





SPECIAL ARTICLE

Social cognition and bipolar disorder: pending questions and unexplored topics

Luisa de Siqueira Rotenberg,¹  Tatiana Cohab Khafif,¹  Kamilla Woznica Miskowiak,^{2,3} 
Beny Lafer¹ 

¹Programa de Transtorno Bipolar do Instituto de Psiquiatria do Hospital das Clínicas da Faculdade de Medicina da Universidade de São Paulo, São Paulo, SP, Brazil. ²Copenhagen Affective Disorder Research Centre, Psychiatric Centre Copenhagen, Copenhagen University Hospital, Rigshospitalet, Denmark. ³Department of Psychology, University of Copenhagen, København, Denmark.

Social cognition has gained prominence in psychiatric research, beginning with schizophrenia and more recently in bipolar disorder. Considering the relevance of this domain to interpersonal relationships and functionality, we aimed to explore the fundamental research and clinical issues regarding social cognition and discuss future directions and challenges in the field of bipolar disorder.

Keywords: Social cognition; bipolar disorder; theory of mind; social perception

Introduction

In the last 15 years, social cognition (SC) has become a relevant research topic in bipolar disorder (BD). This interest is fuelled by evidence that SC could be a moderator of functional outcomes and quality of life in BD and, hence, an interesting doorway to rehabilitating impaired interpersonal functioning.¹ Although advances have been made in understanding the role of SC difficulties in BD, several conceptual and methodological challenges impede overall progress in SC research. Our aim is to examine core issues in this domain and explore challenges and future directions to further SC research in individuals with BD. This includes, but is not limited to, a discussion of the high heterogeneity of SC in BD, the need for more ecologically valid SC tasks, targeted interventions to improve these aspects of cognition, and possible SC biomarkers.

What is social cognition?

SC refers to an “umbrella” construct; it consists of a complex set of psychological processes that encompass understanding, perceiving, interpreting, recognizing, and processing intentions, as well as using appropriate social and adaptive behaviors to respond to social situations.² Moreover, the most recent edition of the DSM introduced the concept of SC as a part of core functional domains that can be affected by psychiatric disorders, which now consist of six cognitive domains: complex attention, executive function, learning and memory, language, perceptual motor, and social cognition.³ After two

National Institute of Mental Health-sponsored workshops on SC and schizophrenia (SZ) in the early 2000s, research in this domain gained prominence in other psychiatric populations, such as BD.^{4,5} These workshops were essential to delineate the necessary recommendations for SC research, in addition to general organization of the definitions and domains of SC. Therefore, according to National Institute of Mental Health consensus, there are five key domains: theory of mind (ToM); emotional processing (EP); social perception (SP); social knowledge (SK); and attributional bias (AB).^{4,5} We based the definition of SC on these five key domains,^{4,5} which are widely used as guidelines in BD research, thus providing consistency for analysis. However, definitions of SC vary in the field and, consequently, the lexicon used to refer to SC domains may be confusing (e.g., cognitive empathy and ToM). As Happé, Cook & Bird⁶ point out, the use of a particular term to refer to SC processes is a matter of taste rather than empirical investigation. However, standardization is still necessary. Additionally, it is recommended to apply new methodologies to reveal the factor structure of SC, such as large-scale normative factor analysis, which has been successfully used in SZ studies. This research has led to the suggestion that SC is multidimensional and separable from neurocognition.⁷ Regarding SC domains in SZ, one study indicated a four-factor structure, in addition to skills including affect recognition, ToM, egocentricity, and rapport (defined by how well the participant could engage and sustain connection during the interview).⁸ Another study suggested a two-factor structure of SC in individuals with SZ: SC skills and hostile attributional style.⁹ Nonetheless, to

Correspondence: Luisa de Siqueira Rotenberg, Universidade de São Paulo, Faculdade de Medicina, Departamento de Psiquiatria, Rua Dr. Ovídio Pires de Campos, 785, CEP 01060-970, São Paulo, SP, Brazil.

E-mail: rotenbergluisa@gmail.com

Submitted Sep 27 2021, accepted Apr 07 2022, Epub Aug 29 2022.

How to cite this article: De Siqueira Rotenberg L, Khafif TC, Miskowiak KW, Lafer B. Social cognition and bipolar disorder: pending questions and unexplored topics. Braz J Psychiatry. 2022;44:655-663. <http://doi.org/10.47626/1516-4446-2021-2272>

our knowledge no research has investigated the underlying factor structure of SC in individuals with BD.

Domains of social cognition

ToM, also known as “mentalizing abilities”, refers to the capacity to understand and attribute meaning to mental states in others and oneself. The term originated from a primate study by Premack & Woodruff – a psychologist and a primatologist.¹⁰ One of the most important aspects of social interaction depends on our ability to successfully interpret the intentions, knowledge, and desires of people around us, as well as our own. ToM allows us to conceive theories about others’ beliefs and intentions, along with emotions and affective states, thus leading to a better understanding and prediction of other people’s behavior. Such comprehension is essential for distinguishing between self and others.¹¹ ToM is traditionally divided into two sub-concepts: affective ToM, which refers to mentalizing about the affective states of others, and cognitive ToM, which refers to mentalizing about cognitive states.¹¹ ToM can also be divided into tasks that demand verbal and/or visual abilities. Such division results in a variety of ToM measures employing different approaches, with distinct neural networks implied, which leads to ToM

being comprehended on many different levels of performance and, thus, deficits.¹²

Different instruments can be used to assess ToM (Table 1), some of which are intended to measure explicit verbal reasoning (verbal cognitive ToM), referring to the ability to perceive when a social indiscretion occurs by reading a social situation and detecting an anomaly. Other tasks focus on implicit social analysis, such as the Reading the Mind in the Eyes Test, a widely used instrument to measure ToM in adults. This type of task elicits a fixed-choice paradigm, since it is based on only an image of eyes and is considered a visual affective ToM task.¹³ Thus, considering the different aspects of affective cognition, ToM instruments should aim to evaluate subjects in an ecologically valid manner, which translates into daily representations of SC. This can be done through tests that require individuals to perceive the environment in a more realistic way, such as by using videos instead of static images, and by adapting tasks depicting daily life situations to different cultural contexts.

