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In Your Eyes: Does Theory of Mind Predict Impaired Life Functioning in Bipolar Disorder?

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Abstract

Background—Deficits in emotion perception and social functioning are strongly implicated in bipolar disorder (BD). Examining theory of mind (ToM) may provide one potential mechanism to explain observed socio-emotional impairments in this disorder. The present study prospectively investigated the relationship between theory of mind performance and life functioning in individuals diagnosed with BD compared to unipolar depression and healthy control groups.

Methods—Theory of mind (ToM) performance was examined in 26 individuals with remitted bipolar I disorder (BD), 29 individuals with remitted unipolar depression (UD), and 28 healthy controls (CTL) using a well-validated advanced theory of mind task. Accuracy and response latency scores were calculated from the task. Life functioning was measured during a 12 month follow-up session.

Results—No group differences for ToM accuracy emerged. However, the BD group exhibited significantly shorter response times than the UD and CTL groups. Importantly, quicker response times in the BD group predicted greater life functioning impairment at a 12-month follow-up, even after controlling for baseline symptoms.

Limitations—The stimuli were static representations of emotional states and do not allow for evaluating the appropriateness of context during emotional communication; due to sample size, neither specific comorbidities nor medication effects were analyzed for the BD and UD groups; preliminary status of theory of mind as a construct.

Conclusions—Results suggest that quickened socio-emotional decision making may represent a risk factor for future functional impairment in BD.

Keywords

emotion; theory of mind; bipolar disorder; depression

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Conflict of interest

The authors declare no conflicts of interest related to the content of this article.

Contributors

Amanda Purcell and June Gruber conceptualized the study idea and design. Amanda Purcell managed the literature searches, undertook all statistical analyses and wrote the first draft of the manuscript. June Gruber contributed to revisions of statistical analyses, manuscript writing, and project funding. Mary Phillips assisted with data analysis and contributed to successive drafts of the paper. All authors contributed to and have approved the final manuscript.

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Introduction

Although the study of emotion perception in psychopathology has garnered increasing attention (e.g. Kring & Sloan, 2010), the specific processes underlying deficits in emotion perception are less clear. Understanding these processes is particularly important to the study of bipolar disorder (BD), a severe psychiatric disorder associated with profound emotion dysfunction (e.g., Johnson et al., 2007; Phillips & Vieta, 2007) and chronic functional impairment (American Psychiatric Association, 2000). The present study examined a particularly salient process associated with emotion perception – referred to as theory of mind (ToM) -- in BD.

Emotion Perception in BD

BD is associated with significant emotion disturbance, including prolonged and heightened emotional reactivity to stimuli and difficulty regulating this reactivity, especially for positive emotions (e.g., Gruber, 2011; Johnson, 2005). One important but understudied feature of emotion disturbance in BD is emotion perception, which involves appraising the emotional significance of a stimulus and accurately identifying its emotional content (Phillips et al., 2003). Previous research has found that BD individuals have a tendency to misidentify negative expressions as positively valenced during mania (Lembke & Ketter, 2002). Additionally, individuals at risk for BD are better able to detect subtle positive facial expressions following a positive mood induction (Trevisani et al., 2008) and demonstrate a bias towards perceiving social touches from strangers as more positive during a validated touch interaction paradigm (Piff et al., 2012). Together, these studies point to possible difficulty in accurately perceiving the emotional content in social stimuli, with a tendency to perceive social stimuli as overly positive.

Social Functioning in BD

BD is associated with profound social impairment that persists across manic, depressed, and remitted mood phases (e.g., MacQueen et al, 2001; Miklowitz, 2011; Coryell et al., 1993; Dilsaver, 2011). During manic mood phases, individuals with BD have demonstrated difficulty in social situations, often engaging in such inappropriate behaviors as meddling, being overly intimate during social encounters, having increased physical contact with others (e.g., sexual activity), and testing limits (Bech et al., 1979; Janowsky et al., 1974). During a depressive mood phase, BD individuals have also been found to have social functioning impairments, including being unable to perform household duties or engage in normal social activities (Simon et al, 2007). Low self-reported social support has also been found to predict depressive symptoms at a 6-month follow-up in manic, depressed, and euthymic BD participants (Johnson et al., 2000). Deficits in psychosocial functioning remain evident even during remission in BD, including strained and limited social relationships, (MacQueen et al., 2001) and work impairment (Goldberg et al., 1995). Troubled social cognition is also associated with remitted BD, including deficits in tests of perspective-taking and emotion recognition in others (Samamé et al., 2012). These studies suggest profound psychosocial impairments in BD as a trait-like marker present across mood phases. However, it is less clear what processes may help explain social functioning difficulties in BD.

