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Cognitive and affective theory-of-mind impairment in people with early-stage bipolar disorder

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Abstract

Background Literature suggests impaired theory-of-mind (ToM) in people with bipolar-disorder (BD). However, prior research primarily examined patients at chronic stage (stage 3c–4) and was constrained by clinical heterogeneity. Deficits in ToM modalities remain to be clarified. We aimed to assess cognitive and affective ToM performance in euthymic people with early-stage BD.

Methods Cognitive and affective ToM were examined in 41 euthymic early-stage (stage 2–3b) BD patients aged 16 -40 years who were treated within three-years from first-episode mania and 40 demographically-matched healthy controls, using Faux-pas task (FPT) and Reading the Mind in the Eyes test (RMET). Relationships of ToM performance with symptom severity, cognitive functions, history of psychosis and depressive episode were assessed.

Results Participants displayed significantly lower scores than controls in both cognitive and affective ToM components in FPT. The two groups showed comparable performance in RMET. No significant correlations were observed between ToM measures and variables of symptom dimensions, cognitive functions and treatment variables in BD patients. Additional analyses revealed no significant differences in ToM performance in FPT and RMET between BD patients with versus without a history of psychosis, and between BD patients with versus without a history of depressive episode.

Conclusion This study extends previous findings of ToM deficits in later-stage BD to euthymic people with early-stage BD who exhibit cognitive and affect ToM impairment. Further research is needed to clarify potential differential trajectories of cognitive and affective ToM deficits and their relationships with psychosis, polarity of mood episodes, and functional outcomes in early-stage BD.

Keywords Theory of mind, Bipolar disorder, Psychosis, Faux pas task, RMET, First-episode mania

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Introduction

Theory of Mind (ToM) is the capacity to describe mental states to oneself and others and the ability to respond accordingly [1]. It comprises two domains: cognitive or social-cognitive ToM - the ability to make inferences about another's thoughts and intentions [2–4], and affective or social-perceptual ToM - the ability to accurately judge another's emotions [2, 4]. ToM is a crucial aspect of social cognitive functioning, and impairments in this ability have been found to be associated with psychosocial difficulties in psychiatric and developmental disorders [5]. In bipolar disorder (BD), particularly bipolar I disorder (BD-I), during inter-episodic periods individuals often experience persistent psychosocial difficulties and functional impairment [6], highlighting an unmet need to investigate their social-cognitive functions, notably ToM impairments. Among various social-cognitive functions to be considered in BD, ToM appears to be one of the most impaired capacities [7]. While extensive research has documented the impact of ToM impairments on social-cognition in conditions such as schizophrenia [8–11] and autism [2, 12], the nature of ToM deficits in BD and how these deficits are related to clinical symptoms of BD remains understudied [13].

Recent meta-analyses have indicated moderate-to-large difference in ToM performance between patients with BD and healthy controls [13, 14]. However, findings of deficits in specific domains of ToM in BD are mixed in the literature [15]. Some BD research points to relatively preserved affective ToM, whereas cognitive ToM is impaired [4, 16, 17]. It has been suggested that preserved neurocognitive domains such as executive functioning and attention are required to succeed on the cognitive ToM domain such as those emphasizing attributions about belief, but not on the affective ToM domain which is based on emotional resonance and mirroring [3, 5, 18]. In addition, some evidence suggested that patients with BD showed deficits in verbal-based ToM, while visual-based ToM remained intact [19, 20]. Therefore, a comprehensive investigation of ToM deficits in BD should include assessments of both cognitive and affective ToM across verbal-based and visual-based modalities.

It is noted that an array of behavioral paradigms evaluating ToM have been developed, varying in terms of ToM domains (i.e., affective and cognitive) and modalities (i.e., visual-based or verbal-based) [21]. For example, the Reading the Mind in the Eyes Test (RMET) [12], a visual-based task requiring participants to infer the emotions of the persons from their face and eye gaze, captures affective ToM. In addition, the Faux Pas Task (FPT) [22], a verbal-based task asking participants to detect if a person has made a "faux-pas" in a conversation, assesses both cognitive and affective ToM. Both tasks have been used in patients with severe mental disorders (including schizophrenia and BD) with established feasibility and validity [4, 7, 13–15].