EP concerns the process of detecting and evaluating emotional stimuli, in addition to being able to regulate one’s own affect in response to such stimuli (also known as emotion regulation).^{23,24} EP includes a set of cognitive processes, including: 1) assessment and identification of the emotional connotation of the stimulus; 2) formulation

Table 1 Key domains, definition, examples, and most common measures of social cognition

Social cognition domains	Definition	Most common measures	Real world example
Theory of mind	Also known as “mentalizing abilities”, refers to the capacity to understand and attribute meaning to mental states in others and oneself.	RMET ¹³ The Hinting Task ¹⁴ Adult Faux Pas ¹⁵	To be able to comprehend and infer someone else’s perspective in a social situation. ToM plays an important role in being able to detect irony, intentions, and desires in others and oneself.
Attributional bias	Concerns the tendency to explain the cause of events in terms of oneself, others, or in relation to a situation as a way of making sense of social events and interactions.	AIHQ ¹⁶ IPSAQ ¹⁷ ASQ ¹⁸	Jumping to the conclusion that someone who does not returning a phone call right away is angry at the caller; rather than simply unavailable.
Emotional processing	Refers to the ability to perceive (identify and recognize emotional displays from facial expressions) and to use and manage one’s own emotions.	BLERT ¹⁹ FEDTER-40 ²⁰	Important for identifying facial expressions in social contexts (e.g., being able to detect disappointment towards you in your partner’s face).
Social perception	The ability to identify, judge, and appropriately use social cues to make adequate judgments regarding social roles, rules, relationships, and the context of others.	SCRT ^{21,22}	Being able to understand the relationship between people through social cues, e.g., boss and employee, by observing a brief conversation.
Social knowledge	Social knowledge (also called social schema) refers to the awareness of rules, goals, and the roles that characterize social situations that aid in social interactions.	SFRT ²¹	Being aware of the social role of a doctor in a general clinic or the general goals of a customer who is talking to clerk at a store.

AIHQ = Ambiguous Intentions and Hostility Questionnaire; ASQ = Attributional Style Questionnaire; BLERT = Bell-Lysaker Emotion Recognition Task; ER-40 = Penn Emotion Recognition Task; FEDT = Face Emotion Discrimination Test; IPSAQ = Internal, Personal and Situational Attributions Questionnaire; RMET = Reading the Mind in the Eyes Test; SCRT = The Social Cue Recognition Task; SFRT = The Situational Features Recognition Test.

of a specific affective state and behavior in reaction to the stimulus; and lastly 3) regulation of the affective state and elicited emotional behavior, which requires a set of abilities known as emotion regulation strategies for the emotional and behavioral experience be appropriate to the social context.²⁴ Hence, methodologies for measuring EP vary but usually include assessment of speed and accuracy in the detection of emotions displayed in facial expressions and/or voices, brief vignettes describing situations of emotion regulation. Similarly, functional magnetic resonance imaging studies of SC measure neural response elicited by emotional stimuli, such as faces and emotional pictures, while participants either react (look at the stimuli or perform a gender discrimination task), down-regulate (intentionally reducing) or up-regulate (intentionally intensifying) their emotional reactions.²⁵

SP involves the identification and appropriate use of social cues to make adequate judgments regarding social roles, rules, relationships, and the context of others. SK is interdependent with SP and refers to one's knowledge of social roles, rules, and goals that characterize social situations and guide social interactions.²⁶ SP is dissimilar to EP, since the former requires the use of social cues to better comprehend interpersonal interactions, such as status, rather than the emotional stimuli.²⁷ For instance, tears can be interpreted as sadness or happiness. Thus, to appropriately perceive a situation one must identify the behavior (i.e., someone is crying) and infer the context which caused this behavior (i.e., the person is crying because she said goodbye to a loved one).²⁸ Thus, SP requires apprehension of both the situation and its context. Although they are two different domains, SK refers to the awareness of social situations, rules, roles, goals, and expectations. Hence, SP requires aligned SK to best interpret the situation and predict the best social reaction. These domains are usually measured by contrived interpersonal scenes consisting of videotaped or short written vignettes of everyday social interactions that require the viewer to make inferences and judgments about ambiguous social situations based on limited verbal and nonverbal social cues, i.e., the Situational Features Recognition Test²⁰ and the Social Cue Recognition Task^{20,21} for SK and SP, respectively.

Still in the sphere of SC, AB is associated with verbal behavior as causal statements and refers to how individuals might infer the causes of positive or negative events. In other words, AB (also known as attributional style) concerns the tendency to explain the cause of events in terms of oneself, others, or in relation to a situation.²² Typically, AB is measured by questionnaires, such as the Internal, Personal and Situational Attributions Questionnaire.²³ AB can be subdivided into two main scopes: a) self-serving bias (or externalizing bias), which refers to the tendency to attribute positive rather than negative events to oneself; and b) personalizing bias, which refers to the tendency to attribute negative events to others (blaming others) rather than the circumstances of an event. It is important to point out that AB exists in healthy individuals, although extreme and intense AB is usually associated with mental health disorders.

Variability in social cognition, neuronal correlates, and functional implications

SC impairments in BD are both state- and trait-related. Specifically, impaired EP has been reported during acute phases,²⁹ as well as during euthymia.^{30,31} This suggests that EP impairment may play a role in mood regulation abilities regarding mood episodes in a subset of individuals with BD. However, further studies are needed to better understand the neural underpinnings of this observation.³¹ A recent meta-analysis comparing cognitive domains in individuals with BD and SZ indicated considerable performance heterogeneity in BD patients, with a subgroup performing the same or worse than the SZ patients.³² Beyond cognitive domains, heterogeneity in SC has also been found among BD patients.^{33,34} In accordance with this finding, a recent study on BD that used a cluster analysis³⁵ found of two subgroups regarding EP performance, one with "intact" performance (71%), who performed as well as healthy controls (HC), and another with "impaired" performance (29%), who performed worse than HC and SZ patients in basic emotion recognition tasks. Patients in the impaired group presented higher rates of childhood trauma, schizotypal traits, lower premorbid intelligence quotient and education, and poor psychosocial functioning and cognitive performance.³⁵

Moreover, a recent systematic review of functional magnetic resonance imaging studies on facial emotional processing circuitry indicated differences in neural activity and connectivity within and between the occipito-temporal, limbic, and prefrontal regions in BD patients and HC. Specifically, there appears to be increased amygdala activity and reduced prefrontal activity in BD, primarily in response to negatively valenced emotional stimuli, with abnormalities occurring across BD mood states, including euthymia.³⁶ Nonetheless, compared to other neurocognitive domains, EP studies in BD are still scarce and this aspect of SC is thus understudied.