Integrating Emotion and Social Functioning in BD: Theory of Mind

Research suggests that BD is characterized by deficits in both emotion perception and social functioning. Studying theory of mind (ToM) in BD allows for an investigation of the underlying processes behind impairments in both emotion perception and social functioning and their clinical significance. ToM is defined as the ability to understand the mental states

of others (Premack & Woodruff, 1978) and is considered a vital component of adaptive social functioning (Frith & Frith, 2003) and is regarded as a promising avenue to understand social functioning difficulties in emotional disorders, ranging from autism spectrum conditions (Baron-Cohen et al., 1997) to schizophrenia (e.g. Frith & Corcoran, 1996). Only recently has ToM ability been explored in BD. In one of the first ToM studies in BD, impairment was reported in currently manic and depressive, but not remitted, BD patients using a false belief task (Kerr et al., 2003). However, more recent work has unveiled deficits in ToM accuracy among remitted BD patients compared to healthy controls using more advanced ToM Tasks (Bora et al., 2005; Malhi et al., 2008; Montag et al., 2009; Lahera et al., 2008). Decreased ToM accuracy and increased ToM response latency (i.e., taking longer to select a response option) have also been reported in remitted BD patients when using story comprehension tasks (Olley et al., 2005). In sum, a growing body of research has suggested ToM deficits across mood phases in BD, yet how these impairments may affect life functioning in BD has yet to be examined. More research is needed to not only better define ToM deficits in BD, but also to understand the clinical importance of ToM performance on life functioning.

The Present Investigation

The present study experimentally investigated ToM using a well-validated and advanced ToM test, the Revised Reading the Mind in the Eyes Task (R-MET; Baron-Cohen et al., 2001) among remitted individuals diagnosed with BD as compared to both a remitted unipolar depressed (UD) and healthy control (CTL) group. Concurrent measurement of both ToM accuracy (ToM_{acc}) and response time (ToM_{rt}) was assessed. Moreover, the prospective clinical significance of ToM in predicting life functioning was assessed at a 12-month follow-up for both clinical groups.

The present investigation builds on prior work in three important ways. First, the present study adopted a transdiagnostic approach to isolate impairments in ToM in individuals with BD relative to a clinical comparison group of individuals diagnosed with UD as well as a healthy control (CTL) group. Previous studies assessing ToM in BD have often lacked a clinical comparison control group (Montag et al., 2009; Malhi et al., 2008; Bora et al., 2005; Olley et al., 2005), making it difficult to isolate disorder specific versus shared ToM impairments across mood disorders. Second, the study isolates the real-world clinical significance of ToM by linking ToM performance with life functioning at a 12-month follow-up assessment. Third, the current study includes BD participants who exhibit comparable levels of cognitive functioning with the comparison control and UD groups. Previous ToM studies in BD typically include participants with significant cognitive impairment compared to healthy controls (e.g., Bora et al., 2005; Montag et al., 2009; Lahera et al., 2008), limiting the ability to carefully tease apart ToM difficulties from more gross cognitive impairment. This multi-method prospective investigation enabled us to test two specific aims:

Specific Aim 1: Group Differences in ToM. The first aim investigated group differences in ToM among the BD compared to the UD and CTL groups. We hypothesized that the BD group would have lower ToM_{acc} and higher ToM_{rt} scores compared to the UD and CTL groups, based on prior work linking remitted BD to deficits in ToM (Bora et al., 2005, Olley et al., 2005). We also conducted exploratory analyses on a subset of emotionally valenced trials to investigate potential group differences specifically for more emotionally-based ToM.

Specific Aim 2: Prospective Associations between ToM and Life Functioning. The second aim investigated the prospective clinical significance of group differences in ToM. Specifically, we investigated associations between significant group differences

in ToM_{acc} and ToM_{rt} with prospective life functioning at a 12-month follow-up for the BD and UD clinical groups. Based on cross-sectional literature linking ToM deficits with impaired interpersonal and life functioning (e.g. Premack & Woodruff, 1978; Frith & Frith, 2003; Baron-Cohen et al. 1997; Frith & Corcoran, 1996) and observed social impairment in BD (Coryell et al., 1993; MacQueen et al., 2001), we hypothesized that ToM deficits would predict increased life functioning difficulties.

