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Different aspects of theory of mind in paranoid schizophrenia: Evidence from a video-based assessment

Christiane Montag [a,*], Isabel Dziobek [b,c], Inga S. Richter [a], Kathrin Neuhaus [a], Anja Lehmann [a], Rudolf Sylla [a], Hauke R. Heekeren [b,c], Andreas Heinz [a], Jürgen Gallinat [a]

[a] Charité University Medicine Berlin (Charité Universitätsmedizin Berlin), Department of Psychiatry and Psychotherapy, Campus Mitte, Charitéplatz 1, 10117 Berlin, Germany
[b] Max Planck Institute for Human Development (Max-Planck-Institut für Bildungsforschung), Lentzeallee 94, 14195 Berlin, Germany
[c] Cluster of Excellence "Languages of Emotion", Freie Universität, Habelschwerdter Allee 45, 14195 Berlin, Germany

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ABSTRACT

In schizophrenia, impairments of theory of mind (ToM) may be due to excessive ('overmentalizing') or defective ('undermentalizing') attribution of mental states. However, most ToM tests differentiate neither between 'overmentalizing' and 'undermentalizing' nor between cognitive and affective ToM in schizophrenia. This study aimed at differentiating these aspects of ToM in 80 patients diagnosed with paranoid schizophrenia and 80 matched healthy controls using the 'Movie for the Assessment of Social Cognition' (MASC). Outcome parameters comprised 1) error counts representing 'undermentalizing' or 'overmentalizing', 2) decoding of cognitive or emotional mental states and 3) non-social inferencing. Multivariate analysis of covariance (MANCOVA) showed significantly abnormal scores for two dimensions of 'undermentalizing' as well as for cognitive and emotional ToM that were not explained by global cognitive deficits. Scores for 'overmentalizing' did not differ between groups, when age, gender, non-social reasoning and memory were controlled. In schizophrenic patients, negative symptoms were associated with a lack of a mental state concept, while positive symptoms like delusions were associated with 'overmentalizing', supporting respective etiological concepts of delusions.

1. Introduction

Over the last few decades, a vast body of literature on social-cognitive abilities in schizophrenia has been accumulated (Penn et al., 2008). In the social-cognitive realm, theory of mind (ToM) or mentalizing was defined originally as the capacity to attribute causal mental states like thoughts, beliefs and intentions to con-specifics (Premack and Woodruff, 1978). ToM deficits are widely recognized in schizophrenia and are mainly considered to be trait markers of the disease (Brüne, 2005a) although some evidence indicates additional deterioration during acute episodes and in the long-term course of the disease (Drury et al., 1998; Langdon and Coltheart, 1999; Lee et al., 2006). Of note, impairments of social cognition affect functional outcome independently from general neurocognitive measures (Green et al., 2000; Pinkham et al., 2003; Brüne et al., 2007). Thus, targeted interventions have been developed in order to mitigate social-cognitive deficits and their secondary impact as interactional stressors (Moritz and Woodward, 2007; Penn et al., 2007).

In his seminal work, Frith (1992) conceived schizophrenia as a disorder of the representation of mental states. Accordingly, difficulties in representing various types of one's own or others' mental states may result in disorders of 'willed action' (e.g., negative and disorganized symptoms), disorders of self-monitoring (e.g., 'passivity' phenomena), or disorders of monitoring other persons' thoughts and intentions (e.g., delusions of persecution and ideas of reference). The failure to correctly infer others' mental states in schizophrenia may be explained by more than one underlying mechanism: Schizophrenic patients – similar to autistic individuals – may not be able to conceptualize mental states at all and hence predict behavior on the basis of the actual state of the world rather than beliefs. Alternatively, patients might possess knowledge about other people's minds but apply it in an incorrect or biased way. This could result either in an overly simplistic or an overly complex attribution of mental states to others (Abu-Akel, 1999; Abu-Akel and Bailey, 2000; Blakemore et al., 2003). Frith (2004) suggested that patients with predominantly negative or disorganized ('behavioral') symptoms and developmental onset of the disease might lack a functional concept of mental states like beliefs or intentions ('undermentalizing'), while patients with paranoid symptoms would tend to 'overmentalize', e.g., to excessively

* Corresponding author. Charité Universitätsmedizin Berlin, Campus Mitte (PUK Charité im SHK), Charitéplatz 1, 10117 Berlin, Germany. Tel.: +49 30 2311 2969; fax: +49 30 2311 2903.
E-mail addresses: christiane.montag@charite.de (C. Montag), dziobek@mpib-berlin.mpg.de (I. Dziobek), inga@zeraphine.de (I.S. Richter), kathrin.neuhaus@charite.de (K. Neuhaus), anja.lehmann@charite.de (A. Lehmann), rudolf.sylla@charite.de (R. Sylla), heekeren@mpib-berlin.mpg.de (H.R. Heekeren), andreas.heinz@charite.de (A. Heinz), juergen.gallinat@charite.de (J. Gallinat).