In recent years, our comprehension of SC deficits in BD regarding course, proportion, and functional consequences has broadened with advances in research, which indicate the importance of SC in everyday functioning. Interpersonal relationships depend heavily on the verbal, visual, and facial cues present in the social environment, and their precise and proper perception and interpretation are essential for decoding underlying emotional states. Moreover, being able to infer the thoughts and emotional states of others, as well as oneself, and establish them within a social context is crucial for action prediction, prosocial behavior, and social eminence.³⁷

As mentioned previously, AB is also present in healthy individuals; an example of functional AB is self-serving bias to maintain appropriate self-esteem.²⁴ Research indicates that dysfunctional AB may influence the formation and perpetuation of persecutory and delusional symptoms in psychiatric patients.^{25,26} Moreover, research indicates that intense AB (both positive and negative) in BD patients may predict relapse of manic/hypomanic episodes and delay recovery from depressive episodes, indicating that the valence of attributions may be less

important than their extremity in predicting recovery from depression.²⁷ This finding is in accordance with previous prospective studies on AB as a predictor of mood elevation in BD, although with smaller sample sizes.^{28,38} In a follow up investigation, Stange et al.³⁹ reported that extreme negative attribution bias predicted the onset of prospective depressive and hypomanic episodes. Therefore, studies suggest that individuals with BD tend to interpret states as both extremely positive and extremely negative, contributing to incongruous attempts to regulate internal states and prompting possible mood swing symptoms.²⁸ Specifically, BD patients have a greater tendency to attribute intentions to ambiguous scenes, together with a tendency to become angry in such situations (anger bias). BD patients with residual depressive symptoms also show higher AB than euthymic BD patients, specifically regarding anger, intention, aggression, and hostility, thus AB is a potential mediator between affective symptoms and functionality in individuals with BD.^{40,41}

However, there are many unresolved issues. First, research with BD cohorts has mainly focused on ToM, AB, and EP, whereas only a few studies have focused on SP and SK.⁴² In a recent meta-analysis of SC in remitted BD patients by Samamé et al.,⁴³ 19 reports comparing the SC performance of 712 BD patients with that of 664 HC were analyzed, revealing small-to-moderate effect-size differences in SC performance between euthymic BD patients and HC. One important finding of this review was that mental state decoding is more preserved than mental state reasoning, both of which are components of ToM. This means that BD patients have less understanding that other people act based on their own representation of reality, rather than reality itself. In other words, if one person perceives something in a certain circumstance, it does not mean everyone else will as well. Moreover, a recent meta-analysis⁴⁴ of 30 studies evaluating ToM in euthymic individuals concluded that ToM is impaired in remitted BD subjects, with a more significant deficit in tasks that demand verbal ToM. In addition, recent studies suggest that ToM performance is also impaired in the relatives of BD patients, which suggests that ToM may be a potential endophenotypic marker of BD.⁴⁵ However, further longitudinal studies are needed to test this hypothesis. These findings are of great significance, since such deficits may impede social reintegration and rehabilitation.⁴⁴

Secondly, to date only three studies have examined the variability of SC in a BD cohort³³⁻³⁵ using hierarchical cluster analysis methods.³³ Varo et al.³³ performed a hierarchical cluster analysis with three SC domains (ToM, EP, and AB) in a sample of 131 individuals (71 BD patients and 60 HC). Their results revealed that one-third of the BD patients had SC deficits, including ToM, AB,³³ and EP.^{33,35} Longer BD duration, male sex, and lower estimated intelligence quotient were associated with lower SC performance.³³ In a recently published follow up study, Varo et al.,³⁴ investigated heterogeneity among remitted patients with mood disorders and explored its association with familial risk. They identified three main clusters: “emotionally preserved” (57%), an “emotionally

blunted” (26%), and “emotionally volatile” (17%). They measured different forms of EP, such as emotional reactivity, using the Social Scenarios Task, facial expression using the facial expression task, and attention vigilance in the emotional-faces dot-probe task. The results indicated that “emotionally blunted” and “emotionally volatile” individuals also had greater deficits in tasks unrelated to emotional cognition. Additionally, relatives of “emotionally preserved” patients were more successful at dampening negative emotions.³⁴ In sum, these findings indicate that SC impairment is less prevalent among individuals with BD than cold cognitive impairment. Therefore, one-third of BD patients may require a specialized and specific treatment focus on SC. The different profiles found in this study indicate important directions for future non-pharmacological interventions due to the heterogeneity of SC deficit among BD groups. Thus, future studies that pinpoint SC deficits should screen subjects to ensure the intervention is aimed only at individuals with current SC deficits.

Third, a recent study of SC in first-episode BD patients found significantly impaired ToM independently of neurocognitive performance, which suggests that ToM deficits may already be present at illness onset.⁴⁶ This finding is congruent with other studies that indicate that SC impairments, mainly EP and ToM deficits, are present at early stages of the disorder and during remission.^{44,47,48} Studies have also investigated unaffected relatives of BD patients to determine whether SC deficits can be considered endophenotypes, i.e., illness-related trait markers present in individuals at familial risk due to a more direct connection to the genetic substrate than to diagnostic categories. Gottesmand & Gould⁴⁹ developed criteria for evaluating candidate endophenotypes, although due to the epigenetic transformations known to occur in psychiatric phenotypes, Hasler et al.⁵⁰ proposed the following adjustments: 1) an endophenotype must be associated with illness in the general population; 2) an endophenotype is heritable; 3) an endophenotype is state independent, although it is age-normed and might require a challenge to be elicited; 4) endophenotypes and illness cosegregate; and 5) endophenotypes can be found in unaffected relatives at a higher rate than the general population.

Initial findings from studies on BD patients and their first-degree relatives indicate that certain SC deficits might be endophenotypes. Impaired facial expression recognition is not only present in remitted and symptomatic BD patients; their unaffected relatives also exhibit this abnormality to a lesser degree at the behavioral and neural levels of EP (for a review, see Miskowiak et al.⁵¹). Thus, according to these recent findings, SC deficits might represent BD endophenotypes, although investigations are still in the early stages and more studies are required to strengthen this hypothesis.⁵¹⁻⁵³

Although few studies to date have investigated the relationship between SC and functional outcomes, their results tend to indicate that SC deficits moderate lower functional outcome. The most common psychosocial functioning measures used in BD research are the Global Assessment of Functioning,⁵⁴ the Functioning Assessment Short Test,^{55,56} and the Social Adjustment Scale