Method

Participants

Participants were 26 persons diagnosed with bipolar I disorder (BD). Two comparison groups were recruited in order to compare BD specific findings, including a healthy control (CTL) group comprising of 28 individuals who did not meet current or past criteria for any DSM-IV-TR Axis I disorder (First et al., 2007), and a clinical comparison group of 29 individuals with unipolar depression (UD). Remitted BD and UD participants were selected in order to examine processing independent of current mood phase as well as to examine prospective associations between ToM and life functioning from a minimally symptomatic baseline. Participants were recruited using online advertisements and flyers posted in New Haven, CT and surrounding communities. Exclusion criteria for all participants included history of severe head trauma, stroke, neurological disease, severe medical illness (e.g., autoimmune disorder), or current alcohol/ substance abuse/dependence within the past 6 months. The CTL group did not meet criteria for any current or lifetime Axis I disorder. Demographic and clinical characteristics are listed in Table 1.

Measures of Clinical Functioning

Diagnostic evaluation—DSM-IV Axis I diagnoses were confirmed using the Structured Clinical Interview for DSM-IV by trained clinical interviewers (SCID-IV; First et al., 2007). Approximately one-fourth ($n = 21$) of videotaped interviews were rated by an independent reviewer, and ratings matched 100 % ($\kappa = 1.00$) for primary Axis I diagnoses.

Mood symptoms—Current symptoms of mania were measured using the Young Mania Rating Scale (YMRS; Young et al., 1978). Current symptoms of depression were measured using the Inventory of Depressive Symptomatology (IDS-C; Rush et al., 1996). The YMRS is an 11-item, clinician-rated measure of current manic symptoms with scores ranging from 0 to 60, with higher scores indicating greater manic severity (scores ≥ 7 represent clinically significant manic symptoms). The IDS-C is a 30-item, clinician-rated measure of current depressive symptoms with scores ranging from 0 to 84, with higher scores indicating greater depressive severity (scores ≥ 11 represent clinically significant depressive symptoms). Intra-class correlations (ICC; Shrout & Fleiss, 1979) for absolute agreement for one-third of study participants ($n = 23$) were strong for both the YMRS ($= 0.98$) and IDS-C ($= 0.98$).

Measures of Cognitive Functioning

Similar to prior ToM studies, baseline cognitive functioning was measured, including general intellectual functioning and working memory, to tease apart ToM ability from more general cognitive abilities (e.g., Bora et al., 2005; Olley et al, 2005; Lahera et al, 2008).

General intellectual functioning—The Shipley Institute of Living Scale (SILS; Shipley, 1986) was included as a conventional measure of verbal intellectual functioning in adults. The vocabulary subtest of the SILS was administered, consisting of 40 multiple-choice questions in which the participant is asked to select which one of four words (e.g., laughter, speed, grace, malice) is closest in meaning to the target word (e.g., hilarity). Raw scores range from 0–40. This subtest is stipulated to rely on verbal reasoning skills including

reading ability, verbal comprehension, acquired knowledge, long-term memory, and concept formation. Time to complete the SILS vocabulary subtest is approximately 10 minutes.

Working memory—Participants were administered the letter-number sequencing subtest of the Wechsler Adult Intelligence Scale-III (WAIS-III; Wechsler, 1997). In the Letter-Number sequencing subtest, participants are read aloud a series of increasingly long lists of randomly ordered numerical digits and alphabetical letters. After the list is read aloud, participants are asked to verbally repeat back all numbers (in numerical order) first, followed by all letters (in alphabetical order). This subtest takes approximately 10 minutes to administer. Raw scores were calculated as the total number of trials correct (ranging from 0 to 21), from which age-normed scaled scores were computed and used in final analyses.

Measures of Life Functioning

Life Functioning Questionnaire—Life functioning was assessed using the Life Functioning Questionnaire (LFQ; Altshuler et al., 2002). The LFQ is a 14-item measure that examines functioning in the past month over four different areas including work, duties at home, leisure time with friends, and leisure time with family. Items are scored from 1 (no problem) to 4 (severe problem), with scores calculated for each of the four domains and a fifth overall functioning score. Higher scores reflect greater functioning impairment. Internal consistency was high for all subscales ($\alpha = 0.87$ for work; $\alpha = 0.87$ duties at home; $\alpha = 0.84$ for the leisure time with friends; $\alpha = 0.88$ for leisure time with family).