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attribute – mainly malevolent – intentions or self-referential meaning to others and therefore predict behavior on the basis of the wrong beliefs. Although of fascinating theoretical appeal, the hypothesis of 'overmentalizing' (Frith, 2004) or 'hyper-theory of mind' (Abu-Akel, 1999) in paranoid subjects has hardly been tested, and the causal influence of impaired ToM on the formation of paranoid experiences is still under debate (Freeman, 2007). In contrast to the multitude of studies that found associations of ToM deficits with negative symptoms or disorganization (Brüne, 2005a), studies linking paranoid symptoms with ToM deficits have shown both consistent (Corcoran et al., 1995, 1997, 2008; Craig et al., 2004; Marjoram et al., 2005; Harrington et al., 2005a) and conflicting results (Sarfati et al., 1997; Randall et al., 2003; Drury et al., 1998). This may be explained by an insensitivity of some ToM tests, which usually use dichotomous ('right/wrong') response formats. The few studies that have reported 'overmentalizing' in schizophrenia reported excessive ascription of contingencies, mental states or negative intentions but used experimental settings remote from real-life interaction (Blakemore et al., 2003; Russell et al., 2006; Langdon, 2007).

Shamay-Tsoory et al. (2007) have suggested that ToM skills refer to emotional as well as cognitive mental states. Affective ToM partly relates to the concept of empathy, which involves both inferring and sharing the emotional experiences of others. Studies trying to dissect cognitive and affective dimensions of ToM in schizophrenia are rare and draw conclusions mostly from heterogeneous tests (Bora et al., 2008; Abu-Akel and Abushua'leh, 2004; Shur et al., 2008) or focus on the role of basic emotion recognition and social perception for mental state attribution (Brüne, 2005b). However, a minority of studies has directly compared cognitive and affective ToM capabilities in combined experiments, but they have yielded conflicting results in schizophrenia (Langdon et al., 2006; Shamay-Tsoory et al., 2007).

Most ToM tests present abstract experimental environments and use stimuli of a single modality. Considering this fact, a video-based experimental setting that approximates the demands of everyday life might alleviate some of the problems of explicit, 'offline' mentalizing and also facilitate the use of more or less successful compensatory strategies (McCabe et al., 2004; Frith and Frith, 2008). Therefore, the present study investigates ToM deficits in schizophrenia with the Movie for the Assessment of Social Cognition (MASC; Dziobek et al., 2006a; Fleck et al., 2006). As another advantage, the MASC allows the separate quantification of the use of aberrant mentalizing strategies like 'overmentalizing' and 'undermentalizing', of the ability to attribute cognitive and affective mental states correctly, as well as of non-social reasoning.

The aim of this work was to clarify the nature of ToM deficits with respect to putative relations to psychopathology in paranoid schizophrenia. It was hypothesized that patients with paranoid schizophrenia would perform worse than controls on both cognitive and emotional mental state attribution, and that this alteration would not be due to deficits of general cognitive function. Furthermore, it was assumed that the extent of 'over-' or 'undermentalizing' would be associated with the expression of positive or negative symptoms, respectively.

2. Materials and methods

2.1. Participants

The study was approved by the local ethics committee (Charité Universitätsmedizin Berlin, Germany). All subjects gave written informed consent. Eighty in- and outpatients diagnosed with schizophrenia were recruited from the Department of Psychiatry, Charité Universitätsmedizin Berlin. Diagnosis was confirmed using the Structured Clinical Interview for DSM-IV (SCID-I; First et al., 1995; German version: Wittchen et al., 1997); symptom severity was assessed with the Positive and Negative Syndrome Scale (Kay et al., 1987). All patients fulfilled criteria for paranoid schizophrenia according to the Diagnostic and Statistical Manual of Mental Disorders IV, text revision (DSM–IV–TR; (Saß et al., 2003). Healthy participants, matched according to age, gender and verbal intelligence, were recruited by newspaper advertisements and screened by a psychiatrist with the Mini–International Neuropsychiatric Interview (M.I.N.I; Sheehan et al., 1998). Exclusion criteria for both groups were DSM-IV axis-I or axis-II disorders (except schizophrenia for the patient group); controls reporting axis-I mental disorders in their first-degree relatives were also excluded.