Self-Report.⁵⁷ The Global Assessment of Functioning measures functional outcomes by analyzing psychological, social, and occupational domains. Considered a more generic scoring system,⁵⁴ it is the most common assessment used in BD studies.⁵⁸ The Functioning Assessment Short Test assesses six main functional domains: financial, interpersonal, leisure, autonomy, occupational, and cognitive functioning, which, when summed together, produce an overall functionality score.⁵⁶ The Social Adjustment Scale Self-Report is another tool that estimates different domains of functionality, mainly more specific aspects such as work/school roles, social/leisure activities, relationships with extended family, marital role, parental role, and membership in a family unit.⁵⁷ Regarding community functioning, the most common measure is the World Health Organization Disability Assessment Schedule 2.0.⁵⁹ A recent study assessed whether SC modulates the influence of neurocognition on community functioning in BD, finding that SC had a moderating (rather than a mediating) effect: in patients with poor SC, better neurocognition was associated with better functioning, which was not seen in BD patients with high SC. Thus, this study suggests that a possible relationship between neurocognition and community functioning in BD may be dependent on SC status, hence implying the presence of SC heterogeneity.¹ Along these lines, a systematic review found that psychosocial functioning was significantly correlated with three domains of SC (ToM, EP, and AB) in individuals with BD.⁵⁸ These emerging findings are of interest, since they enhance current understanding of SC in BD and, by doing so, point to interesting directions for interventions that better target psychosocial adversities in BD patients. However, to our knowledge, no research has examined whether variability in these different domains of functioning plays a role in SC. A recent study assessed whether SC modulates the influence of neurocognition on community functioning in BD, finding that SC may have a moderating (rather than a mediating), effect in patients with poor SC and that better neurocognition was associated with better functioning. However, this association was not seen in BD patients with good SC. This indicates that a possible relationship between neurocognition and community functioning in BD may be dependent on SC status, which implies SC heterogeneity.¹ Along these lines, a systematic review found that psychosocial functioning was significantly correlated with three domains of SC (ToM, EP, and AB) in individuals with BD.⁵⁸ These findings are of interest, since they enhance current understanding of SC and how it relates to BD and, by doing so, can help interventions better target psychosocial adversities in individuals with BD. However, to our knowledge no studies have determined whether variability in these functional domains plays a role in SC. Many functional measures rely on self-reports, which require sufficient insight to observe and report possible impairments. These challenges are also present in self-assessment of cognitive abilities, functional abilities, SC, and social outcomes⁶⁰ and are shared across psychiatric conditions.⁶¹ Such insight is frequently lacking during manic states and may be lacking during depressive states.^{58,61,62} Regarding SC,

one study found that self-reports of very low levels of sadness were associated with overestimated functioning.⁶⁰ Interestingly, experience plays an important part in self-perception, since participants who were commonly home alone rated their social functioning as better than participants who were commonly outside the home and in the company of others.⁶⁰

Methodological challenges in social cognition research

Some key challenges in SC research should be mentioned. Several reports have indicated that psychotropic medication may negatively affect some aspects of SC performance in BD patients.⁶³ A meta-regression analysis reported that psychotropic medication influences EP. This potential influence frequently appears as a study limitation and prevents clear conclusions about SC patterns in BD patients, given that the treatment regimens of most involve psychotropic medication. Martino et al.⁶³ observed that benzodiazepine use was associated with poor ToM performance. However, other studies have reported positive findings, such as Bora et al.,⁶⁴ who found no relationship between ToM and lithium dose, which agrees with Harmer et al.,⁶⁵ who found no significant association between emotion recognition and lithium dose. Lahera et al.⁶⁶ found no relation between mentalizing performance and medication status. Regarding EP specifically, the influence of psychotropic medication should be carefully appraised, since lithium (and possibly dopamine) antagonists may be associated with reduced anger cue processing in individuals with BD.⁶⁷ However, these potential effects should be further explored, which could be done by adding a small group of unmedicated BD patients to study design where possible.

Another challenge in SC research is the vast heterogeneity of measures investigating this cognitive domain. Most tasks for measuring SC were originally designed to evaluate SC in autism spectrum disorder, the archetypal disorder of SC⁶ and, thus, there is no agreement about which measures are most suitable for assessing SC in BD.¹⁶ SC research in BD is based largely on research in SZ patients, i.e., the choice of SC measures and study design are based on a different diagnosis. Although similar, SC impairment is more severe in SZ than BD, specifically regarding ToM and EP,⁶⁸ which must be taken into consideration. Since SC is a social construct, its measures must resemble real-life scenarios, i.e., they must be more ecologically suited. Therefore, measures that enhance the SC “experience” are more likely to capture certain nuances of it. Thus, measures involving videos and real-life images are always more suitable, although they must be made culturally relevant to ensure applicability. Another potential bias is the use of only White actors in many such tasks, for example, the Pictures of Facial Affect.⁶⁹ Since meta-analysis has demonstrated that recognizing emotion in people from other races may be more difficult than doing so in one's own race,⁷⁰ such stimuli might limit SC research. They should be critically examined or modified to overcome

these limitations. Additionally, brief SC screening is recommended to detect possible deficits – and their pattern- which could provide a basis for more personalized interventions.

According to the International Bipolar Disorder Society,¹⁶ the most sensitive tasks for detecting deficits in facial expression recognition (i.e., that assess EP) use a static morphed facial expression across various intensity levels. Regarding ToM, the Reading the Mind in the Eyes Task¹³ or the Hinting Task are recommended.⁷¹ No recommendations have been made regarding AB, SP, and SK tasks. However, this study proposes using Affective Go/No-Go and/or the Emotional Stroop tasks to measure implicit emotion regulation and the Iowa or Cambridge Gambling Tasks to measure reward processing and affective decision-making.¹⁶ Both domains (implicit emotion regulation and reward processing/ affective decision-making) are not SC domains *per se*, but may yield interesting findings and, thus, may be added to better comprehend emotional functioning in BD patients. The task force also recommends using a measure of facial expression recognition as a secondary outcome, in addition to a primary non-emotional cognition outcome, since SC may be a clinically meaningful outcome for review.⁷² Nevertheless, a consensus opinion about the battery of tasks needed to measure affective cognition in BD patients has yet to be published. Developing and validating a consensus-based SC battery and a brief SC screening tool would be essential for comparability of findings across studies and a more coherent and comprehensive understanding of SC in BD. The current International Society for Affective Disorders Targeting Cognition Task Force is currently working to resolve this issue.

The implications of social cognitive impairment for clinical practice

Beyond research and neuropsychological evaluation, knowledge of SC is essential in clinical practice. Due to the significant evidence that BD patients have SC deficits, even in remission, mental health workers must be prepared to experience discrepancies in social interaction and communication impediments when dealing with them. Simple modifications to the clinical setting might help mitigate such problems, such as using different communications modes (verbal vs. visual), always checking whether the patient comprehends what is being said and constantly asking for feedback about what is being communicated. Simply asking others if they perceive a situation in the same way is often avoided by people with mental disorders due to a combination of stigma, low self-esteem, and, in some cases, ignorance that their interpretations of the world might originate from deficient SC circuitry. Psychoeducation focusing on specific SC deficits might lead to better self-knowledge, awareness, and caution when interpreting and inferring other people's intentions. Emotional intelligence strategies can also be applied to improve SC functioning, such as the RULER acronym, developed by Yale researcher Marc Brackett, which focuses on teaching individuals to Recognize,

Understand, Label, Express, and Regulate their emotions.⁷³ Other than that, mindfulness-based interventions, such as the mindful self-compassion program, might help individuals with SC deficits improve awareness of their surroundings and become more conscious to the non-verbal cues expressed by others.⁷⁴ However, such interventions have not yet been tested in randomized clinical trials with BD patients to determine their clinical efficacy.