Measure of ToM Performance

Revised Reading the Mind in the Eyes Task—ToM ability was measured using the Revised Reading the Mind in the Eyes Test (R-MET; Baron-Cohen et al., 2001). The R-MET task consists of 36 individual trials in which the participant must match a single photo of a facial expression with the corresponding emotional mental state word. Each individual trial consists of an image of a person's face focused around the eyes. For each image, participants are asked to choose which mental state is best exemplified by the image from one of four forced-choice options. Following precedent, participants were given a handout that provided the definitions of all words used in case any word meanings were unclear. Completing the R-MET task took approximately 15 minutes. From the R-MET task, both ToM_{acc} and ToM_{rt} scores were derived. ToM_{acc} scores were calculated as proportion of the number of times the participant selected the correct mental state out of 36 trials, ranging from a possible 0% (poor accuracy) to 100% (excellent accuracy). ToM_{rt} scores were calculated as the average time elapsed (in milliseconds) from the moment the trial was presented on screen to when the participant made a response using the computer keypad.

Procedure

Baseline Session 1—Study design and procedures were reviewed and approved by the Yale University institutional review board governing human subjects research. Session 1 consisted of six parts. First, participants provided written and verbal informed consent. Second, the SCID-IV, YMRS, IDS-C, and WAIS-III subtest were administered. Third, participants were oriented to the experiment by the experimenter in front of a 26" high-resolution computer monitor, and given a handout including definitions of all words included in the task to refer to as needed. Fourth, participants completed the R-MET task using computerized software (MediaLab v2008, MediaLab, Inc., Atlanta, GA). Fifth, participants completed a series of questionnaires, including the SILS. Sixth, participants were debriefed and compensated for their participation.

Follow-up Session 2—Session 2 occurred approximately 12 months after Session 1 ($M = 383.62$ days, $SD = 31.09$) during which participants were re-contacted by email/phone and asked to complete an anonymous Qualtrics™ survey online and a separate phone interview with a trained clinical interviewer. Sixteen (62%) BD, 21 (72%) UD, and 25 (89%) CTL participants from Session 1 agreed to participate in Session 2. The present study specifically focused on the LFQ measure obtained from the online survey given our a priori interest in social and general functioning, though we report clinical symptom differences in Table 1.

Results

Demographic and Clinical Characteristics

Demographic and clinical characteristics of the BD, UD, and CTL groups are reported in Table 1. Participants did not significantly differ with respect to age, gender, ethnicity, or education ($ps > 0.40$). At baseline, both the BD and UD group scored lower on the GAF than the CTL group. All groups scored below YMRS (< 7) and IDS-C (< 11) cutoffs, though the BD and UD participants scored somewhat higher than CTL participants on the IDS-C. There were no group differences in general intellectual functioning or working memory scores. At the follow-up, the three groups differed in LFQ scores, $F(2,59) = 3.74$, $p < 0.03$, with pairwise comparisons revealing the CTL group had significantly lower LFQ scores than the UD group ($p < 0.01$), but no significant differences between the CTL group and the BD group or between the UD and the BD group were found.

Preliminary Analyses

First, we confirmed that accuracy and response latency scores were normally distributed using the Kolmogorov-Smirnov test. Second, we examined potential gender differences and found that gender did not significantly affect accuracy performance on the R-MET, $F(1, 83) = 0.20$, $p > 0.65$, or response latency, $F(1, 83) = 0.13$, $p > 0.71$. Given that the BD and UD groups scored significantly higher than the control group in subsyndromal depressive symptoms, it was examined whether IDS-C scores correlated with accuracy or response latency, which they did not for any group ($ps > 0.05$). Furthermore, all groups scored below clinical cut-off scores for current symptom measures. As such, IDS-C scores were not included as a covariate in our analyses. Given that BD has been associated with deficits in cognitive functioning in previous work, we investigated if working memory and general cognitive functioning impacted performance on the R-MET task. Baseline working memory did not correlate with accuracy or response latency on the ToM task ($ps > 0.20$), and so we did not include working memory scores as a covariate in our analyses. However, SILS scores were highly correlated with total task accuracy, such that high SILS scores predicted higher task accuracy ($p < .05$). Thus, SILS scores were included in all analyses as a covariate.