Previous research has indicated that ToM deficits are found in patients with BD across different mood states including depressive, manic and euthymic states [7, 13–15]. It is noteworthy that inconsistent results have been observed in the literature comparing ToM performance between euthymic BD patients and healthy controls. Several studies reported small effect sizes or no difference in ToM task performance between euthymic individuals with BD and controls [17, 20, 23], whereas others (e.g., [24]) observed inferior performance across all ToM tasks in the BD group when compared to controls. These divergent findings may be attributed to the heterogeneous participant samples (such as those including subsyndromal depressive/manic or mild depression), small sample size, and insufficient control of subclinical and clinical variables. For instance, the study conducted by Haag et al. [20] reported that individuals with BD performed similarly to controls on ToM tasks, and did not show differences in neurocognitive measures either. This suggested that their sample exhibited higher neurocognitive functioning and fewer executive function deficits compared to patient samples of other studies. Moreover, other studies included participants with elevated levels of manic symptoms and a shorter remission period prior to assessment (e.g., [24]) These factors may contribute to inconsistencies in the literature. Additionally, pharmacological factors such as exposure to antipsychotics is shown to be associated with poorer ToM performance [17, 23]. Of note, the vast majority of previous BD studies examining ToM focused on patients at later stages of BD (i.e., stage 3c to 4) [25, 26], which is confounded by illness chronicity and prolonged exposure to psychotropic agents. There is a paucity of research specifically examining ToM performance in the early stage of BD. A recent meta-analysis focusing on social cognitive measures in pediatric samples with BD (in the early stage of BD) revealed significantly poorer ToM performance in patients with BD than healthy controls (based on 3 studies) [14]. Using both FPT and RMET in a sample of first-episode BD-I patients, Szmulewicz et al. [27] found that, compared to healthy controls, patients performed poorer in the cognitive domain of FPT, but not the affective domain of FPT or the RMET. However, worse performance on RMET (but not FPT) in patients with euthymic first-episode BD than healthy controls was found in Bora et al [28]. These inconsistent findings highlight the need for investigation and better characterization of ToM deficits in people with early-stage (i.e., stage 2 to 3b) [25, 26] BD to facilitate the development of targeted interventions to promote early functional recovery.

In the current study, we sought to examine both cognitive and affective ToM domains, as well as visual-based and verbal-based modalities of ToM performance within a cohort of the Chinese people with early-stage (i.e., stage 2 to 3b) BD-I during the euthymic phase. We also aimed to investigate the relationships of ToM performance with clinical profiles, treatment characteristics and cognitive functions in early-stage BD-I. Exploratory analyses were also conducted to clarify the associations of ToM performance with a history of psychosis and prior depressive episode among people with early-stage BD-I. We hypothesized that euthymic people with bipolar I disorder (BD-I) would display inferior performance on the verbal-based ToM tasks compared to healthy controls, with impaired cognitive and affect ToM domains. Based on the prior literature [20, 23, 27, 28], we expected that our correlational analyses would reveal no significant associations between ToM performance and the aforementioned variables.

Methods

Participants and study setting

Forty-one euthymic patients with early-stage (i.e., stage 2 to 3b) BD-I and 40 demographically-matched healthy controls participated in this study. Participant recruitment took place from January 2020 to December 2021, and patients were enrolled from the psychiatric outpatient units covering four catchment areas in Hong Kong (Hong Kong Island, Kowloon West, New Territories East and West). All participants were aged between 16 and 40 years. Patients who were treated within three years from their first-episode mania with diagnostic ascertainment of BD-I and were maintained in euthymic state for at least 4 weeks were recruited. Diagnostic assignment was based on verification of all available information, including data from the Chinese-bilingual Structured Clinical Interview for DSM-IV (CB-SCID/P) [29], informant histories and medical records. People with a history of alcohol or substance abuse, known neurological disorders, intellectual disability, attention deficit hyperactivity disorder or Asperger syndrome were excluded. The study was performed in accordance with the Declaration of Helsinki, and was approved by the Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (HKU/HA HKW) and all participants provided written informed consent. For those under 18 years old, parental consent was obtained (clinical trial number: not applicable).