Directions for future research

Despite these promising results, questions remain. Most studies do not combine “hot” (also known as SC) and “cold” cognition in their research with BD cohorts; this is essential to better comprehend how these domains interact and influence one another. For instance, studies indicate that AB, such as cognitive bias and mood stability, are in convergence with attention processes.⁷⁵ Further research on SC should emphasize how it manifests early in the course of BD, since it offers insight into whether SC deficits in adults with BD already occur at illness onset or emerge at later stages.

To develop a full picture of the structure and function of SC and its possible interactions with cold cognition, additional studies focusing on neuroimaging data across mood disorders will be needed. The International Bipolar Disorder Society Cognition Task Force's methodological recommendations for cognition trials in BD strongly suggest the use of neuroimaging assessments to avoid the lack of insight into specific neurocircuitry targets, especially regarding SC. This important step in future studies could lead to a transdiagnostic neurocircuitry-based biomarker model for pro-cognitive effects. To date, only a handful of studies have examined structure-function relationships^{76,77}; usually focusing on neurocircuitry as a whole and not specific cognitive domains.

In light of the recent finding that one-third of BD patients have impaired SC,³³ further work is required to establish the neuroprogression of BD, and progress can be made by investigating specific clusters of SC among BD patients and unaffected relatives. In a critical systematic review, Miskowiak et al.⁵¹ included 72 studies of first-degree relatives of BD patients, as well as HC comparison groups, investigating “cold” and “hot” cognition and functional and structural neuroimaging. Only 15 studies involved structural neuroimaging, which provides a “landscape” view of current studies in unaffected relatives of BD patients with “cold” and “hot” cognition and neuroimaging. Regarding SC, the unaffected relatives had consistently impaired facial expression recognition, increased reactivity to emotional stimuli, impaired emotion regulation, and emotional stimuli interfered more in attentional resources.⁵¹ However, the studies included in their review were cross-sectional; longitudinal studies are needed for a more critical analysis of causal inferences. Additionally, the structural and resting state functional neuroimaging results were less consistent, indicating the need for future clinical studies to incorporate such measures, as well as a comprehensive analysis of these results in mood disorders and SZ.⁵¹

Recent studies indicate that emotion dysregulation, an emotional processing subdomain, might specifically characterize BD and could even be an endophenotype marker. This hypothesis has made recent progress, such as deficient prefrontal top-down regulation of limbic reactivity during positive emotion processing as a possible predisposition to (hypo)mania.⁷⁷ Moreover, findings indicate aberrant neural activation and connectivity during voluntary emotion regulation in individuals with BD.^{14,51,78} These studies indicate that individuals with BD exhibit amygdala hyperactivation during voluntary down-regulation of negative emotional responses, coupled with abnormal activation within the dorsolateral and ventrolateral prefrontal cortex.^{79,80} Thus, they support the notion that the neural bases of emotion dysregulation in BD may be related to impaired prefrontal top-down control in conjunction with amygdala hyperactivity. If so, emotional dysregulation could be a specific cognitive biomarker to better define diagnosis and predict illness progression. In association with genetic liability, it may provide a specific target for preventive treatment strategies. Nevertheless, future studies should focus on more longitudinal outcomes and trials that compare BD patients with unaffected relatives and HC groups.

As suggested by Kessing & Miskowiak,⁵³ a valid biomarker model for cognitive improvement must follow five main validity criteria. Such a model must: 1) be sensitive to treatment and pro-cognitive effects; 2) determine kin effects in patients with cognitive dysfunction and healthy participants; 3) be perceptive to effective treatments with dissimilar neurochemical mechanisms; 4) be insensitive to ineffective treatments; and, lastly, 5) be sensitive to both cognitive decline and improvement. These steps may help determine whether SC deficits are actually a diagnostic intermediate phenotype in BD.

Furthermore, it remains to be seen if SC deficits are primary in nature or secondary to more general neurocognitive impairments, the use of psychotropic medications, or even perhaps other illness-related factors. To determine the direct effect of an impaired EP cluster on psychosocial functioning and its possible moderation of neurocognitive impairment in individuals diagnosed with BD, Szmulewicz et al.⁸¹ found that more than half of the total effect of EP clusters on psychosocial functioning is mediated through neurocognitive functioning. This may indicate that improvement in neurocognitive impairments could ameliorate poor EP abilities in individuals with BD.⁸¹ These findings are in line with the neural network model of emotion regulation, which indicates that the processing of emotional information stems from core cognitive control, which has been observed in SZ patients.⁸² It has been speculated that cognitive remediation strategies could lead to better development of EP and, thus, SC,^{83,84} since these processes depend on the same regulatory circuits,⁸² although these studies only involved SZ patients.

Finally, recent research has led to interesting and creative perspectives about the SC domain. A new study proposed an experimental medicine-based randomized controlled trial using yoga therapy as a form of rehabilitating SC in SZ patients, since the principle of imitation is part of yoga training and may lead to better activation of

SC abilities.⁸⁵ Although that study's sample was small, it found positive results as a possible add-on treatment to improve SC.⁸⁵ Additionally, novel analytic strategies, such as machine learning approaches, could help identify multimodal endophenotypes of BD, integrating BD illness-related changes with "hot" and "cold" cognitive and neuroimaging measures.^{86,87}

In conclusion, current research indicates that BD patients have SC impairments, specifically ToM, AB, and EP, even during remission. As a result, certain measures should be considered. Firstly, consensus is needed about which SC tasks should be included in an integrative cognition test battery for mood disorders. Miskowiak et al.¹⁶ have accepted this challenge and set out to establish norms for affective cognition testing in BD patients. In addition, focus on rehabilitating SC abilities and teaching skills and strategies to improve possible deficits are beginning to emerge. Interventions such as Social Cognition and Interaction Training⁸⁸ and MetaCognitive Training⁸⁹ focus on group treatment, aiming to improve social functioning based on SC paradigms. These novel interventions are innovative approaches that add to common cognitive remediation strategies that tend to focus on cold cognition and often leave emotional and functional difficulties aside. Although these interventions have not been replicated in a large cohort, they show promising results regarding functional improvement. Most important of all, we believe that research findings should have practical applications in clinical settings, especially when the topic is social interaction, for example, whether SC deficits predict poorer functioning or more relapses. Thus, SC researchers must try to translate the findings of scientific research to a clinician's viewpoint, especially the way such deficits influence daily functioning, social life, and, ultimately, long-term outcomes in patients with BD.

Acknowledgements

This study was supported in part by a generous private donation from Paulo Sergio Galvão to the Programa de Transtorno Bipolar (PROMAN) of the Universidade de São Paulo. LDSR and TCK have received support from Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES; 88887.475730/2020-00 and 88887.461435/2019-00, respectively). KM received a 5-year Lundbeck Foundation Fellowship (R215-2015-4121). BL has received support from Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP; 17/07089-8, 2018/11963-8, 2020/05087-0). The funding agencies had no role in writing the manuscript or the decision to submit it for publication.

Disclosure

The authors report no conflicts of interest.