Specific Aim 1: Group Differences in ToM—The study's first aim was to examine group differences in ToM_{acc} and ToM_{rt} scores between the BD, UD, and CTL groups. ANCOVAs were performed with Group (BD, UD, CTL) as the between subjects factor separately for both ToM_{acc} and ToM_{rt} . Consistent with our hypotheses, the three groups did differ in ToM_{rt} scores, however follow-up pairwise comparisons revealed that BD participants had significantly faster response times (i.e., lower ToM_{rt} scores) compared to both the UD and CTL groups, who did not themselves differ (See Table 2). Contrary to our hypotheses, ToM_{acc} scores did not significantly differ between groups.

Exploratory follow-up analyses were conducted to examine potential group differences in the emotionally valenced R-MET trials. Specifically, three independent raters dichotomously evaluated each trial for emotional valence (positive affect, negative affect, or

no emotional valence) with good inter-rater reliability ($\kappa = 1.0$) across the 36 ToM trials. 28 trials were selected as the emotional ToM subset (eToM) and analyses were run on the eToM_{acc} and eToM_{rt}. Based on these trials, we note that the three groups differed in eToM_{rt} scores, such that BD participants had significantly quicker response times to emotional trials (i.e., lower eToM_{rt} scores) than both the UD and CTL groups, who did not themselves differ (See Table 2). Groups did not differ in ToM_{acc} on the emotional R-MET trials.

Specific Aim 2: Prospective Associations between ToM and Life Functioning

—Across all participants, the follow-up study completers did not significantly differ from non-completers with respect to age, ethnicity, years of education, YMRS scores, or ToM_{acc} and ToM_{rt} scores ($ps > 0.10$), but did have higher GAF ($p < 0.01$) and SILS ($p < 0.05$) scores, and lower IDS-C scores ($p < 0.001$) compared to non-completers. Completers did not differ from non-completers in SILS, illness duration, age of onset, number of manic episodes, number of depressive episodes, psychotropic medication use, or number of current comorbidities ($ps > 0.05$). For the BD group, completers differed from non-completers with respect to having higher IDS-C scores ($p < 0.05$). For the UD group, completers had higher working memory scores ($p < 0.05$) and a greater percentage were female ($p < 0.05$) than UD non-completers. For the CTL group, completers did not differ from non-completers in any demographic variables ($p < 0.26$). Potential gender differences were examined and it was found that gender did not significantly affect total accuracy or response latency on the R-MET among BD, UD, or CTL groups ($ps > 0.30$). As the BD group significantly differed from the UD and CTL groups in depressive symptoms at the time of the R-MET task, these IDS-C scores were included as a covariate in analyses to control for baseline symptom levels. As in Aim 1, SILS scores were included in analyses to control verbal functioning in the R-MET task.

Aim 2 examined whether significant group differences that emerged in Aim 1 (i.e., ToM_{rt}) prospectively predicted impaired life functioning at the 12-month follow-up. Linear regressions using the SILS and baseline IDS-C scores as covariates revealed that lower ToM_{rt} scores (i.e., faster response time) predicted increased overall life functioning impairment for the BD group, specifically within the home duties subscale (See Table 3). Moreover, higher ToM_{rt} scores (i.e., slower response times) predicted increased impairment in the leisure time with family subscale for the UD group specifically. Exploratory analyses examining emotionally valenced trials revealed that lower eToM_{rt} scores predicted greater overall life functioning difficulties for the BD group, specifically within the home duties and work duties subscales.

Discussion

Research suggests that BD is characterized by deficits in emotion perception and social functioning. One way to investigate the relationship between emotion perception and social functioning is by studying theory of mind. The present study experimentally investigated ToM ability among remitted individuals diagnosed with BD as compared to both the UD and CTL groups. Concurrent measurement of both ToM accuracy (ToM_{acc}) and response time (ToM_{rt}) was assessed. The prospective clinical significance of ToM performance in predicting life functioning was assessed at a 12-month follow-up for both clinical groups.

Aim 1: Group Differences in ToM

The first aim investigated group differences in ToM among the BD compared to the UD and CTL groups. We hypothesized that the BD group would have lower ToM_{acc} (i.e., worse accuracy) and higher ToM_{rt} (i.e., slower item selection responsivity) scores compared to the UD and CTL groups. The current study found that the BD group recorded shorter response

times during the general ToM trials than both the UD and CTL groups. In exploratory analyses, the BD group also had significantly lower $eToM_{rt}$ scores compared to the UD and CTL groups. The current study found no group differences in ToM accuracy, consistent with previous findings reporting no ToM accuracy deficits in euthymic BD patients (Kerr et al, 2003). Additionally, exploratory analyses revealed no systematic group differences in ToM accuracy for more “emotional” trials, consistent with previous findings that euthymic BD patients have preserved emotional mentalizing abilities (Montag et al., 2010).

