Psychological Medicine, 2004, **34**, 391–400. © 2004 Cambridge University Press
DOI: 10.1017/S0033291703001284 Printed in the United Kingdom

REVIEW ARTICLE

Social cognition, brain networks and schizophrenia

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ABSTRACT

Background. A better understanding of the neural basis of social cognition including mindreading (or theory of mind) and empathy might help to explain some deficits in social functioning in people with schizophrenia. Our aim was to review neuroimaging and neuropsychological studies on social cognition, as they may shed light on the neural mechanisms of social cognition and its dysfunction in patients with schizophrenia.

Method. A selective literature review was undertaken.

Results. Neuroimaging and neuropsychological studies suggest convergence upon specific networks for mindreading and empathy (the temporal cortex, amygdala and the prefrontal cortex). The frontal lobe is likely to play a central role in enabling social cognition, but mindreading and empathic abilities may require relatively different weighting of subcomponents within the same frontal-temporal social cognition network.

Conclusions. Disturbances in social cognition may represent an abnormal interaction between frontal lobe and its functionally connected cortical and subcortical areas. Future studies should seek to explore the heterogeneity of social dysfunction within schizophrenia.

INTRODUCTION

A deficit in social functioning is one of the most disabling clinical features of schizophrenia and is a significant factor in the resulting social isolation experienced by many with the disorder (American Psychiatric Association, 1994). One factor that leads to this deficit is miscommunication with others. For example, patients may misidentify social information (rules, affect and goals in social situations) especially when asked abstract, rather than concrete, questions about social situations (Corrigan & Green, 1993; Corrigan & Nelson, 1998). Some current models of schizophrenia postulate that it can be best understood as a disorder of the representation of mental states (i.e. the inability to represent what others are thinking) (Frith, 1992; Broks, 1997).

Social cognition skills, including recognizing mental states (mindreading or theory of mind: attributing desire, intention and attention to others) and entering into another's feelings (empathy), are developed after the acquisition of secondary representation ('holding in mind') in the second year of life (see Suddendorf & Whiten, 2001, for a review). Deficit of the former has been referred to as 'lack of intuitive attunement' (Stanghellini, 2000), whereas deficit of the latter we refer to as 'dysempathy' (Farrow *et al.* 2001). Neurodevelopmental disorders such as autism (Frith, 2001), frontal cortex brain injury (Stone *et al.* 1998; Stuss *et al.* 2001) and amygdala damage (Adolphs *et al.* 1998; Fine *et al.* 2001) have all been associated with deficits in both mindreading and empathy.

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In this review we focus on mindreading and empathy in particular, although social cognition is quite a broad area.

Our primary aim was to explore the neural mechanisms of mindreading and empathy deficits in schizophrenia. We first outline some conceptual and methodological issues in measuring mindreading and empathy. We then summarize mindreading and empathy studies in schizophrenia. In subsequent sections, we discuss the ways in which brain imaging and neuropsychological studies have shed light upon the brain mechanisms underlying mindreading and empathy deficits in people with schizophrenia. Our conclusion focuses on the convergence of findings across different levels of investigation and highlights new directions for potentially fruitful research.

CONCEPTUAL AND METHODOLOGICAL ISSUES IN MEASURING SOCIAL COGNITION

Social cognition is a specialized domain of cognition hypothesized to have developed in order to solve social, adaptive problems. The ability to interpret the mental states (beliefs and intentions) of others in order to predict and explain their behaviour has been conceptualized as 'theory of mind' (Premack & Woodruff, 1978) or 'mindreading'. One aspect of this, hitherto under-explored in studies of social cognition, is empathy. Empathy is critical for human bonding. However, as a term, its meaning has varied (Batson *et al*. 1987). Some authors have defined empathy as a 'largely involuntary, vicarious response to affective cues from another person or his situation' (Hoffman, 1978, p. 227). In this regard, empathy has been defined as the condition in which a match exists between the affect experienced by the observer and that experienced by another (Hoffman, 1978). Empathy has also been conceptualized as a role-taking or perspective-taking ability (Hogan, 1969). Here, we distinguish 'empathy' from mindreading or perspective taking, to refer to the attribution of emotion.