References

- 1 Ospina LH, Nitzburg GC, Shanahan M, Perez-Rodriguez MM, Larsen E, Latifoglu A, et al. Social cognition moderates the relationship

- between neurocognition and community functioning in bipolar disorder. *J Affect Disord.* 2018;235:7-14.
- 2 Harvey PD, Penn D. Social cognition: the key factor predicting social outcome in people with schizophrenia? *Psychiatry (Edgmont).* 2010;7:41-4.
 - 3 Simpson JR. DSM-5 and neurocognitive disorders. *J Am Acad Psychiatry Law.* 2014;42:159-64.
 - 4 Green MF, Olivier B, Crawley JN, Penn DL, Silverstein S. Social cognition in schizophrenia: recommendations from the measurement and treatment research to improve cognition in schizophrenia new approaches conference. *Schizophr Bull.* 2005;31:882-7.
 - 5 Green MF, Penn DL, Bental R, Carpenter WT, Gaebel W, Gur RC, et al. Social cognition in schizophrenia: an NIMH workshop on definitions, assessment, and research opportunities. *Schizophr Bull.* 2008;34:1211-20.
 - 6 Happé F, Cook JL, Bird G. The structure of social cognition: in (ter) dependence of sociocognitive processes. *Annu Rev Psychol.* 2017;68:243-67.
 - 7 van Hooren S, Versmissen D, Janssen I, Myin-Germeys I, à Campo J, Mengelers R, et al. Social cognition and neurocognition as independent domains in psychosis. *Schizophr Res.* 2008;103:257-65.
 - 8 Bell M, Tsang HWT, Greig TC, Bryson GJ. Neurocognition, social cognition, perceived social discomfort, and vocational outcomes in schizophrenia. *Schizophr Bull.* 2009;35:738-47.
 - 9 Buck BE, Healey KM, Gagen EC, Roberts DL, Penn DL. Social cognition in schizophrenia: factor structure, clinical and functional correlates. *J Ment Health.* 2016;25:330-7.
 - 10 Premack D, Woodruff G. Does the chimpanzee have a theory of mind? *Behav Brain Sci.* 1978;1:515-26.
 - 11 Walter H. Social cognitive neuroscience of empathy: concepts, circuits, and genes. *Emot Rev.* 2012;4:9-17.
 - 12 Abu-Akel A, Shamay-Tsoory S. Neuroanatomical and neurochemical bases of theory of mind. *Neuropsychologia.* 2011;49:2971-84.
 - 13 Baron-Cohen S, Wheelwright S, Hill J, Raste Y, Plumb I. The "Reading the Mind in the Eyes" test revised version: a study with normal adults, and adults with Asperger syndrome or high-functioning autism. *J Child Psychol Psychiatry.* 2001;42:241-51.
 - 14 Townsend J, Altshuler LL. Emotion processing and regulation in bipolar disorder: a review. *Bipolar Disord.* 2012;14:326-39.
 - 15 Phillips ML, Drevets WC, Rauch SL, Lane R. Neurobiology of emotion perception I: the neural basis of normal emotion perception. *Biol Psychiatry.* 2003;54:504-14.
 - 16 Miskowiak KW, Seeberg I, Kjaerstad HL, Burdick KE, Martinez-Aran A, Del Mar Bonnin C, et al. Affective cognition in bipolar disorder: a systematic review by the ISBD targeting cognition task force. *Bipolar Disord.* 2019;21:686-719.
 - 17 Penn DL, Ritchie M, Francis J, Combs D, Martin J. Social perception in schizophrenia: the role of context. *Psychiatry Res.* 2002;109:149-59.
 - 18 Van Rheenen TE, Ganella EP, Bauer IE, Bartholomeusz CF. Characterization of social cognitive deficits on the schizophrenia-bipolar disorder spectrum: an overview of current evidence. *Soc Cogn Psychosis.* 2019;1:1-36.
 - 19 Trope Y. Identification and inferential processes in dispositional attribution. *Psychol Rev.* 1986;93:239-57.
 - 20 Corrigan PW, Green MF. The Situational Feature Recognition Test: a measure of schema comprehension for schizophrenia. *Int J Methods Psychiatr Res.* 1993;3:29-35.
 - 21 Corrigan PW, Silverman R, Stephenson J, Nugent-Hirschbeck J, Buican BJ. Situational familiarity and feature recognition in schizophrenia. *Schizophr Bull.* 1996;22:153-61.
 - 22 Tracy A, Bauwens F, Martin F, Pardoën D, Mendlewicz J. Attributional style and depression: a controlled comparison of remitted unipolar and bipolar patients. *Br J Clin Psychol.* 1992;31:83-4.
 - 23 Kinderman P, Bental RP. Causal attributions in paranoia and depression: internal, personal, and situational attributions for negative events. *J Abnorm Psychol.* 1997;106:341-5.
 - 24 Mezulis AH, Abramson LY, Hyde JS, Hankin BL. Is there a universal positivity bias in attributions? A meta-analytic review of individual, developmental, and cultural differences in the self-serving attributional bias. *Psychol Bull.* 2004;130:711-47.