There are two potential explanations for the present set of findings. First, it is possible that the null findings for group differences in ToM are reflective of preserved performance in remitted BD. This is consistent with literature documenting similarities in performance on ToM and mentalizing tasks in remitted BD participants (Kerr et al, 2003; Montag et al., 2010). Thus it may be the case that ToM deficits are state-dependent, and covary with symptom severity in BD (Kerr et al, 2003). Although such findings diverge from previous studies that suggest increased response latency in BD (Olley et al, 2005), the present study is unique insofar as the BD group was matched on measures of cognitive functioning with the control comparison group. For example, previous studies have reported impairments in baseline cognitive and executive functioning such as verbal fluency and sustained attention, (Bora et al., 2005; Lahera et al., 2008), baseline cognitive control tasks (Montag et al., 2010) and increased reading and response latency in non-theory of mind trials (Olley et al, 2005). As such, the reported impairment in ToM in these studies may be partially attributable to more general cognitive dysfunction in the BD group rather than specific deficits in ToM ability.

Second it is also possible that some aspects of performance on ToM trials are reflective of trait-like deficits in emotional decision-making in BD. Interestingly, the BD group exhibited shorter response times during the general ToM trials than both the UD and CTL groups. This pattern of quicker responding associated with the BD group may also support the growing research linking impulsivity with BD. Several putative core components of impulsivity include attentional impulsiveness (Barratt, 1972) and the tendency to respond impulsively to emotion states (Whiteside & Lynam, 2001). Prior findings indicate impulsivity is elevated as manic symptoms increase (Najt et al., 2007; Swann, 2009; Swann et al., 2001) and is positively associated with BD even during euthymic periods (Strakowski et al., 2010; Swann et al., 2001; Lombardo et al., 2012). Reduced $eToM$ response times in the current study bolster this notion of impulsive emotional decision-making in euthymic BD. Importantly, these findings were unique to the BD group, and did not generalize to the UD group, suggesting that this pattern of responding is specific to BD. Therefore, it is possible that while the reduced response times do not impact $eToM$ accuracy during remission, this impulsive pattern of attending less to emotional stimuli may contribute to reported difficulties in ToM while symptomatic. Thus, the quick response rates of euthymic BD participants may signal a latent vulnerability toward understanding the emotional states of others during mania.

Aim 2: Prospective Associations between ToM and Life Functioning

The second aim examined the clinical significance of lower ToM_{rt} and $eToM_{rt}$ in the BD group. Specifically, we investigated prospective associations between ToM_{rt} and $eToM_{rt}$ and life functioning at a 12-month follow-up. Consistent with our hypotheses, lower ToM_{rt} and $eToM_{rt}$ scores predicted greater overall life functioning impairment in the BD group uniquely. Examining specific LFQ subscales, it was found that quicker response times predicted increased impairment in home and work duties for the BD group.

Considering the result that lower ToM_{rt} and $eToM_{rt}$ scores predicted greater life functioning impairment at a 12 month follow-up, this study suggests that making quick emotional

inferences in social situations is an important mechanism in understanding functional impairment in BD. This study demonstrates that the time course of perceiving emotional cues plays an important role in social functioning. Furthermore, the results were robust despite the small sample size and limited power, providing an important first step for future prospective designs analyzing emotional ToM in BD. These results provide persuasive evidence that the temporal dynamics of perceiving emotional states of others is an important mechanism in understanding life functioning in BD.

Greater ToM response latency predicted increased impairment in the leisure time with family subset for the UD group. While further research should examine ToM performance in UD, these results may support the research linking social withdrawal in daily life with subclinical UD (e.g., Brown et al., 2011). Importantly, these results are in contrast to the findings that shorter response times predict life functioning impairment in BD, providing support that the temporal dynamics of socio-emotional decision making may be distinct among mood disorders.

