to interference from acute symptoms, this is unlikely because attention and comprehension for story content were controlled for by using data from only those subjects who correctly answered the control questions in the Affective Story Task. Additionally, passages on the Hinting Task and the Affective Story Task were repeated if necessary, to ensure adequate comprehension. In light of this, however, it is impossible to rule out entirely the contribution of attentional factors on task performance. Interestingly, PBD youth with a co-morbid diagnosis of ADHD performed more poorly on the Hinting Task compared to PBD youth without co-morbid ADHD. However, it is unclear whether attentional factors accounted for these differences or whether they were related to a more severe form of psychopathology in the co-morbid group (i.e. increased symptom severity and greater functional impairment), as PBD youth with ADHD evidenced significantly greater manic symptomatology on the YMRS compared to PBD youth without co-morbid ADHD. Consistent with the latter explanation, we also found poorer performance on the Hinting Task among youth with BD type I compared to type II. Future studies of ToM in PBD that also investigate aspects of attention and concentration, and their influence on task performance, among PBD youth with and without co-morbid ADHD are warranted.

ToM ability and age of illness onset

Both age and earlier illness onset were associated with poorer ToM performance on the Hinting Task in the PBD group. The ability to understand another person's mental state develops gradually throughout childhood and adolescence (Wellman & Lagattuta, 2000). Thus, the significant association between age and earlier onset of PBD with ToM deficits may indicate that PBD can interfere with the development of social cognition abilities, with potentially long-term impact on social skills. Consistent with this hypothesis, an earlier age of illness onset has been associated with a more severe form of the disorder among bipolar samples (Carter *et al*. 2003; Craney & Geller, 2003). This suggests significant developmental consequences of PBD, with more pronounced impairments in empathy and perspective taking the earlier the disorder develops. Early disruptions in empathy and perspective taking would probably result in significant impairments in the formation of social networks, and reduced opportunities to interact socially and develop social-cognitive skills, which in turn would exacerbate the severity of ToM impairments.

For example, among preschool-aged children in the general population, higher rates of success on false-belief tasks have been associated with more cooperative play with siblings (Dunn *et al*. 1991), and social competence with peers (Watson *et al*. 1999).

ToM ability and symptomatology

Among PBD patients, increased symptoms of mania were associated with poorer performance on both the Hinting Task and the negative condition of the Affective Story Task. Furthermore, the finding that the ToM impairment was more pronounced with negatively valanced stimuli further suggests that mood-incongruent stimuli may be most disruptive for manic PBD patients. Consistent with this possibility, past investigations report greater affect processing impairments for negative *versus* positive stimuli among manic adults (Lembke & Ketter, 2002; Lennox *et al*. 2004). A possible mechanism operative in impaired perspective taking and social inference difficulties in PBD patients, especially those in manic states, may be that they are too 'internally focused' to perform well on ToM tasks, which require taking the focus off oneself and adopting the perspective of another person (Kerr *et al*. 2003). It is important to note that we did not find a relationship between increased symptoms of depression and performance on the ToM tasks. Because PBD youth in this sample presented with greater symptoms of mania compared to depression, it is difficult to draw any definitive conclusions on the association of depressive symptoms and ToM performance. Future investigations that include a broader range of symptom profiles (e.g. children in manic, euthymic and depressed states), as well as studies that examine both prepubertal and adolescent PBD youth, are needed to better address relationships between depressive and manic symptomatology, and the development of ToM ability in PBD samples.