Clinical and cognitive assessments

The Positive and Negative Syndrome Scale (PANSS) [30] was used to evaluate psychopathology, which was further subdivided into three symptom dimensions, namely positive symptoms, negative symptoms and disorganization [31]. Current symptoms of mania and depression were measured by the Young Mania Rating Scale (YMRS) [32] and Hamilton Rating Scale for Depression (HAM-D) [33], respectively. Medication treatment status, including the dose of antipsychotic medications converted to chlorpromazine equivalents [34], was obtained. A battery of standardized cognitive assessments was administered to all participants, assessing various cognitive domains including processing speed (digit symbol coding, Wechsler Adult Intelligence Scale-Revised, WAIS-R-HK) [35], visual memory (visual reproduction test, WMS-R-HK) [35], verbal memory (Hong Kong List Learning Test, HKLLT) [36], working memory (letter number span test) [37], sustained attention (letter cancellation test) [38], and executive function (trail making tests A and B) [39].

Faux-pas task (FPT)

To assess higher-order verbal-based ToM we utilized the Chinese version [40] of Baron-Cohen's Faux Pas Task [22], as it shows good test-retest and interrater reliability. It was conducted verbally and enabled concurrent assessment of cognitive and affective ToM. The FPT comprises 10 different stories, each involving two or three characters in a hypothetical social encounter. Each story presents a social faux pas in which a character unintentionally says something socially inappropriate, thereby inducing unpleasant emotions in other characters. Participants were tasked with recognizing which character in the story committed a social faux pas, and to infer what the other character(s) would experience. The interviewer read out all the stories to the participants, who then answered five questions: (1) Did any characters speak inappropriately? (2) Which of the characters in the story committed social faux pas? (3) Why would his/her words constitute a social faux pas? (4) Why did he/she commit a social faux pas (intention of character)? and (5) A control question to ascertain participant's understanding of the stories. The first question assesses participants' cognitive ToM (recognition), and the second to fifth questions assess affective ToM (inferences of emotion, intention, and belief). If the participant answered 'No' to the first question, they immediately answered the control question. Each correct response scored 1 point. The total cognitive and affective ToM scores were obtained. The total cognitive ToM score was equivalent to the sum of the scores for the first question of each of the 10 stories and was therefore on a scale from 0 to 10. The total affective ToM score was the sum of the scores for questions 2 to 4 across all 10 stories and is on a scale from 0 to 30.

Reading the Mind in the Eyes Test (RMET)

A Chinese version of the RMET [41], derived from Baron-Cohen et al. [12], was delivered using E-prime 2.0 software. As a visual-based task, this test comprises 34 black-and-white photographs depicting the eye areas of Asian individuals [41]. For each photo presented on the computer screen, participants were required to choose one of four adjectives to best describe the emotional state of the person in the picture as expressed by the eye region [42]. All emotion adjectives conformed to Baron-Cohen's original material. For each photo, participants were required to choose from four adjectives that best describe the expression as deduced from the eye region. For each photograph, there were one correct and three incorrect choices. Participants' response times were recorded, and there was no response time limit for each trial or the whole test. As a control question, participants were asked to determine the sex of the person in each photo. The maximum score a participant could receive from the emotional stimulus section was 34.