Limitations and Future Directions

The present investigation should be interpreted within the confines of several caveats. First, the R-MET task, although an advanced theory of mind task, only examines the attribution of mental states, and does not investigate the ability to infer the environment context of mental states (Baron-Cohen et al, 2001). Understanding the context of emotional communication has important social implications, and future research should focus on studying the ability to perceive the context appropriateness of emotions in BD using dynamic tasks. Related, although the R-MET task is a well-validated advanced theory of mind task, it does have ecological validity constraints, including utilizing static photos as stimuli, allowing unlimited time to make a response, and only including regions around the eyes in the images instead of the entire face. Second, although theory of mind has garnered increasing attention given its relevance to psychopathology, additional research on this preliminary construct is warranted. Third, although this study is one of the first to examine emotional theory of mind in BD, the trials used were limited, and did not represent the entire spectrum of normal emotional expression. Additional research sampling a broader array of emotional states and emotional expressions is warranted. Fourth, given the challenges of accessing an unmedicated BD sample, we were unable to investigate the influence of medication effects on results. However, future studies with larger sample sizes, assessment of blood serum levels, and random assignment of individuals on different medication classes are warranted. Fifth, in order to obtain ecologically valid populations, participants were not excluded from the BD and UD groups on the basis of comorbidities; future studies are warranted to examine the specificity of theory of mind performance in individuals diagnosed only with BD or UD. Sixth, we note that the present task compliance rates are impressive given the severe nature of the psychiatric groups recruited and complexity of the measured variables. However, it is still critical to replicate these findings in a larger sample. Seventh, BD participants were currently remitted at the time of testing which represented a relative strength insofar as it enables the identification of vulnerability factors during the remission period that enabled us to examine associations with impairment. Nonetheless, it will be critical to examine the relative influence of depressive and manic mood symptoms in order to more carefully isolate trait versus more state-related features of theory of mind in this disorder. Eighth, concurrent measurement of theory of mind ability using both laboratory and more naturalistic methods (e.g., dyadic interactions or experience-sampling techniques) would throw light on the relationship between emotion perception and bipolar disorder in everyday life. Finally, lack of group differences in cognitive ability limit the generalizability of the results, given that it is common in BD to have comorbid cognitive impairment. However, this study was careful to select a BD group with significant illness course severity,

as evidenced by comparable clinical characteristics to other studies such as illness duration, age of onset, number of manic episodes, and number of depressive episodes (e.g. Bora et al., 2005, Malhi et al, 2008). Therefore, we suggest that having limited cognitive deficits is a considerable strength to the study, as it allowed for the separation of ToM performance from general cognitive functioning.

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Table 1

Demographic and Clinical Participant Characteristics

Demographics	Session 1 (Baseline)				Session 2 (12-Month Follow-up)				Statistic
	BD n=26	UD n=29	CTL n=28	Statistic	BD n=16	UD n=21	CTL n=25	Statistic	
Age (Yrs)	29.62 (8.45)	31.97(11.4)	32.11 (8.96)	F = 0.46	31.19 (9.72)	33.25 (11.18)	32.56 (9.48)	F = 0.19	
Female (%)	65%	68%	64%	$\chi^2 = 0.08$	63%	80%	60%	$\chi^2 = 2.23$	
Caucasian (%)	88%	90%	89%	$\chi^2 = 0.02$	94%	90%	88%	$\chi^2 = 0.31$	
Education (Yrs)	15.33 (2.23)	15.24 (2.26)	16.04 (2.47)	F = 0.97	15.59 (2.29)	15.24 (2.51)	16.13 (2.59)	F = 0.73	
YMRS	1.88 (2.04)	1.59 (1.80)	1.11 (1.79)	F = 1.18	1.38 (1.71)	1.61 (1.69)	1.24 (1.85)	F = 0.27	
IDS-C	5.85 (3.55)	5.55 (3.07)	1.96 (2.12)	F = 14.80**	4.25(3.28)	5.38 (2.69)	2.12 (2.17)	F = 8.89**	
GAF	76.38 (5.54)	79.10 (7.01)	87.89 (3.10)	F = 33.06**	76.94 (6.36)	80.52 (5.64)	88.00 (3.23)	F = 26.31**	
WAIS-III	10.73 (3.15)	12.03 (2.78)	12.04 (3.10)	F = 1.68	10.44 (3.05)	12.71 (2.57)	11.84 (3.14)	F = 2.73	
SILS	32.5 (3.72)	33.48 (4.23)	33.36 (3.06)	F = 0.56	33.13 (3.70)	33.86 (4.48)	33.56 (3.10)	F = 0.17	
LFQ Overall	-	-	-	-	1.50 (0.47)	1.70 (0.56)	1.29 (0.50)	F=3.74*	
LFQ Work	-	-	-	-	1.61 (0.66)	1.58 (0.67)	1.31 (0.70)	F=1.31	
LFQ Home	-	-	-	-	1.55 (0.67)	1.76 (0.81)	1.30 (0.57)	F=2.61	
LFQ Friends	-	-	-	-	1.38 (0.45)	1.75 (0.64)	1.24 (0.40)	F=5.89**	
LFQ Family	-	-	-	-	1.38 (0.54)	1.75 (0.61)	1.29 (0.66)	F=3.31*	
Illness Duration (Yrs)	13.44 (9.27)	15.8 (10.6)	-	-	14.13 (11.24)	15.93 (8.36)	-	-	
Age of Onset	16.27 (7.02)	16.10 (7.61)	-	-	17.13 (7.02)	17.26 (8.28)	-	-	
# (Hypo)Manic Episodes	10.15 (18.83)	-	-	-	7.46 (6.16)	-	-	-	
# Depressive Episodes	13.18 (22.06)	5.76 (7.67)	-	-	17.00 (28.08)	5.57 (8.25)	-	-	
# Psychotropic Medications	2.04 (1.61)	0.58 (0.88)	-	-	1.88 (1.41)	0.55 (0.76)	-	-	
#Comorbid Disorders	0.62 (.98)	0.62 (0.90)	-	-	0.56 (1.03)	0.43 (0.75)	-	-	