Characteristics of the patient group are given in Table 1. Medication protocols were as follows: unmedicated: $n=6$(7.5%); atypical neuroleptic: $n=64$(80%); conventional neuroleptic: $n=2$(2.5%); combination atypical + conventional neuroleptic: $n=8$ (10%); additional antidepressant: $n=14$(17.5%); additional benzodiazepine: $n=7$ (8.8%), additional antiepileptic: $n=8$(11.2%); and additional anticholinergic: $n=3$ (3.8%). Chlorpromazine (CPZ) equivalents were calculated according to Lambert et al. (2004) and Schulz et al. (1989); CPZ equivalents of intramuscular Risperidone were estimated on the basis of recommended doses.

2.2. Tasks

The Movie for Assessment of Social Cognition (MASC) was developed for the ecologically valid assessment of mindreading abilities in adults. It adopts the traditional social cognition concepts such as first- and second-order false belief, faux pas, metaphor, or sarcasm multimodally (visual and auditory input) and operationalizes these concepts through a short movie approximating real-life social interactions. The MASC was validated in a sample of patients diagnosed with Asperger syndrome (Dziobek et al., 2006a); Fleck (2007) evaluated the test and its subscales in patients with paranoid schizophrenia and Asperger syndrome. In both investigations, the MASC showed the highest discriminative power in detecting ToM deficits compared to standard social-cognitive tasks, like the Reading the Mind in the Eyes test (Baron-Cohen et al., 2001), the Strange Stories Task (Happé, 1994), and basic emotion recognition (Ekman and Friesen, 1971), a good interrater reliability and internal consistency. The MASC was also used in healthy individuals indicating a reliable detection of even subtle mindreading difficulties in individuals of normal IQ (Smeets et al., 2009). A recent study investigated healthy subjects carefully screened for mental health and euthymic bipolar patients (Montag et al., 2009). Bipolar patients showed significant impairments of cognitive, but not of affective ToM in comparison to normal controls (Montag et al., 2009). Moreover, MASC sum scores were found to be related to amygdala volumes in healthy adults (Dziobek et al., 2006b). We used a computerized multiple-choice version of the MASC that offers four options for each query (MASC-MC; Fleck et al., 2006). Correct answers are presented together with three distractors corresponding to three types of errors in mental state reasoning tasks (Fig. 1). Distractors were modeled on the basis of incorrect answers given by participants in different validation samples (Dziobek et al., 2006a; Fleck et al., 2006; Fleck, 2007; Adenauer et al., 2007). The movie plot comprises the interaction of four characters getting together for an evening of cooking, dining, and playing a board game. Participants are instructed to try to understand the characters' mental states and to answer 48 multiple-choice questions at given breaks. Questions mostly refer to complex mental states and allow a detection of subtle mindreading difficulties (Dziobek et al., 2006a). Questions and multiple-choice answers are read aloud by the instructor and silently by the participant. The MASC provides a sum score for all mental state decoding questions, and the following additional subcategories:

Error categories: Categories are: 1) 'undermentalizing' with two forms, either 1a) overly simplistic mental state inferences despite an intact capacity to represent mental states ('reduced ToM'), or 1b) the complete lack of a mental state concept ('no ToM'), and 2) 'overmentalizing', i.e. overly complex mental state reasoning ('exceeding ToM').

Mental state modalities are reflected by the factors 1) cognitive ToM (e.g. attribution of thoughts, knowledge or action plans; 'What is X thinking/intending?'; 23 items) and 2) emotional ToM (e.g. attribution of anger or guilt; 'What is X feeling?'; 19 items).

Non-social inferencing was assessed with six control questions requiring a high degree of mental flexibility and abstract reasoning devoid of demands on social-cognitive competencies (for example "How was the weather this evening?"; the correct answer has to be inferred from the clothing of the arriving protagonists.). Correct answers are also presented together with three distractors.

2.2.1. General cognitive functioning

In addition to the MASC control condition, a multiple-choice vocabulary test (Mehrfachwahlwortschatztest, MWT-B; Lehrl, 1991) was applied to estimate 'pre-morbid' verbal intelligence. The Auditory Verbal Learning Test (AVLT; Heubrock, 1992)

Table 1
Characteristics of illness in schizophrenic patients ($n=80$).