Statistical analysis

Demographics and cognitive functions were compared between patients and controls using chi-squared test and independent samples t-test as appropriate. Group differences in FPT and RMET performance were examined using independent sample t-tests. These included differences in FPT cognitive ToM score, FPT affective ToM score and RMET total score. Correlation analyses were conducted to assess the associations of ToM performance measures with symptom dimensions, cognitive task performance and antipsychotic dose as quantified by chlorpromazine equivalents [34] Bonferroni correction was applied for the correlations involving numerous variables. As there is evidence suggesting that ToM performance is impaired by psychotic symptoms in schizophrenia [9, 10] and is poorer for people with more depressive episodes [14], exploratory comparison analyses were conducted between BD patients with (n= 33) versus without (n= 8) a history of psychotic symptoms (BD-I-P versus BD-I-NP) and BD patients with (n= 24) versus without (n= 17) a history of depressive episode (BD-I-D versus BD-I-ND). For additional analyses, ANCOVA was performed for between-group comparisons of ToM performance, in which the effects of significant demographic, clinical and cognitive variables on ToM performance were adjusted. The threshold of statistical significance for all analyses was set at $p< 0.05$.

Results

Characteristics of the sample

Table 1 summarizes the demographics, cognitive functions, clinical and treatment characteristics of the sample. No significant differences were found between people with BD-I and controls in demographics. Patients performed significantly worse than controls on most individual cognitive tests, including letter number span (t = − 3.22, $p = 0.002$), digit symbol coding (t = − 4.14, $p < 0.001$), HKLLT immediate recall (t = − 2.16, $p = 0.034$), and trail-making A (t = 2.56, $p = 0.012$) and B (t = 3.22, $p = 0.002$). No significant differences were found for letter cancellation, visual reproduction or HKLLT delayed recall scores.

Relationship of ToM task performance with clinical and cognitive variables

The comparison of ToM performance between patients and controls is detailed in Table 2. In the FPT task, patients demonstrated significantly lower cognitive ToM scores (6.8 ± 2.9) compared to controls (8.0 ± 2.1), indicating deficits in the cognitive ToM domain (t = − 2.14, $p = 0.036$, Cohen's $d = 0.475$). Similarly, in the affective ToM component of the FPT, patients scored lower (22.9 ± 10.7) than controls (28.1 ± 8.2), reflecting deficits in the affective ToM domain (t = − 2.42, $p = 0.018$, Cohen's $d = 0.538$). Meanwhile, no significant differences were found in the RMET between patients and controls ($p = 0.170$), revealing a relatively preserved visual-based ToM. As shown in Table 3, our correlation analysis revealed no significant relationships between ToM performance measures and clinical characteristics (including YMRS, HAM-D, and different subscales of PANSS subscales). Additionally, no significant correlations between ToM performance measures and antipsychotic dose were noted. ToM performance measures did not correlate with any cognitive measures in patient and control samples after Bonferroni correction (Supplementary Tables S1 and S2).

Relationship of ToM task performance with history of psychosis and depressive episode

Additional analyses were performed to examine ToM task performance between BD-I patients with history of psychosis (BD-I-P) versus without history of psychosis (BD-I-NP), as well as between BD-I patients with history of depressive episode (BD-I-D) versus without history of depressive episode (BD-I-ND). BD-I-P did not differ from BD-I-NP in demographics or cognitive functions, but BD-I-P had significantly higher PANSS disorganization score and fewer depressive episodes as compared with BD-I-NP. (Supplementary Table S3). As shown in Supplementary Table S4, no significant differences were observed in the REMT ($p = 0.603$) or the FPT performances between BD-I-P and BD-I-NP (cognitive ToM: $p = 0.110$; affective ToM: $p = 0.232$). Alternatively, BD-I-D patients were significantly younger than BD-I-ND

Table 1 Demographics, cognitive functions and clinical characteristics of patients and controls