 - 25 Murphy P, Bental RP, Freeman D, O'Rourke S, Hutton P. The paranoia as defence model of persecutory delusions: a systematic review and meta-analysis. *Lancet Psychiatry.* 2018;5:913-29.
 - 26 Bental RP, Kinderman P, Kaney S. The self, attributional processes and abnormal beliefs: towards a model of persecutory delusions. *Behav Res Ther.* 1994;32:331-41.
 - 27 Stange JP, Sylvia LG, Magalhaes PV, Frank E, Otto MW, Miklowitz DJ, et al. Extreme attributions predict transition from depression to mania or hypomania in bipolar disorder. *J Psychiatr Res.* 2013;47:1329-36.
 - 28 Kelly RE, Mansell W, Wood AM, Alatiq Y, Dodd A, Searson R. Extreme positive and negative appraisals of activated states interact to discriminate bipolar disorder from unipolar depression and non-clinical controls. *J Affect Disord.* 2011;134:438-43.
 - 29 Lembke A, Ketter TA. Impaired recognition of facial emotion in mania. *Am J Psychiatry.* 2002;159:302-4.
 - 30 Lahera G, Ruiz-Murugarren S, Iglesias P, Ruiz-Bennasar C, Herreria E, Montes JM, et al. Social cognition and global functioning in bipolar disorder. *J Nerv Ment Dis.* 2012;200:135-41.
 - 31 Van Rheenen TE, Rossell SL. Let's face it: facial emotion processing is impaired in bipolar disorder. *J Int Neuropsychol Soc.* 2014;20:200-8.
 - 32 Bora E, Pantelis C. Meta-analysis of cognitive impairment in first-episode bipolar disorder: comparison with first-episode schizophrenia and healthy controls. *Schizophr Bull.* 2015;41:1095-104.
 - 33 Varo C, Solé B, Jiménez E, Bonnin CM, Torrent C, Valls E, et al. Identifying social cognition subgroups in euthymic patients with bipolar disorder: a cluster analytical approach. *Psychol Med.* 2020 Jun 17;1-10. doi: 10.1017/S0033291720001865. Online ahead of print.
 - 34 Varo C, Kjaerstad HL, Poulsen E, Meluken I, Vieta E, Kessing LV, et al. Emotional cognition subgroups in mood disorders: associations with familial risk. *Eur Neuropsychopharmacol.* 2021;51:71-83.
 - 35 Szmulewicz A, Millett CE, Shanahan M, Gunning FM, Burdick KE. Emotional processing subtypes in bipolar disorder: a cluster analysis. *J Affect Disord.* 2020;266:194-200.
 - 36 Furlong LS, Rossell SL, Caruana GF, Cropley VL, Hughes M, Van Rheenen TE. The activity and connectivity of the facial emotion processing neural circuitry in bipolar disorder: a systematic review. *J Affect Disord.* 2021;279:518-48.
 - 37 Van Rheenen TE, Ganella EP, Bauer IE, Bartholomeusz CF. Chapter One – Characterization of social cognitive deficits on the schizophrenia-bipolar disorder spectrum: an overview of current evidence. *Soc Cogn Psychosis.* 2019;1:1-36.
 - 38 Alloy LB, Reilly-Harrington N, Fresco DM, Whitehouse WG, Zechmeister JS. Cognitive styles and life events in subsyndromal unipolar and bipolar disorders: stability and prospective prediction of depressive and hypomanic mood swings. *J Cogn Psychother.* 1999;13:21-40.
 - 39 Stange JP, Adams AM, O'Garro-Moore JK, Weiss RB, Ong ML, Walshaw PD, et al. Extreme cognitions in bipolar spectrum disorders: associations with personality disorder characteristics and risk for episode recurrence. *Behav Ther.* 2015;46:242-56.
 - 40 Lahera G, Benito A, González-Barroso A, Guardiola R, Herrera S, Muchada B, et al. Social-cognitive bias and depressive symptoms in outpatients with bipolar disorder. *Depress Res Treat.* 2012;2012:670549.
 - 41 Lahera G, Herrera S, Reinares M, Benito A, Rullas M, González-Cases J, et al. Hostile attributions in bipolar disorder and schizophrenia contribute to poor social functioning. *Acta Psychiatr Scand.* 2015;131:472-82.
 - 42 Samame C. Social cognition throughout the three phases of bipolar disorder: a state-of-the-art overview. *Psychiatry Res.* 2013;210:1275-86.
 - 43 Samame C, Martino DJ, Strejilevich SA. An individual task meta-analysis of social cognition in euthymic bipolar disorders. *J Affect Disord.* 2015;173:146-53.
 - 44 de Siqueira Rotenberg L, Beraldi GH, Okawa Belizario G, Lafer B. Impaired social cognition in bipolar disorder: a meta-analysis of Theory of Mind in euthymic patients. *Aust N Z J Psychiatry.* 2020;54:783-96.
 - 45 Bora E, Özerdem A. Social cognition in first-degree relatives of patients with bipolar disorder: a meta-analysis. *Eur Neuropsychopharmacol.* 2017;27:293-300.
 - 46 Szmulewicz AG, Lomastro MJ, Valerio MP, Igoa A, Martino DJ. Social cognition in first episode bipolar disorder patients. *Psychiatry Res.* 2019;272:551-4.