	Mean (S.D.)
Illness duration [y]	9.8 (±8.6)
Number of episodes	5.6 (±5.4)
Age of onset [y]	29.2 (±10.0)
Current medication	
Antipsychotics (sum) [CPZ equiv.; mg]	446 (±369)
Atypical antipsychotics [CPZ equiv.; mg]	379 (±288)
Conventional antipsychotics [CPZ equiv.; mg]	529 (±403)
PANSS positive score	15.9 (±6.6)
PANSS negative score	17.8 (±7.7)
PANSS global score	32.4 (±12.5)

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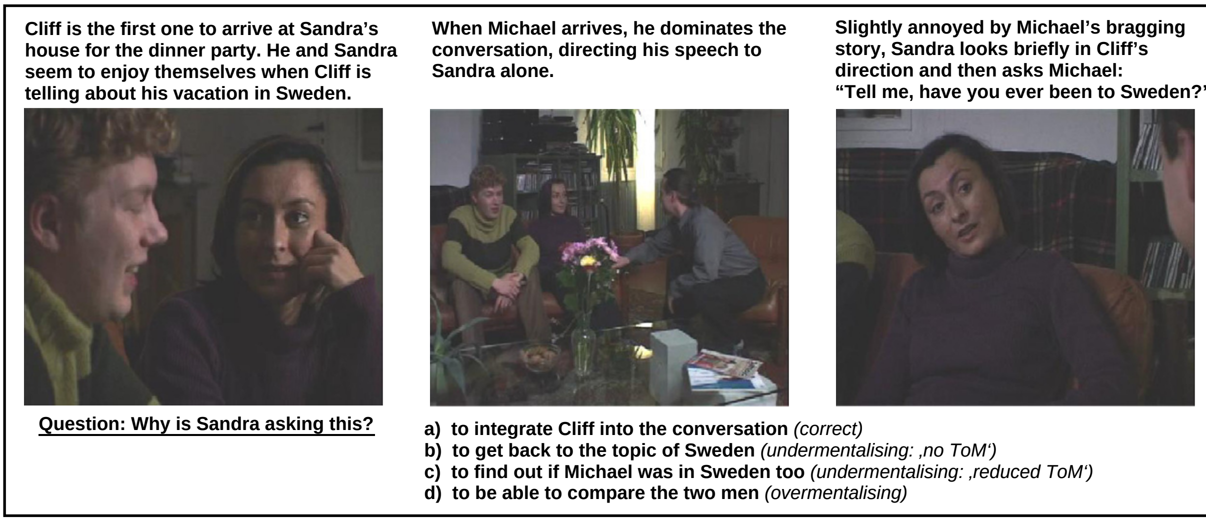

Fig. 1. Example of an MASC scene, a correct response and error categories.

was chosen because it examines a relatively broad spectrum of not only general cognitive functions like multiple verbal memory components (short term memory, verbal learning, delayed recall, and recognition) but also executive functions like the prefrontal control of mnemonic strategies and inhibitory control related to interference. For statistics, the mean score of the five initial presentations (AVLT$^{(1–5)}$), scores for proactive interference (AVLT$^{(int)}$) and delayed recall (AVLT$^{(del)}$) were used.

2.3. Statistical calculations

These were carried out as indicated in the Results section using SPSS for Windows 14.0®. All tests were performed with a 2-sided $p<0.05$. Control for Type I error was performed according to Bonferroni–Holm (Shaffer, 1995).

3. Results

Demographic and neuropsychological data are given in Table 2. Patients did not significantly differ from controls in age, gender or premorbid intelligence levels, but had significantly fewer years of education. Schizophrenic patients scored significantly lower than controls on AVLT scores, MASC sum score, MASC error scores (Fig. 2), MASC cognitive and emotional mental state attribution and MASC control questions (Fig. 3).

Multivariate analysis of covariance (MANCOVA) was performed to control for confounds of non-social inferencing, verbal memory, age and gender. To examine group differences in mentalizing styles, the error scores for 'undermentalizing' ('no ToM' and 'reduced ToM') and for 'overmentalizing' ('exceeding ToM') were introduced as dependent variables: factors were diagnosis and gender; MASC control questions and AVLT$^{(1–5)}$ scores served as covariates. Analysis showed that the two kinds of 'undermentalizing' errors were significantly affected by diagnosis, but 'overmentalizing' was not. 'Reduced ToM' was affected by MASC control questions as well as age. All MASC error scores were associated with AVLT$^{(1–5)}$.

To compare performance for the different mental state modalities, a second MANCOVA was conducted with MASC scores for 'emotional' and 'cognitive' ToM as dependent variables and the same set of covariates. There was a significant influence of diagnosis on both cognitive and emotional mental state decoding. MASC control questions significantly affected cognitive mental state attribution. Additionally, age and AVLT$^{(1–5)}$ had significant effects on both modalities. Gender had no significant impact on MASC performance (Table 3).

The association of diagnostic group with MASC results remained significant when additional cognitive covariates (AVLT$^{(int)}$, AVLT$^{(del)}$ and verbal IQ) were introduced to the model (MANCOVA 1: $F=9.41$; [3;147]; $p<0.001$; MANCOVA 2: $F=14.01$; [2;148]; $p<0.001$). For MANCOVAs, Levene's tests of equality of error variances were significant.