Variables[a]	Patients ($n = 41$)	Controls ($n = 40$)	Statistics[b] t/χ2	*p*-value
Demographics				
Age in years	26.2 (5.9)	26.0 (5.8)	0.21	0.837
Male gender, *n* (%)	22 (53.7)	20 (50.0)	0.11	0.742
Years of education	14.5 (2.5)	15.3 (2.1)	− 1.44	0.155
Cognitive function				
Letter-number span	15.7 (3.3)	18.2 (3.6)	− 3.22	0.002
Digit symbol coding	11.6 (3.3)	14.3 (2.5)	− 4.14	< 0.001
Letter cancellation[c]	3.6 (3.1)	2.7 (3.7)	1.19	0.239
Visual reproduction: immediate recall	43.1 (1.2)	42.5 (1.9)	1.69	0.096
Visual reproduction: delayed recall	42.6 (2.5)	42.5 (1.5)	0.13	0.895
HKLLT: immediate recall	26.3 (7.9)	29.7 (6.3)	− 2.16	0.034
HKLLT: delayed recall	19.6 (6.6)	22.1 (6.1)	− 1.71	0.091
Trail making A	28.9 (11.2)	23.4 (7.9)	2.56	0.012
Trail making B	64.8 (29.5)	47.6 (17.2)	3.22	0.002
Clinical characteristics				
Age at illness onset	23.0 (6.2)	-		
Illness duration, years	3.1 (1.8)	-		
Past depressive episode, *n* (%)	27 (65.9)	-		
Number of past depressive episodes	1.3 (3.3)	-		
Number of past manic/hypomanic episodes	1.7 (2.9)	-		
History of psychotic symptoms, *n* (%)	33 (80.5)	-		
YMRS score	1.0 (2.2)	-		
HAM-D score	2.2 (3.4)	-		
PANSS positive symptom score [d]	7.2 (2.5)	-		
PANSS disorganization score [d]	7.3 (0.9)	-		
PANSS negative symptom scored[d]	9.9 (2.9)	-		
Treatment characteristics				
Lithium, *n* (%)	10 (24.4)	-		
Sodium valproate, *n* (%)	21 (51.2)	-		
Antidepressants, *n* (%)	5 (12.2)	-		
Antipsychotics, *n* (%)	33 (80.5)	-		
Chlorpromazine equivalents,[e] mg/day	322.9 (179.5)	-		

HAM-D Hamilton Depression Rating Scale, *HKLLT* Hong Kong List Learning Test, *PANSS* Positive and Negative Syndrome Scale, *YMRS* Young Mania Rating Scale

[a] Data are presented in mean and standard deviations, except gender, past depressive episode, history of psychotic symptoms, and use of medications

[b] Potential group differences were examined using independent sample t-tests and chi-square tests for continuous and categorical variables, respectively

[c] Letter cancellation test performance was measured by the number of omission errors committed, with higher number of omission errors indicating poorer performance

[d] PANSS positive symptom, negative symptom and disorganization scores were derived on the basis of a previous factor-analytic study in early psychosis patients [24]

[e] Chlorpromazine equivalents were computed according to [27]

Table 2 Comparison of theory-of-mind performance measures between patients and controls[a]

Performance measures	Patients	Controls	*t*	*p*-value	Cohen's *d*
RMET total score	25.5 (2.9)	26.4 (2.5)	− 1.39	0.170	0.309
Faux pas cognitive ToM score	6.8 (2.9)	8.0 (2.1)	− 2.14	0.036	0.475
Faux pas affective ToM score	22.9 (10.7)	28.1 (8.2)	− 2.42	0.018	0.538

RMET Reading the Mind in the Eyes task, *ToM* Theory of mind

[a] Independent-sample t-tests were performed for patient-control comparisons

Table 3 Correlations of theory-of-mind performance measures with clinical and treatment characteristics in patients[a]

Performance measures	YMRS	HAM-D	PANSS POS	PANSS DISORG	PANSS NEG	APD [b]
RMET	0.043	0.010	0.022	0.301	− 0.071	0.327
Faux pas Cognitive ToM	− 0.071	− 0.106	− 0.063	− 0.035	− 0.134	− 0.067
Faux pas Affective ToM	0.010	− 0.067	− 0.056	− 0.013	− 0.142	− 0.093

Statistically significant correlations at $p < 0.05$ are in bold typeface (No significant correlations were noted)

APD Antipsychotic dose, *DISORG* Disorganization score, *HAM-D* Hamilton Depression Rating Scale, *NEG* Negative symptom score, *PANSS* Positive and Negative Syndrome Scale, *POS* Positive symptom score, *RMET* Reading the Mind in the Eyes task, *ToM* Theory of mind, *YMRS* Young Mania Rating Scale