There has been a theoretical debate about how we attribute the mental states of others. Two primary, yet fundamentally different, theories to account for such 'mindreading' have been proposed. The 'theory-theory' proposes that we employ a theory to make attributions of mental states of others. It has been argued that our understanding of mind is a framework or a theory analogous to scientific theories (Gopnik & Wellman, 1995). In contrast, the 'simulation theory' argues that 'mindreading' depends not on the possession of such a theory, but on the ability to simulate another person's mind. For example, it is proposed that our brain actually begins to function like the other's brain by generating similar processes in oneself (Gordon, 1995). While the relative significance of these theories is still under debate, the recent discovery of mirror neurons (which discharge when a goal-directed action is observed but do not discharge when the same movements are observed outside the context of the goal (Rizzolatti *et al*. 1996)) make it highly likely that actions attracting attention are continuously simulated in the brain (see Williams *et al*. 2001 for a recent review). This finding may be compatible with older psychodynamic views of mental function such as introjection, projection, and projective identification (namely, those concepts which have been used to explain shared subjectivity phenomena).

Mindreading abilities have been tested using a number of paradigms, mostly involving 'false belief'. The false-belief test measures the ability to represent or understand what other people believe. For example, in the classic 'Sally-Anne' false-belief test (Baron-Cohen *et al*. 1985), Sally has a basket and Anne has a box. Sally puts a marble into her basket, and then she leaves the scene. While she is outside, Anne takes the marble from the basket and puts it into her own box. Then Sally comes back and wants to play with her marble. Children are asked to predict where Sally will look for her marble. Four-year-old children tend to pass the test (correctly predicting she will look for her marble in her basket). Wellman *et al*. (2001) who performed a meta-analysis of 143 published studies on young children's false-belief task performance, concluded that the ability to perform the task successfully was dependent on brain maturation between 3 and 5 years, independent of cultural background. As Bloom & German (2000) point out, there are attention and memory resources, in addition to mindreading ability, required to pass this test. In another meta-analysis of false-belief performance and executive function

studies in young children (Perner & Lang, 1999), there was a significant association between these two measures, but testing duration per session systematically affected the association.

While the false-belief task has been useful to test children's mindreading ability, and its development and dysfunction, some recent studies have developed tasks appropriate for adult subjects, mainly for people with schizophrenia. They include the hinting task (Corcoran *et al.* 1995) and the joke appreciation task (Corcoran *et al.* 1997; Happé *et al.* 1999) both involving inferring the intention of a character in stories and cartoons, and the sequencing task (Sarfati *et al.* 1997) involving inferring the character's intention and choosing the most likely card to complete comic strip sequences. While there is a need to develop mindreading tasks assessing more than intention attribution (e.g. needs, values of others), the relationships between various tasks should also be established. Further task validation might include investigating whether poor performance in the task is related to poor social skills and functioning using social functioning measures (e.g. The Life Skills Profile, Rosen *et al.* 1989).

By contrast, experimental paradigms for measuring empathy are relatively rare. The most common paradigms are those based upon emotional reactions to perceiving another person in need or distress. For example, some studies have used experimental situations such as a crying baby (Jones *et al.* 2000) or a display of distress by an adult (Charman *et al.* 1997) to observe empathic responses (facial expression and helping behaviours) in children. Blair *et al.* (1997) used skin conductance response recordings to quantify empathic responses to distressing pictures such as a crying face. Instead of using experimental manipulations, many other studies have used psychometric questionnaires to assess empathic ability. Widely used questionnaires are the Hogan Empathy scale (Hogan, 1969), which focuses on the cognitive aspects of empathy (social self-confidence, even-temperedness, sensitivity and non-conformity) and the Questionnaire Measure of Emotional Empathy (QMEE) (Mehrabian, 1972), which is more concerned with responsiveness to another's emotional experience (see Chlopan *et al.* 1985, for a review of various empathy measures). Based on the factor analysis of various empathy items, Davis (1983) developed the Interpersonal Reactivity Index (IRI) measuring four different aspects of empathy (perspective taking, fantasy, empathic concern and personal distress). Davis found that the Hogan scale was associated with perspective taking, whereas QMEE was related to empathic concern. Fantasy is related to tendency to become deeply involved in fictional situations. Personal distress refers to self-oriented feelings in response to perceiving another in need.

The ability to perform well on mindreading tasks is closely linked to the development of empathy. For example, Charman *et al.* (1997) found that 20-month-old children with autism were impaired on the tasks of empathy (affective and attentional responses to a display of distress by an adult), as well as on other basic mindreading tasks such as joint attention ('social looks' – switching gaze between ambiguous objects) and imitation behaviour, compared with developmentally delayed and 'normal' children. However, exploration of the relationship between empathy and mindreading has not yet established whether or not mindreading is a prerequisite for empathy (Gillberg, 1992) or vice versa (Preston & de Waal, 2002). Simulation theory, considering the common neural mechanism for perception and action, may provide a theoretical ground to answer this question.