The relationship of PANSS scores, duration of illness and current medication with MASC parameters was analysed by partial correlation controlled for age. Analysis revealed weak yet significant correlations between PANSS positive subscale and PANSS delusion scores with 'overmentalizing', but not with the two 'undermentalizing' scores. By contrast, the PANSS negative subscale was significantly related to 'no ToM' responses, although this was reduced to a trend after α-level-adjustment. MASC 'cognitive mental state attribution' correlated significantly with PANSS positive, delusion and negative scores, but the latter two were not maintained after correction. MASC 'emotional mental state attribution' was associated with PANSS negative and positive

Table 2
Demographic and neuropsychological data from schizophrenic patients and healthy controls. Between-group comparisons: *T*-test for independent samples (two-tailed),[1] χ^2-Test.

	Schizophrenic patients	Healthy controls	Statistics
N	80	80	–
Age [y]	39.1 ± 10.7	38.4 ± 12.3	$T=0.400$, $p=0.690$
Gender [m/f][1]	47/33	41/39	$\chi^2=0.909$, $p=0.427$
Education [y]	14.0 ± 2.8	15.4 ± 2.3	$T=-3.372$, $p=0.001$
MWT-B-IQ	108.0 ± 13.2	110.7 ± 10.8	$T=-1.405$, $p=0.162$
AVLT$^{(1–5)}$	8.3 ± 2.7	10.9 ± 1.6	$T=-7.495$, $p<0.001$
AVLT$^{(int)}$	5.0 ± 2.0	7.0 ± 2.4	$T=-5.673$, $p<0.001$
AVLT$^{(del)}$	8.0 ± 4.0	11.3 ± 3.0	$T=-6.046$, $p<0.001$
MASC$_{\text{mental state decoding}}$	25.0 ± 7.9	34.1 ± 3.7	$T=-9.361$, $p<0.001$
MASC$_{\text{control questions}}$	3.7 ± 1.2	5.1 ± 1.0	$T=-7.392$, $p<0.001$
Overmentalizing ('exceeding ToM')	6.1 ± 3.7	4.6 ± 2.2	$T=2.983$, $p<0.003$
Undermentalizing ('reduced ToM')	9.1 ± 5.1	4.5 ± 2.5	$T=7.220$, $p<0.001$
Undermentalizing ('no ToM')	4.9 ± 3.5	1.8 ± 1.4	$T=7.153$, $p<0.001$
MASC cognitive mental states	12.4 ± 4.2	17.5 ± 2.5	$T=-7.585$, $p<0.001$
MASC emotional mental states	10.5 ± 3.8	14.2 ± 2.1	$T=-7.392$, $p<0.001$

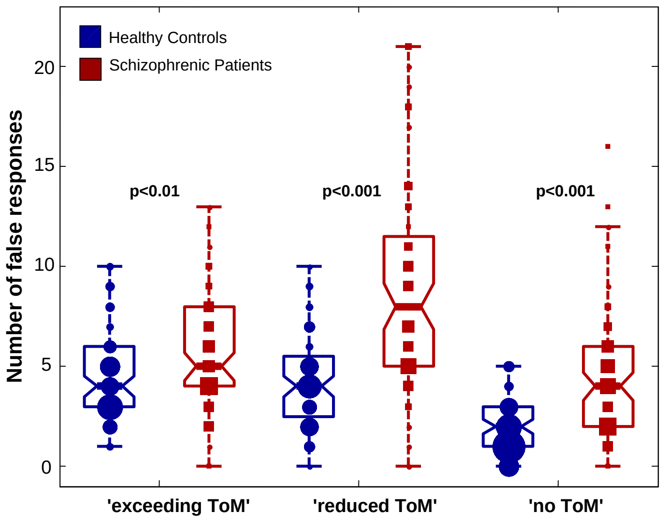

Fig. 2. MASC scores for different types of false responses ('undermentalizing': 'no ToM' and 'reduced ToM' score, and 'overmentalizing': 'exceeding ToM' score) in schizophrenic patients and healthy controls ($n = 80/80$; boxplot: medians, interquartile range; marker size (squares and circles) proportional to number of values; between-group comparisons: *T*-test for independent samples).

scores; both correlations vanished after correction. MASC cognitive and affective ToM performances were moderately correlated to all error scores in the patient group. No significant correlation was found between MASC parameters and medication or duration of illness (Table 4).

4. Discussion

The present study investigated social cognition in schizophrenic patients and healthy controls in a realistic experimental setting that allows the simultaneous examination of the quality of false responses made at the ToM task and a distinction between cognitive and emotional mental state attribution.