[a] Pearson correlation analyses were performed and r values were presented

[b] Antipsychotic doses were quantified as chlorpromazine equivalents (mg/day)

patients, had an earlier age at illness onset, higher rate of history of psychosis, performed better on visual reproduction immediate recall, and had higher YMRS and HAM-D scores (Supplementary Table S5). No significant differences were observed in the REMT ($p = 0.869$) or the FPT performances between BD-I-D and BD-I-ND (cognitive ToM: $p = 0.777$; affective ToM: $p = 0.818$) (Supplementary Table S6).

Discussion

To our knowledge, this is one of the few studies that investigated ToM deficits across ToM domains and modalities in euthymic patients at a relatively early stage (stage 2 to 3b) of BD-I, with additional subgroup analyses encompassing BD-I-P versus BD-I-NP (i.e., with versus without history of psychosis) and BD-I-D versus BD-I-ND (with versus without history of depressive episode). Our results revealed that people with early-stage BD-I performed significantly worse on both the cognitive and affective domains on the FPT but not on the RMET, implying deficits specifically within the verbal-based ToM modality but not the visual-based modality. These results contrasted with some previous studies, such as Barrera et al. [17] and Caletti et al. [42], which found no difference between BD patients and controls in both ToM tasks. Notably, these two studies were constrained by small sample size (n=12–18 BD patients), clinically heterogeneity with mixed patient sample (comprised BD-I and BD-II) and later stages of the illness. Alternatively, our results are more aligned with a recent study which assessed euthymic first-episode BD-I patients using the same ToM tasks as we did, and reported worse performance in FPT (albeit cognitive domain only rather than both affective and cognitive domains) but not in the RMET in patients relative to controls [27]. Another first-episode BD study, however, observed that BD patients underperformed relative to controls in RMET but not in FPT [28]. In sum, the discrepant findings underscore the need for further investigations to clarify the differential deficits in cognitive and affective domains as well as verbal-based and visual-based modalities in the early-stage BD.

Our study illustrated that people with BD-I exhibited deficits in both cognitive and affective ToM, which diverges from previous studies where affective ToM was often found preserved and cognitive ToM impaired [16, 17, 27]. Literature revealed that these two ToM components could depend on distinct neural networks: cognitive ToM predominantly involves the frontal-medial cortex, while affective ToM involves the orbitofrontal and temporal cortices [2, 8]. It is suggested that cognitive ToM may be a trait-marker and affective ToM a state-marker in BD [17]. This dichotomy raises the possibility of differential impairments in these domains, yet it is feasible that both systems could be concurrently compromised by shared underlying neurocognitive dysfunctions. Treatment strategies should be multifaceted, incorporating both cognitive behavioral interventions to enhance reasoning and perspective-taking abilities, and emotional recognition training to address effective ToM deficits. Findings regarding the relationship between the two ToM domains remains inconsistent: One study revealed intact cognitive ToM but impaired affected ToM, and argued that contextual information had compensated for the mild affective ToM deficit, leading to adequately preserved cognitive ToM [43]. To clarify the relationship between the two ToM domains, further research is warranted to replicate and expand upon the existing findings.

Importantly, we observed that ToM deficit in individuals with BD-I may represent a trait-dependent characteristic, as observed in our sample of euthymic patients. This indicates that ToM deficits in BD occur independently of clinical state, rather than state-dependent changes associated with acute episodes, potentially contributing to persistent functional impairment even during periods of symptom remission. This is in line with previous investigations on people with euthymic BD [5, 19, 44]. Nonetheless, it is important to recognize that some studies have linked ToM impairments directly to clinical symptoms and cognitive functions, suggesting that ToM may also

have state-dependent features in BD [11, 41, 45]. Taken together, ToM deficits should be assessed early in the course of treatment, even in clinically-stable patients, to better understand their potential impact on social-cognitive functioning. Future longitudinal studies are needed to explore the trajectory of ToM deficits in BD and their relationship with clinical and functional outcomes, which could inform whether these deficits predict poorer social engagement or higher risk of mood-episode recurrence.