Neural circuitry in ToM and PBD

Findings from this study imply that, in PBD, there is abnormally high interference from emotional activity on higher level cognitive abilities, such as those used in perspective taking. This possibility is supported by findings that the neural systems implicated in BD overlap considerably with the circuitry thought to be involved in ToM. Circuitry implicated in ToM includes the cingulate cortex (error monitoring and selection of correct responses; Berthoz & Blair, 2002; Völlm *et al*. 2006), the medial prefrontal cortex (self-referencing abilities; McGuire *et al*. 1996; Mitchell *et al*. 2002; Völlm *et al*. 2006), the orbitofrontal cortex (processing and evaluating emotional stimuli; Adolphs, 2002; Phan *et al*. 2004; Rolls, 2004; Hynes *et al*. 2006) and the amygdala (receiving and appraising emotional experience; Adolphs, 2001; Blair, 2003). In line with these findings, structural and functional abnormalities in the amygdala, anterior cingulate, medial prefrontal cortex, dorsolateral prefrontal cortex and orbitofrontal cortex, and their connections, have been implicated in BD (Blumberg *et al*. 1999; Yurgelun-Todd *et al*. 2000; Chang *et al*. 2004; Pavuluri *et al*. 2004, 2007; Altshuler *et al*. 2005; Kronhaus *et al*. 2006; Kruger *et al*. 2006). The tasks used in this study involved both cognitive and emotional perspective taking. Recent imaging research suggests that there are common pathways involved in emotional and cognitive perspective taking (medial prefrontal cortex and temporoparietal junction; Hynes *et al*. 2006; Völlm *et al*. 2006), along with unique systems recruited for emotional perspective taking (orbitofrontal cortex, cingulate cortex and amygdala; Hynes *et al*. 2006; Völlm *et al*. 2006). Future studies of the neural circuitry involved in both cognitive and emotional perspective taking in PBD can provide valuable information about the mechanisms involved in social disability in PBD. Longitudinal studies that follow patients from euthymic through symptomatic periods (or vice versa) would more firmly establish the role of specific circuitry changes in the emergence of social cognitive dysfunction in PBD, and help to evaluate their longer-term developmental trajectory through euthymic inter-morbid periods.

The extent to which difficulties in social cognition in PBD reflect emotional interference with language-based processes is also an issue in need of exploration. Clarification of this issue is relevant to this study, as McClure *et al*. (2005*a*) reported impairments among PBD youth on a measure of pragmatic language skills, or the ability to understand appropriate language in varying social contexts, along with the ability to modify verbal responses as necessary. Such a difficulty would interfere with the ability to formulate socially appropriate responses. Similarly, Corcoran (2000) suggested that poor performance on ToM tasks, such as the ones used in this study, is due to impairments in conditional reasoning. However, it is not yet clear whether these types of cognitive disturbances precede the emotional disturbance in PBD or result from it.

Clinical implications

Findings from this study have potential treatment implications. Consistent with the link between poorer social cognition and illness onset, the development of cognitive treatment strategies to improve accurate assessment of social cues might help to reduce the severity of acute episodes and also possibly prevent developmental delays in social cognition and functioning. In addition, the role of pharmacological

intervention in improving social cognition, either directly, or indirectly by reducing emotional interference on social cognitive processes, remains to be explored. Improving social cognitive abilities holds the promise of improved social functioning, thus allowing for the beneficial effects of social support from peers, family and treatment providers. Early identification and intervention for social cognitive impairments in PBD may help to reduce some of the neurodevelopmental consequences of PBD, along with reducing morbidity and risk for relapse.

Appendix

Example 1

We present examples of positive-, neutral- and negative-valenced stories from the Affective Story Task. False-belief and story comprehension (control) questions are also presented.

Positive-valenced

Kathy and Mary live a few short blocks from Julie. On weekends, Kathy, Mary, and Julie usually see each other. On Saturday morning, Julie was getting ready to go to a party at Kathy's house. The doorbell rang just after Julie finished getting dressed. It was Kathy and Mary. They were excited to see Julie. 'Hey, are you ready to go to the party?' they asked. 'Yes, let's go!' Julie said in an excited voice. Julie brought some of her games with her. Before she left, Julie's mother said, 'Have fun at the party. Be back by 6:00 for dinner.' At the party, Julie saw many of her friends from school. The kids in the room were laughing as Julie walked into the room. Julie asked, 'What's going on?' The kids were taking turns telling jokes to each other. Kathy told a joke and Julie laughed so hard she fell on the floor. Julie yelled out 'Good one!' Julie told another joke and everyone laughed even more. Then Kathy's mom came into the room and said it was time to eat. All the kids raced into the kitchen to eat. Julie was the first one to get a piece of pizza. After the pizza, all the kids played the games Julie brought from home. Julie won all of the games she played. Julie got first prize for winning the games and was given a gift to take home. At the end of the party, Julie left with her gift and games. She walked home with Mary. Just before Julie got home, Mary told a joke. Julie started to laugh. She was laughing as she walked into her house. She walked into the kitchen and saw her mother with her little sister. Her little sister was getting ready for a costume party and was wearing a silly mask.