Results corroborate existing evidence for ToM impairments in schizophrenic patients (Brüne, 2005a; Harrington et al., 2005b; Sprong et al., 2007; Bora et al., 2009). However, the specificity of the social-cognitive deficit in relation to general neurocognition is still a matter of debate (Sarfati et al., 1997; Hardy-Baylé, 1994; Greig, et al., 2004). In this study, patients and controls were matched according to IQ, and MANCOVAs revealed robust group differences for 'undermentalizing', 'cognitive' and 'emotional' mental state attribution when controlled for non-social inferencing and verbal memory. Our results are thus indicative of the partly independent nature of the ToM deficit, a result which is in line with recent views (Pickup, 2008).

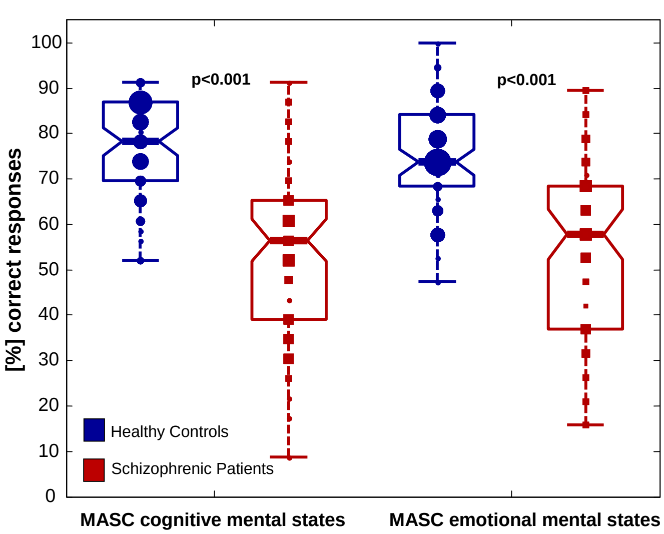

Fig. 3. Percentage of correct responses for MASC cognitive and emotional mental state attribution in schizophrenic patients and healthy controls ($n = 80/80$; boxplot: medians, interquartile range; marker size (squares and circles) proportional to number of values; between-group comparisons: *T*-test for independent samples).

Frith (2004) proposed 'undermentalizing' to affect ToM competence in the presence of negative symptoms and 'overmentalizing' in the case of delusions of persecution and reference and encouraged attempts to distinguish these mechanisms. In the present sample, paranoid schizophrenic patients made significantly more mistakes through both increased 'undermentalizing' and 'overmentalizing' than did controls. MASC 'overmentalizing' scores, however, did not differ significantly between groups when general cognitive function was covaried. Of note, there was a significant correlation between 'overmentalizing', PANSS overall positive and delusion scores in patients, which is in line with theories of Frith (1992, 2004) and Abu-Akel (1999). The relatively small group difference in 'overmentalizing' may be due to MASC's disregard of individual delusional content and the fact that no severely deluded patients were included. In the control group, errors occurred most frequently by 'overmentalizing', which was not the case in the patient group (Fig. 2). Fyfe et al. (2008) observed 'overmentalizing' in healthy adults exhibiting delusion proneness, indicating a hyper-associative cognitive style that led to an exaggeration of the normal human tendency to attribute mental states. As a limitation of our study, healthy participants were not controlled for schizotypal traits and delusion proneness outside frank DSM-axis-I or -II disorder. 'Overmentalizing' scores in our control group may have been confounded by differences in social-cognitive styles, while 'overmentalizing' in schizophrenic individuals may develop along a different pathophysiological path.

Besides 'overmentalizing', 'undermentalizing' accounted for main group differences in MASC false responses, confirming the co-occurrence of both erroneous mentalizing strategies (Russell et al., 2006; Langdon, 2007). However, there was some debate over whether schizophrenic patients appear 'mind-blind' with respect to representational mental states, as was suggested for autistic individuals, or rather are able to conceptualize mental states but fail to utilise this knowledge successfully (Langdon et al., 2001, 2006). Paranoid patients in our sample not only exhibited predominantly incorrect answers while knowing about mental states in general ('reduced ToM'), but also rather frequently chose responses indicating a complete lack of ToM ('no ToM'). There was a positive correlation between 'no ToM' answers- and PANSS negative scores. Although significance was not maintained after α-level-adjustment, these findings are in line with the hypotheses of Frith (2004) and a number of previous investigations which point to a subgroup of patients with prominent negative and disorganized symptoms who experience the most severe malfunctions or loss of ToM and failure to use appropriate mentalizing language (Brüne, 2005a).