No significant correlation was observed between ToM performance and clinical profiles among people with early-stage BD, indicating that ToM deficits might be independent of symptom dimensions. This corroborates with most previous reports of ToM impairment in people with euthymic BD [20, 23]. Of note, our patients were clinically-stable, in euthymic state with mild-to-minimal symptom levels. This may account for the discrepancy with studies that have identified significant correlations [46–49]. Likewise, no significant correlations were found between ToM deficits and cognitive functioning, possibly due to limited variance in the cognitive functioning among euthymic patients.

In our additional analysis, we found no significant differences in ToM performance between BD-I-P and BD-I-NP. This is consistent with a study examining patients in the later stages of BD [18]. Our results also corroborated with a recent study on first-episode BD patients showing no significant association between ToM performance and the severity of attenuated psychotic symptoms [28]. In line with previous research (e.g., [50]), antipsychotic dose was also uncorrelated with ToM performance in BD-I patients. Alternatively, our lack of significant difference in ToM performance between BD-I-D and BD-I-ND patients is contrary to a prior report demonstrating a trend of more impaired ToM in BD patients with more depressive episodes [17]. Research specifically addressing the effect of psychotic and depressive symptoms on ToM performance in BD remains scant, further investigation is required to further clarify whether there is any differential ToM impairment among patients with BD in relation to their history of psychosis and depression.

The study results have to be interpreted considering the following methodological limitations. First, the study sample comprised people with euthymic BD-I, meaning that our results are not easily generalizable to people with BD-II and those in the acute phase of illness. Second, our sample size was modest which may compromise the statistical power to detect subtler differences on ToM deficits between BD-I patient subgroup comparisons. In particular, caution should be exercised in interpreting the results of the comparison between BD-I-P versus BD-I-NP, with the latter subgroup comprising only 8 patients, thereby resulting in limited validity of our findings in this regard. Third, this study was a cross-sectional in design. Prospective follow-up investigation is needed to evaluate the longitudinal trajectories of ToM deficits along the course of illness. Lastly, social cognitive domains other than ToM were not evaluated in this study. Future research evaluating multiple social cognitive domains concurrently will provide a more comprehensive picture regarding potential differential deficits across various specific social cognitive functions in early-stage BD.

In conclusion, the current study extends previous research on ToM deficits in later-stage BD-I to early-stage BD-I, and indicates significant deficits in both cognitive and affective ToM, revealed by FPT but not RMET. Owing to the limited research in this respect, more studies should be conducted to verify our findings. In addition, further longitudinal investigation is warranted to elucidate the development and trajectories of ToM impairment in early-stage BD, and its relationship with antipsychotic treatment and clinical variables, particularly history of psychotic symptoms. It would facilitate a more holistic treatment model that not only targets symptom relief, but also addresses the cognitive and social dimensions, and hence to improve functional outcomes in people with BD.

Supplementary Information

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Supplementary Material 1.

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Authors' contributions

W.C.C. designed and conceptualized the study. J.M.T.C., C.T.K.K., and C.H.Y.T. performed data collection. J.M.T.C. conducted statistical analysis, and wrote the first draft of the manuscript. W.C.C., J.M.T.C, H.K.Y.L. interpreted the study data. W.C.C., A.S.Y.M., H.K.Y.L. and A.K.C.C. revised and finalized the manuscript. All authors provided critical feedback to the manuscript and have approved the final manuscript.

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Data availability

The data that support the findings of this study are available from the corresponding author upon reasonable request.

Declarations

Ethics approval and consent to participate

The study was performed in accordance with the Declaration of Helsinki, and was approved by Institutional Review Board of the University of Hong Kong/Hospital Authority Hong Kong West Cluster (HKU/HA HKW) and all participants provided written informed consent. For those under 18 years old, parental consent was obtained.

Consent for publication
Not applicable.

Competing interests
The authors declare no competing interests.

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