Note: BD = Bipolar disorder group; UD = Unipolar Depression group; CTL = Healthy control group; YMRS = Young Mania Rating Scale; IDS-C = Inventory of Depressive Symptomatology-Clinician Rating; GAF = Global assessment of functioning; WAIS-III = Letter-number sequencing working memory subset from WAIS-III; SILS = Shipley Institute of Living Scale; LFQ= Life Functioning Questionnaire; # of Psychotropic Medications = the number of psychotropic medications currently taken, including anticonvulsants, lithium, neuroleptics, stimulants, antidepressants, and sedative-hypnotics; # Comorbid Disorders = the number of current DSM-IV-TR Axis I comorbidities, including panic disorder, agoraphobia, social phobia, specific phobia, obsessive-compulsive disorder, generalized anxiety disorder, hypochondriasis, body dysmorphic disorder, binge-eating disorder, and bulimia. Mean values are displayed with standard deviations in parentheses where applicable.

* $p < .001$;

** $p < .05$

Table 2

ToM scores by Diagnostic Group

	BD (n = 26)	UD (n = 29)	CTL (n = 28)
ToM _{acc}	76.70%	76.25%	76.88%
ToM _{rt}	8.34 ^{a,b}	11.10 ^a	10.93 ^b
eToM _{acc}	76.37%	75.7%	76.79%
eToM _{rt}	8.37 ^{a,b}	11.08 ^a	11.00 ^b

Note. BD=Bipolar disorder group; UD=Unipolar Depression group; CTL=Healthy control group.; ToM_{acc}= mean theory of mind accuracy score (% correct out of 36 trials); ToM_{rt}= mean theory of mind response time score in seconds; eToM_{acc} = mean emotional theory of mind accuracy score (% correct out of 28 trials); eToM_{rt} = mean emotional theory of mind response time score in seconds.

^aBD vs. UD ($p < .05$);

^bBD vs. CTL group ($p < .05$);

Table 3

Prospective Associations Between ToM_{rt} and LFQ Scores by Diagnostic Group

	BD		UD		CTL	
	ToM _{rt}	eToM _{rt}	ToM _{rt}	eToM _{rt}	ToM _{rt}	eToM _{rt}
LFQ Overall	-0.55 [†]	-0.68 *	0.36	0.32	0.01	0.03
Work Duties	-0.48	-0.57 *	0.41	0.41	0.01	0.04
Home Duties	-0.62 *	-0.71 **	0.18	0.15	-0.03	-0.11
Friends Leisure	-0.29	-0.45	0.12	0.09	0.01	0.03
Family Leisure	-0.21	-0.29	0.47 *	0.42 *	0.05	0.06

Note. BD=Bipolar disorder group; UD=Unipolar Depression group; CTL=Healthy control group. LFQ=Life Functioning Questionnaire. ToM_{rt}= mean theory of mind response time score in seconds; eToM_{rt} = mean emotional theory of mind response time score in seconds. Values represent standardized Beta β coefficients from block 2 of the regression model, controlling for SILS and baseline IDS-C scores in block 1.

* $p < 0.05$

** $p < 0.01$

[†] $p < 0.06$