On the other hand, it is conceivable that 'mind-blind' or 'concrete' interpretations of social stimuli in schizophrenia might not necessarily mark a complete lack of ToM. Selective inattention towards social cues and diminished social reward salience must also be considered (Combs et al., 2008; Cramer et al., 1992; Heinz, 2002). Alternatively, in the light of co-occurring general cognitive deficits (Pickup, 2008; Hardy-Baylé, 1994), physical 'no ToM' responses may be more easily understood than sentences about mental states (e.g. "The flat is beautiful." rather than: "He is afraid of the dog."), and schizophrenic patients may fail to inhibit such a simple response (Langdon et al., 2001). However, MASC multiple-choice questions directly cued mental state causation and patients were also reminded to focus on mental states by the investigator. Finally, 'undermentalizing' measures remained significantly abnormal even after statistical control for non-social cognition.

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Table 3
MANCOVAs to determine the effect of diagnosis, age, gender, MASC control questions and AVLT$^{(1-5)}$ on MASC subscores in 80 schizophrenic patients and 80 healthy subjects (*F*-value [hypothesis d.f.; error d.f.]): Significant results are indicated (in bold type: $p<0.05$; *: $p<0.01$; **: $p<0.001$). MANCOVA 1: MASC error scores as dependent variables. MANCOVA 2: MASC mental state modality scores as dependent variables.

Factors/covariates → / Dependent variables↓	Diagnosis	Gender	MASC control questions	Age	AVLT$^{(1-5)}$	Gender* diagnosis
MANCOVA 1:	**F = 8.88** [3;151]**	F = 0.72 [3;151]	**F = 2.75 [3;151]**	**F = 4.43* [3;151]**	**F = 6.13** [3;151]**	F = 0.58 [3;151]
Post-hoc ANOVA						
MASC 'no ToM' (adjusted $R^2=0.286$)	**F = 15.99** [1;153]**	F = 0.29 [1;153]	F = 2.57 [1;153]	F = 3.01 [1;153]	**F = 3.99 [1;153]**	F = 0.19 [1;153]
MASC 'reduced ToM' (adjusted $R^2=0.391$)	**F = 14.44** [1;153]**	F = 1.26 [1;153]	**F = 5.11 [1;153]**	**F = 12.31* [1;153]**	**F = 9.54* [1;153]**	F = 1.26 [1;153]
MASC 'exceeding ToM' (adjusted $R^2=0.075$)	F = 0.51 [1;153]	F = 1.87 [1;153]	F = 1.06 [1;153]	F = 0.53 [1;153]	**F = 4.83 [1;153]**	F = 0.13 [1;153]
MANCOVA 2:	**F = 13.13** [2;152]**	F = 0.20 [2;152]	**F = 4.73 [2;152]**	**F = 5.59* [2;152]**	**F = 9.30** [2;152]**	F = 0.78 [2;152]
Post-hoc ANOVA						
MASC Cognitive mental states (adjusted $R^2=0.477$)	**F = 22.19** [1;153]**	F = 0.06 [1;153]	**F = 9.51* [1;153]**	**F = 5.40 [1;153]**	**F = 13.55** [1;153]**	F = 0.33 [1;153]
MASC Emotional mental states (adjusted $R^2=0.401$)	**F = 16.30** [1;153]**	F = 0.40 [1;153]	F = 2.40 [1;153]	**F = 10.43* [1;153]**	**F = 14.01** [1;153]**	F = 0.51 [1;153]

Detailed MASC error analysis can also contribute to the ongoing debate about the putative trait versus state characteristic of ToM deficits in schizophrenia (Bora et al., 2009). The present results support the hypothesis that 'overmentalizing' may only be detectable in acute paranoid states, while 'undermentalizing' may dominate in remission (Horan et al., 2008). Only 'undermentalizing' may be a trait marker for schizophrenia (Brüne, 2005a).

In the present study, schizophrenic patients showed impairments in both MASC cognitive and affective mental state attribution (Fig. 3, Table 3). Although this is in keeping with a number of studies in schizophrenia patients demonstrating profound difficulties in separate test paradigms that focus on either cognitive or affective mentalizing (Bora et al., 2009) or studies comparing ToM performance with emotion attribution (Langdon et al., 2006) or basic emotion recognition (Brüne, 2005b), comparisons between results are hampered for methodological reasons: Only Shamay-Tsoory et al. (2007) used a combined ToM test paradigm and reported deficits of affective mental state decoding in schizophrenia patients compared to healthy controls but no group differences in cognitive mental state decoding. The discrepancy to the present results may be explained by the fact that MASC scenes demand the attribution of more complex mental states than does the experiment of Shamay-Tsoory et al. (2007). Only a minority of MASC items is non-ambiguous and decodable on the basis of direct perception. In fact, participants had to consider all affective dispositions, biographic details, wishes and expectations of a character in order to identify his/her correct mental state. Processing of situational context may have masked or alleviated problems with basic emotion recognition. Correspondingly, evidence from imaging studies suggests that within the social-cognitive networks, low-level stimulus-triggered processing of social-perceptual cues is supplemented by higher-level mental state reasoning associated with activation of the medial prefrontal cortex (Olsson and Ochsner, 2007). However, the influence of emotion processing and more basic social-perceptive functions (Pinkham et al., 2007; Schneider et al., 2006) on higher emotional mental state reasoning should be subject to further research and may help to bridge the gap between studies on ToM and dimensions of empathy (Montag et al., 2007).