- 47 Bora E, Özerdem A. Meta-analysis of longitudinal studies of cognition in bipolar disorder: comparison with healthy controls and schizophrenia. *Psychol Med*. 2017;47:2753-66.
- 48 Kjaerstad HL, Mistarz N, Coello K, Stanislaus S, Melbye SA, Harmer CJ, et al. Aberrant cognition in newly diagnosed patients with bipolar disorder and their unaffected relatives. *Psychol Med*. 2020;50:1808-19.
- 49 Gottesman II, Gould TD. The endophenotype concept in psychiatry: etymology and strategic intentions. *Am J Psychiatry*. 2003;160:636-45.
- 50 Hasler G, Drevets WC, Gould TD, Gottesman II, Manji HK. Toward constructing an endophenotype strategy for bipolar disorders. *Biol Psychiatry*. 2006;60:93-105.
- 51 Miskowiak KW, Kjaerstad HL, Meluken I, Petersen JZ, Maciel BR, Köhler CA, et al. The search for neuroimaging and cognitive endophenotypes: a critical systematic review of studies involving unaffected first-degree relatives of individuals with bipolar disorder. *Neurosci Biobehav Rev*. 2017;73:1-22.
- 52 Meluken I, Ottesen NM, Harmer C, Scheike TJ, Kessing L, Vinberg M, et al. Is aberrant affective cognition an endophenotype for affective disorders? – A monozygotic twin study. *Psychol Med*. 2019;49:987-96.
- 53 Kessing LV, Miskowiak K. Does cognitive dysfunction in bipolar disorder qualify as a diagnostic intermediate phenotype? – A perspective paper. *Front Psychiatry*. 2018;9:490.
- 54 Monrad Aas IH. Collecting information for rating Global Assessment of Functioning (GAF): sources of information and methods for information collection. *Curr Psychiatry Rev*. 2014;10:330-47.
- 55 Rosa AR, Franco C, Martínez-Aran A, Sanchez-Moreno J, Reinares M, Salamero M, et al. Functional impairment in patients with remitted bipolar disorder. *Psychother Psychosom*. 2008;77:390-2.
- 56 Rosa AR, Sánchez-Moreno J, Martínez-Aran A, Salamero M, Torrent C, Reinares M, et al. Validity and reliability of the Functioning Assessment Short Test (FAST) in bipolar disorder. *Clin Pract Epidemiol Ment Health*. 2007;3:5.
- 57 Weissman MM, Bothwell S. Assessment of social adjustment by patient self-report. *Arch Gen Psychiatry*. 1976;33:1111-5.
- 58 Vlad M, Raucher-Chéné D, Henry A, Kaladjian A. Functional outcome and social cognition in bipolar disorder: is there a connection? *Eur Psychiatry*. 2018;52:116-25.
- 59 Üstün TB, Chatterji S, Kostanjsek N, Rehm J, Kennedy C, Epping-Jordan J, et al. Developing the World Health Organization disability assessment schedule 2.0. *Bull World Health Organ*. 2010;88:815-23.
- 60 Durand D, Strassnig MT, Moore RC, Depp CA, Ackerman RA, Pinkham AE, et al. Self-reported social functioning and social cognition in schizophrenia and bipolar disorder: using ecological momentary assessment to identify the origin of bias. *Schizophr Res*. 2021;230:17-23.
- 61 Strassnig M, Kotov R, Fochtmann L, Kalin M, Bromet EJ, Harvey PD. Associations of independent living and labor force participation with impairment indicators in schizophrenia and bipolar disorder at 20-year follow-up. *Schizophr Res*. 2018;197:150-5.
- 62 Miskowiak K, Petersen JZ, Ott CV, Knorr U, Kessing LV, Gallagher P, et al. Predictors of the discrepancy between objective and subjective cognition in bipolar disorder: a novel methodology. *Acta Psychiatr Scand*. 2016;134:511-21.
- 63 Martino DJ, Strejilevich SA, Fassi G, Marengo E, Igoa A. Theory of mind and facial emotion recognition in euthymic bipolar I and bipolar II disorders. *Psychiatry Res*. 2011;189:379-84.
- 64 Bora E, Vahip S, Gonul AS, Akdeniz F, Alkan M, Ogut M, et al. Evidence for theory of mind deficits in euthymic patients with bipolar disorder. *Acta Psychiatr Scand*. 2005;112:110-6.
- 65 Harmer CJ, Grayson L, Goodwin GM. Enhanced recognition of disgust in bipolar illness. *Biol Psychiatry*. 2002;51:298-304.
- 66 Lahera G, Montes JM, Benito A, Valdivia M, Medina E, Mirapeix I, et al. Theory of mind deficit in bipolar disorder: is it related to a previous history of psychotic symptoms? *Psychiatry Res*. 2008;161:309-17.
- 67 Bilderbeck AC, Atkinson LZ, Geddes JR, Goodwin GM, Harmer CJ. The effects of medication and current mood upon facial emotion recognition: findings from a large bipolar disorder cohort study. *J Psychopharmacol*. 2017;31:320-6.
- 68 Bora E, Pantelis C. Social cognition in schizophrenia in comparison to bipolar disorder: a meta-analysis. *Schizophr Res*. 2016;175:72-8.
- 69 Ekman P, Friesen WV. Pictures of facial affect. Palo Alto: Consulting Psychologists Press; 1976.
- 70 Meissner CA, Brigham JC. Thirty years of investigating the own-race bias in memory for faces: a meta-analytic review. *Psychol Public Policy Law*. 2001;7:3-35.
- 71 Corcoran R, Mercer G, Frith CD. Schizophrenia, symptomatology and social inference: investigating "theory of mind" in people with schizophrenia. *Schizophr Res*. 1995;17:5-13.
- 72 Miskowiak KW, Burdick KE, Martínez-Aran A, Bonnin CM, Bowie CR, Carvalho AF, et al. Methodological recommendations for cognition trials in bipolar disorder by the International Society for Bipolar Disorders Targeting Cognition Task Force. *Bipolar Disord*. 2017;19:614-26.
- 73 Brackett MA, Rivers SE. Transforming students' lives with social and emotional learning. In: Pekrun R, Linnenbrink-Garcia L, eds. *International handbook of emotions in education*. Abingdon: Routledge/Taylor & Francis Group; 2014. p. 368-88.
- 74 Germer C, Neff K. Teaching the mindful self-compassion program: a guide for professionals. Nova lorque: Guilford Publications; 2019.
- 75 Berry K, Bucci S, Kinderman P, Emsley R, Corcoran R. An investigation of attributional style, theory of mind and executive functioning in acute paranoia and remission. *Psychiatry Res*. 2015;226:84-90.
- 76 Cattarinussi G, Di Giorgio A, Wolf RC, Balestrieri M, Sambataro F. Neural signatures of the risk for bipolar disorder: a meta-analysis of structural and functional neuroimaging studies. *Bipolar Disord*. 2019;21:215-27.
- 77 Phillips ML, Swartz HA. A critical appraisal of neuroimaging studies of bipolar disorder: toward a new conceptualization of underlying neural circuitry and a road map for future research. *Am J Psychiatry*. 2014;171:829-43.
- 78 Zilverstand A, Parvaz MA, Goldstein RZ. Neuroimaging cognitive reappraisal in clinical populations to define neural targets for enhancing emotion regulation. A systematic review. *Neuroimage*. 2017;151:105-16.
- 79 Corbalán F, Beaulieu S, Armony J. Emotion regulation in bipolar disorder type I: an fMRI study. *Psychol Med*. 2015;45:2521-31.
- 80 Kanske P, Schönfelder S, Forneck J, Wessa M. Impaired regulation of emotion: neural correlates of reappraisal and distraction in bipolar disorder and unaffected relatives. *Transl Psychiatry*. 2015;5:e497.
- 81 Szmulewicz A, Valerio MP, Martino DJ. Longitudinal analysis of cognitive performances in recent-onset and late-life bipolar disorder: a systematic review and meta-analysis. *Bipolar Disord*. 2020;22:28-37.
- 82 Hooker CI, Bruce L, Fisher M, Verosky SC, Miyakawa A, Vinogradov S. Neural activity during emotion recognition after combined cognitive plus social cognitive training in schizophrenia. *Schizophr Res*. 2012;139:53-9.
- 83 Mendella PD, Burton CZ, Tasca GA, Roy P, St Louis L, Twamley EW. Compensatory cognitive training for people with first-episode schizophrenia: results from a pilot randomized controlled trial. *Schizophr Res*. 2015;162:108-11.
- 84 Peña J, Ibarretxe-Bilbao N, Sánchez P, Uriarte JJ, Elizagarate E, Gutierrez M, et al. Mechanisms of functional improvement through cognitive rehabilitation in schizophrenia. *J Psychiatr Res*. 2018;101:21-7.
- 85 Govindaraj R, Naik SS, Mehta UM, Sharma M, Varambally S, Gangadhar BN. Yoga therapy for social cognition in schizophrenia: an experimental medicine-based randomized controlled trial. *Asian J Psychiatr*. 2021;62:102731.
- 86 Librenza-Garcia D, Kotzian BJ, Yang J, Mwangi B, Cao B, Lima LNP, et al. The impact of machine learning techniques in the study of bipolar disorder: a systematic review. *Neurosci Biobehav Rev*. 2017;80:538-54.
- 87 Passos IC, Mwangi B, Cao B, Hamilton JE, Wu MJ, Zhang XY, et al. Identifying a clinical signature of suicidality among patients with mood disorders: a pilot study using a machine learning approach. *J Affect Disord*. 2016;193:109-16.
- 88 Lahera G, Benito A, Montes JM, Fernandez-Liria A, Olbert CM, Penn DL. Social cognition and interaction training (SCIT) for outpatients with bipolar disorder. *J Affect Disord*. 2013;146:132-6.
- 89 Haffner P, Quinlivan E, Fiebig J, Sondergeld LM, Strasser ES, Adli M, et al. Improving functional outcome in bipolar disorder: a pilot study on metacognitive training. *Clin Psychol Psychother*. 2018;25:50-8.