In summary, while experimental paradigms for measuring mindreading have been developed, the majority of studies of empathy have used questionnaires to measure empathic ability. There may, however, be different empathic responses which might depend to varying degrees upon perceptual and cognitive processes (e.g. working memory demand). 'Perspective taking ability', described in the empathy literature, might be closely related to mindreading. The following section outlines empirical studies on mindreading and empathy deficits in people with schizophrenia.

MINDREADING AND EMPATHY DEFICITS IN SCHIZOPHRENIA

To date, a number of empirical studies have shown that mindreading is disrupted in people with schizophrenia (Corcoran *et al.* 1995, 1997; Frith & Corcoran, 1996; Sarfati *et al.* 1997; Doody *et al.* 1998; Pickup & Frith, 2001). The

authors in most of these studies employed first-order and second-order false-belief tasks (which test the ability to understand one person's belief about that of another person). When considered as a group, subjects with schizophrenia exhibited deficits in mindreading ability, relative to non-psychiatric control subjects. The mindreading deficit in schizophrenia is reported to be less pronounced than that of autism (Pilowsky *et al*. 2000).

Whether the mindreading deficit in schizophrenia is a trait, or is influenced by mental state changes is not clear to date, but both children and chronically affected adults with schizophrenia exhibit the deficit (Pilowsky *et al*. 2000). Some studies have revealed that symptom severity is, in fact, associated with the observed mindreading deficit (Doody *et al*. 1998). For instance, the observation that only patients during an acute episode, but not following recovery, exhibit this particular deficit (Corcoran *et al*. 1997; Drury *et al*. 1998), suggests the presence of an association between disturbed mental state and performance on mindreading tasks (but see also Herold *et al*. 2002). Roncone *et al*. (2002) found that a better mindreading ability predicted low levels of symptom severity, together with high levels of social functioning. Specific symptoms posited to be related to mindreading deficit include negative symptoms, thought disorder, or persecutory delusions (Frith & Corcoran, 1996). Langdon *et al*. (2002) reported a specific association between positive formal thought disorder and a mindreading deficit using a false-belief picture-sequencing task. A study examining the relationship to the broad positive/negative symptom dichotomy (Doody *et al*. 1998) found that both positive and negative symptoms were associated with the observed mindreading deficit. Pickup & Frith (2001) found that both positive (incoherent or inappropriate speech) and negative (avolition, poverty of speech, social withdrawal or flat affect) behavioural signs were associated with mindreading deficit. Some studies have examined mindreading deficit in relation to Liddle's three schizophrenia sub-syndromes of disorganization (defined primarily by thought disorder), reality distortion (hallucinations and delusions) and psychomotor poverty (negative symptoms) (Liddle, 1987). Mazza *et al*. (2001) reported most pronounced mindreading deficit in the psychomotor poverty syndrome patients, whereas Sarfati *et al*. (1997) found that the mindreading deficit was more severe in disorganization than in other subgroups. Sarfati *et al*. (1999) found the association between disorganization symptoms and mindreading deficit common to paradigms presented both visually and verbally. Taken together, this small group of studies does not seem to support a specific relationship between discrete items of schizophrenia symptomatology and impaired mindreading. This inconsistency may also be due in part to the fact that some studies have used different symptom grouping methods (e.g. Frith & Corcoran, 1996).

Empathic ability has not been directly examined in people with schizophrenia, although a number of studies have suggested empathy deficit. Given the lack of empirical empathy studies in people with schizophrenia, it might be important to note Feshbach's conceptualization of empathy processes (Feshbach, 1987): (1) the ability to discriminate different affective cues in others; (2) the ability to assume the perspective and role of another person; and (3) the ability to experience and express emotions. As applied to schizophrenia: (1) impairment in facial emotion perception (the decoding of emotions in others) may contribute to an empathy deficit in people with schizophrenia given the frequent finding that such patients have difficulty in identifying facial emotions in others (e.g. Archer *et al*. 1994; Hooker & Park, 2002); (2) social cognitive deficit in perspective taking has been implicated in a number of mindreading studies (Penn *et al*. 1997); and finally, (3) there have been reports suggesting that the experience of emotion is distorted in people with schizophrenia. For example, some patients experience negative emotions more intensely and positive emotions less intensively than healthy controls (Myin-Germeys *et al*. 2000).