False-belief question: *Why does Julie's mother think she is laughing?*
Control question: *Why do you think she is laughing?*

Negative-Valenced

Sally lives a few short blocks from her school. Every day Sally walks home with her two friends Jane and Susan. Today, Sally walked home alone because Jane and Susan were not around. Sally ate a snack after she got home from school. Sally then decided to go to the park to play outside. The park is a short walk from where Sally lives. Many of the kids from Sally's school hang out at that park. Just before Sally left to go to the park, her mother stopped her on the way out and said, 'Have fun at the park Sally. Be back by 6:00 for dinner.' When Sally got to the park, she saw her friends Jane and Susan from school. Jane and Susan were playing with some other children who Sally did not know. She went over to talk to Jane and Susan and the other kids. Just at that moment, Jane and Susan and the other kids ran to hide behind the slide. Sally went over so see what was going on. She looked behind the slide and asked, 'Hey, what are you doing?' Jane and Susan started laughing. The other children started laughing too. Sally yelled at them, 'Hey, stop laughing. It's not funny!' After that, Jane and Susan began laughing even harder. Sally yelled, 'Shut up!' Everyone kept laughing. Sally yelled even louder. She told the children they were mean and to be quiet. After that, the other children began to make fun of Sally and call her names. Sally started to cry. The children teased her more. Sally screamed and ran home crying. On her way home, Sally was so upset she slipped and fell on the sidewalk. When she got up she noticed a large rip down the front of her pants. When Sally got home, she saw her mother standing in the doorway.

False-belief question: *Why does Sally's mother think she is crying?*
Control question: *Why do you think she is crying?*

Neutral-valenced

Sunday morning Beth woke up and heard her dog Spot barking. Spot usually makes a lot of noise in the morning when she is hungry. Beth went down to the kitchen to eat breakfast and to find Spot. Beth made herself a bowl of cereal to eat. She looked for Spot, but could not find her. Beth finished her breakfast and went upstairs to get dressed. Beth's mother called to her, 'Beth, I am going to the store to get food for Spot.' Beth finished getting dressed. Then she heard her dog Spot barking again. Beth went downstairs to look for Spot a second time. Beth called out to her, 'Spot, where are you!' Beth heard barking coming from the basement. Beth walked over to the basement door and opened it. Spot ran up the stairs barking, and jumped up on Beth. Beth went into the kitchen to look for Spot's food. Beth could not find Spot's food anywhere.

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She looked all over the kitchen. There was no dog food. Beth would have to wait to feed Spot until her mother came back from the store with more food. Just at that moment, Beth's father walked into the kitchen. Beth told her father that Spot did not have any food. Beth's father said, 'There might be an extra bag of dog food in the garage.' Beth found an extra bag of dog food in the garage hidden behind some boxes. She poured some food in a bowl for Spot. Spot ate up all the food quickly. Then Beth went outside to get the mail. Beth's mother came back from the store while Beth was outside. Beth's mother poured some food in Spot's bowl and gave it to her. Spot looked at the food and then walked away. Beth walked into the kitchen and saw her mother with a puzzled look on her face.

False-belief question: *Why does Beth's mother think Spot is not eating the food?*
Control question: *Why do you think Spot is not eating the food?*

Example 2. Sample stimuli from the Hinting Task (Corcoran et al. 1995)

Rebecca's birthday is approaching. She says to her Dad, 'I love animals, specially dogs.'

Question 1: What does Rebecca really mean when she says this?
Answer: She wants her dad to get her a dog for her birthday.

If incorrect answer given to question 1: Rebecca goes on to say, 'Will the pet shop be open on my birthday, Dad?'

Question 2: What does Rebecca want her dad to do?
Answer: She wants her dad to get her a dog for her birthday.

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Declaration of Interest

None.

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