Our group of schizophrenic patients displayed significant inverse correlations between negative symptoms and cognitive as well as emotional mental state decoding abilities. However, significance was reduced to a trend after α-level-adjustment. PANSS positive symptoms were significantly related to impairments of cognitive, but not significantly to emotional mental state decoding (Table 4). Our findings indicate a stronger interaction between positive symptoms and a dysfunction of cognitive mentalizing than emotional mentalizing and thus partly confirm the results of Shamay-Tsoory et al. (2007), who reasoned that paranoid 'overmentalizing' might apply to the cognitive dimension of ToM only, whereas 'undermentalizing' in patients with behavioral (i.e. negative or disorganized) symptoms may specifically impair affective ToM. In this study, 'undermentalizing' was correlated with cognitive as well as emotional mental state decoding, and it can be speculated that it plays a role in both higher-level cognitive and affective mentalizing in schizophrenia.

A limitation of the study concerns the fact that most patients were medicated. Drugs modulating different neurotransmitter systems may also affect distinct aspects of ToM (Montag et al., 2008). However, we

Table 4
Partial correlation coefficients for MASC outcome parameters, psychopathological scores, medication and duration of illness in schizophrenic patients ($N=80$): Significant results are indicated (in bold type: $p<0.05$; *: $p<0.01$; **: $p<0.001$); darker shading indicates maintenance of significance after α-level-adjustment (Bonferroni–Holm).

Control variable: age	MASC 'no ToM'	MASC 'reduced ToM'	MASC 'exceeding ToM'	MASC cognitive mental states	MASC emotional mental states
PANSS negative	**r = 0.33***	r = 0.14	r = 0.20	**r = −0.32***	**r = −0.31***
PANSS positive	r = 0.21	r = 0.05	**r = 0.38***	**r = −0.35***	**r = −0.23**
PANSS delusions	r = 0.16	r = −0.05	**r = 0.37****	**r = −0.25**	r = −0.18
medication (CPZ equiv.)	r = −0.00	r = 0.07	r = 0.09	r = −0.15	r = 0.05
duration of illness	r = 0.21	r = −0.06	r = 0.17	r = −0.17	r = −0.70
MASC cognitive mental states	**r = −0.56****	**r = −0.70****	**r = −0.45****		
MASC emotional mental states	**r = −0.62****	**r = −0.63****	**r = −0.44****		

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did not detect any association between medication status and MASC outcome parameters (Table 4). The low number of patients receiving conventional neuroleptics in our sample did not allow for sub-analyses with respect to medication classes. Although there are first reports of a differential impact of antipsychotics on social cognition (Savina and Beninger, 2007), further research on this topic should involve larger samples of stabilized outpatients.

A further limitation lies in the fact that the study does not control for participants' actual social function and personal circumstances. Social cognition may predict social outcome in schizophrenia (Brüne et al., 2007), but may also develop with practice. The interdependency of both aspects could be the subject of longitudinal research.

Moreover, our group of schizophrenic patients comprised patients with the paranoid subtype only. Although the validity of clinical subtyping can be considered limited, the focus on the paranoid subtype in this study does not allow generalization of the results to other clinical subtypes of schizophrenia. Further research on ToM should include the assessment of genetic or endophenotypical markers in addition to psychopathology.

Another limitation of the study involves the problem of heteroscedasticity in parametric statistics. In our samples, MANCOVA dependents were normally distributed, but error variances of the dependent variables were not equal across groups. However, MANCOVA is relatively robust to violations of the homogeneity of variances assumption if groups are of nearly equal size as they were in this study (Leech et al., 2005). Also, there is no easy alternative to MANCOVA when attempting to control for important confounds like general cognition in social-cognitive research. However, results should therefore be viewed with additional caution.

Altogether, this is a study of social cognition in patients with paranoid schizophrenia using a test that allowed to differentiate various dimensions of ToM. Patients showed pronounced deficits in both the cognitive and emotional domains of ToM, which were not entirely explained by global cognitive deficits. 'Undermentalizing' scores were related to negative symptoms, whereas positive symptoms corresponded to 'overmentalizing'. Because of the impact of ToM impairments on disease outcome, further research should focus on the biological mechanisms of mentalizing in schizophrenia (Montag et al., 2008; Brüne et al., 2008).

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