Disturbances in mindreading and empathy in schizophrenia appear to be independent of generalized cognitive deficits. For example, in a study analysing patients' free responses on the emotional state of the principal protagonist in videotaped social interactions, Cramer *et al*. (1992) concluded that selective inattention to psychological and emotional factors, rather than attentional and cognitive deficits, was responsible for obscured misinterpretation of

the emotional states of others in people with schizophrenia. Penn *et al.* (1996) used measures of non-social cognitive processing (the continuous performance task, span of apprehension test, backward masking, reaction time, and card sorting task) and social cognition including affect recognition, empathy questionnaire, and sequencing of social stimuli to predict patients' ward behaviour. By so doing, they found that poor scores on cognitive measures were more closely related to impairments in ward behaviour (based on a behavioural checklist for nurses). The authors suggested that cognitive abnormalities in these patients might have had only an indirect effect on their ward behaviour, whereas deficits in social cognition were directly associated with impairments in such behaviour. These observations are in accord with the finding that cognitive dysfunctions (of verbal ability, memory, executive functioning, visual-spatial ability, and attention) seen in people with schizophrenia are largely independent of social functioning measures such as the Social Dysfunction Index (SDI) and the Social Adjustment Scale-II (SAS-II) (Addington *et al.* 1998). It should also be noted here that evidence concerning the association between cognitive impairments and social dysfunction remains contradictory (Velligan *et al.* 2000). The contribution of generalized cognitive impairments to mindreading and empathy deficits in schizophrenia remains to be determined, because there have been no studies that focus specifically on the links between them. Neuroimaging and neuropsychological lesion studies might provide crucial complementary information for the understanding of social cognition dysfunction in people with schizophrenia.

BRAIN NETWORKS FOR MINDREADING AND EMPATHY

A mindreading network

Evidence from functional neuroimaging studies points to the existence of specific brain regions responsible for mindreading performance in healthy subjects. The first study by Baron-Cohen *et al.* (1994) reported increased activity in the right orbitofrontal cortex but decreased activity in the left frontal-polar region during a mental state word recognition task (mind related words *versus* body related words), using

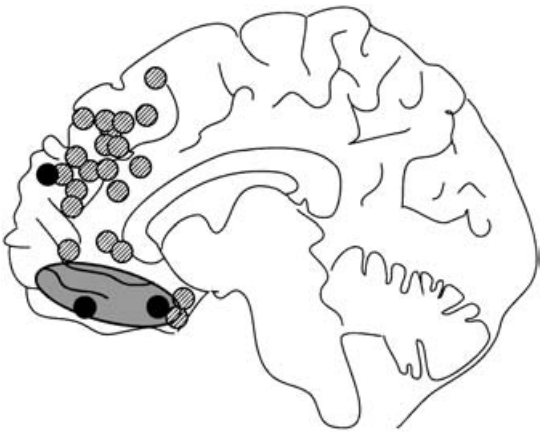

FIG. 1. Location of activations during: ▨, mindreading (Brodmann areas 6, 8, 9, 10, 24, 32, 47); ●, empathy (Brodmann areas 9, 11, 47); ■, the orbitofrontal cortex region was implicated in empathy.

PET. While Baron-Cohen *et al.* used a region-of-interest approach, later studies using mindreading stories reported that brain regions implicated included, left middle and medial frontal cortex (Fletcher *et al.* 1995; Gallagher *et al.* 2000; Vogeley *et al.* 2001). Fig. 1 highlights medial prefrontal regions activated during mindreading tasks (Siegal & Varley (2002) provided a detailed discussion about the role of the domain-specific brain regions subserving language and visuospatial functioning for mindreading). Functional neuroimaging studies of clinical populations have shown that underactivation of the medial prefrontal cortex may be associated with mindreading deficits. For example, patients with Asperger's syndrome failed to activate left medial frontal cortex despite task-related activity in other brain regions (Happé *et al.* 1996). The one published fMRI study of mindreading in schizophrenia reported a deficit in left medial prefrontal cortex activation in people with schizophrenia (Russell *et al.* 2000).

Neuropsychological studies have emphasized the role of the frontal cortex in mindreading performance, although the evidence relating to frontal laterality is controversial (Channon & Crawford, 2000; Stuss *et al.* 2001). Patients with bilateral orbitofrontal lesions have been found to have a mindreading deficit, whereas patients with unilateral damage in left dorsolateral prefrontal cortex performed normally on mindreading tasks (Stone *et al.* 1998). A clear

https://doi.org/10.1017/S0033291703001284 Published online by Cambridge University Press

dissociation between mindreading ability and frontal executive function has been demonstrated. Lough *et al.* (2001) reported a case study of a patient with frontal dementia who showed relatively intact neuropsychological executive function, but extremely poor performance on mindreading tasks (first-order and second-order false-belief tasks, and the '*Faux pas*' test). With structural MRI evidence for orbitomedial (but not dorsolateral) atrophy in the prefrontal cortex, they suggested distinct and separate neural circuitry for mindreading (orbitomedial) and executive (dorsolateral) function in the frontal lobes. Similarly, patients with frontal lobe excisions showed mindreading deficits that are relatively independent of their deficits in executive function (Rowe *et al.* 2001). A recent study also reported impairments on mindreading tasks, but not on general executive function tests (measuring inhibition, intentionality and working memory), in a patient with early left amygdala damage (Fine *et al.* 2001). Gregory *et al.* (2002) found that mindreading performance (first and second order false-belief and '*Faux pas*' tests) was not associated with performance in traditional tests for frontal lobe function (e.g. verbal fluency test) in 19 patients with frontal dementia. In their study, only '*Faux pas*' task performance (which requires the highest working memory demands among mindreading tasks) was related to perseverative errors on the Wisconsin Card Sorting Test (WCST). Thus, the ability to perform most mindreading tasks may rely on a neural network distinct from that employed by working memory (which implicates dorsolateral prefrontal cortex).

An empathy network

Brothers (1989) suggested that the amygdala projects to the sensory association cortex to process social emotional information. A review by Preston & de Waal (2002) suggests two empathy networks; (1) amygdala, cingulate and orbitofrontal cortices, involved in perception and emotion regulation; and (2) dorsolateral and ventromedial prefrontal regions engaged in holding and manipulating this information.

Neuropsychological studies have found both the prefrontal and the temporal cortices to be implicated in empathic ability, but the patterns of associations are different depending upon whether cognitive or emotional empathy is examined. Grattan *et al.* (1994) examined the effect of cerebral damage upon Hogan's cognitive empathy scores. They found that orbitofrontal lesions specifically impaired empathic ability, but not executive functioning (Wisconsin Card Sorting and Alternate Uses Tests). However, medial frontal lesions were related to executive dysfunction, not empathic deficit. Left and right dorsolateral lesions were associated with impairment of both executive and empathic functioning. Hence, although most mindreading tasks do not implicate dorsolateral prefrontal cortex, some empathic tasks do engage these regions. By contrast, Shamay *et al.* (2001) reported that emotional empathy (which was associated with facial expression recognition, affective prosody and ability to recognize ironic meaning) was unrelated to cognitive empathy in the Interpersonal Reactivity Index (IRI) as well as neuropsychological frontal lobe test scores in patients with lesions in the prefrontal cortex. Perry *et al.* (2001) measured emotional processing (as indexed by facial affect discrimination, facial affect naming, emotional prosody discrimination, and prosodic affect naming) and empathy (IRI, completed by the spouses of subjects) in four patients with temporal lobe dementia (with volume reduction in the amygdala and the anterior temporal cortex). They found that both cognitive (perspective taking) and emotional (empathic concern) empathic abilities were reduced in the patients without any significant changes in two other subscales in IRI (fantasy and personal distress). It is therefore of interest whether the neural basis of empathy is distinct from that of less emotionally demanding cognitive judgements. In our recent fMRI study of healthy subjects (Farrow *et al.* 2001), subjects were required to exercise empathy judgements to predict and experience the emotions of others. The task produced significant activations of left anterior middle temporal, left superior frontal, left inferior frontal and orbitofrontal gyri and precuneus, relative to a baseline social reasoning task. These results support the hypothesis that the functional anatomy of empathy is distinct from that subserving inference of other's intentions, and they provide a basis from which to explore the neural foundation of 'dysempathy' as part of the social cognitive deficits associated with schizophrenia.

Taking mindreading and empathy studies together, evidence from neuroimaging and neuropsychological studies suggests convergence on specific (though overlapping) networks for mindreading and empathy. Studies have suggested that the amygdala is critically involved in both these abilities. Kling & Brothers (1992) highlighted the role of the amygdala in social cognition. They proposed that the amygdala might be involved in 'the neural representations of the dispositions and intentions of others' by giving subjective feelings (or evaluations) about the representations. Frith (1992) suggested that the brain system for social cognition included the temporal cortex and the amygdala, interacting with the prefrontal cortex. Although the mindreading and empathy networks overlap considerably, it would appear likely that empathy is more strongly mediated by temporal and amygdala activities than more 'cognitive' mindreading tasks. As to the relationship between specific areas of the frontal cortex and mindreading and empathy abilities, the orbitofrontal cortex appears to be preferentially associated with empathy, whereas the medial frontal cortex might be more strongly involved in mindreading ability. It is therefore likely that the two abilities require relatively different weighting of subcomponents within an overlapping frontal-temporal social cognition architecture.

SCHIZOPHRENIC PSYCHOPATHOLOGY AND SOCIAL COGNITION

Evidence suggests that impaired social skills and social functioning might be present only in certain types of schizophrenia. Several models have been proposed to account for the heterogeneity of schizophrenia with respect to social functioning. Strauss *et al.* (1974) proposed 'the disorder of personal relationship' as a subtype of schizophrenia which was distinct from positive and negative subtypes. This subtype was characterized by poor social relationships and associated with a poor recovery from the positive and negative symptoms of the disorder. Two other typologies associated with social dysfunction, emphasize the longitudinal course of the illness over time. Keefe *et al.* (1987) asserted that a 'Kraepelinian' subtype was associated with very poor outcome, less response to neuroleptics, and a strong family history. 'Kraepelinian' patients had more severe negative symptoms and formal thought disorder, without significant differences in delusions and hallucinations (Keefe *et al.* 1996). Similarly, Carpenter *et al.* (1988) have attempted to distinguish 'deficit' negative symptoms (negative symptoms that are manifested as enduring traits) from 'non-deficit' negative symptoms (reflecting transient 'pseudo-negative' symptoms, that are secondary to a variety of factors such as medication side-effects, depression, or environmental understimulation). Patients with a deficit syndrome are reported to have poorer pre-morbid adjustment and prognosis, and more neurological impairment than non-deficit syndrome patients (Buchanan *et al.* 1990).

Studies on social dysfunction in schizophrenia using the positive/negative symptom dichotomy have not found specific associations between these domains. For example, both positive and negative symptoms were associated with social dysfunction. There is isolated evidence for the association between social dysfunction and the three symptom dimensions of Liddle. For instance, disorganization has been associated with poorer social functioning (Norman *et al.* 1999), and psychomotor poverty has been associated with a poor pre-morbid adjustment (Schroder *et al.* 1992). Hoffmann & Kupper (1997) found an association between negative symptoms and deficits in social functioning, but this relationship was no longer present in a four dimensional model (disorganization, psychomotor poverty, reality distortion, and disorder of relating). Instead, they found that both 'disorganization' and 'disorder of relating (characterized by emotional and social withdrawal)' predicted impaired social functioning. This study suggests the need for focusing upon the social domain of schizophrenic psychopathology as well as its positive and negative symptomatology. The impairment of empathy (implicating the circuit of social affiliation: the amygdala and the prefrontal cortex) in people with schizophrenia has been proposed by Kirkpatrick and colleagues (Kirkpatrick *et al.* 1989; Kirkpatrick & Buchanan, 1990). Together, these studies indicate that there is a pressing need for empirical studies of the relationship between social cognition and social dysfunction in schizophrenia.

CONCLUSION

Our review suggests that mindreading and empathy networks are distinct from the executive functioning/working memory network. The evidence from neuroimaging and neuropsychological studies suggests that brain networks underlying mindreading and empathy may be overlapping, yet distinct. Although, mindreading and empathic abilities require relatively different weighting of subcomponents within the same frontal-temporal social cognition network, empathy might be more reliant upon temporal/amygdala and orbitofrontal activity, whereas mindreading places a heavier burden on medial frontal cortex resources. The frontal lobe is likely to play a central role in enabling social cognition. However, involvement of multiple brain regions in social cognition indicates that a lesion model of social cognition dysfunction would be insufficient in explaining its occurrence in schizophrenia and in other complex disorders. Instead, the dysfunction may represent an abnormal interaction between the frontal lobes and their functionally connected cortical and subcortical areas.

Elucidation of the exact nature of social dysfunction in schizophrenia will require a substantial amount of further research. While there is little controversy concerning the existence of social dysfunction in the disorder, to date, little attention has been given to the relationship between social cognition and specific schizophrenia subtypes or symptoms. In this regard, future studies might target schizophrenia subtypes that are hypothesized to be associated with social dysfunction, such as the 'disorder of relating' or 'deficit syndrome'.

We thank anonymous referees for their helpful comments and suggestions. K.H.L. is supported by a grant from Janssen-Cilag.

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