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Theory of mind impairments in schizophrenia: symptomatology, severity and specificity

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ABSTRACT

Background. Several studies have examined the ability of schizophrenic patients to represent mental states ('theory of mind'; ToM). There is consensus that some patients have impaired ToM, but there is disagreement about the relation between ToM and symptomatology, and about the severity and specificity of the deficit.

Methods. Two first-order and one second-order false belief tests of ToM were given to groups of schizophrenic patients and psychiatric and normal controls. The relation between ToM and symptomatology was explored using regression and symptom subgroup analyses. Severity was investigated by using the same task methodology as in autism research, to enable direct comparison with that disorder. Specificity was investigated using matched control tasks which were as difficult as the ToM tasks, but did not require ToM.

Results. Symptom subgroup analysis showed that schizophrenic patients with behavioural signs were impaired relative to controls on ToM, and that remitted patients and a single case with passivity symptoms performed as well as controls. Regression analysis showed that ratings of behavioural signs predicted impaired ToM in schizophrenia. There was weak evidence that a subgroup with paranoid symptoms had ToM impairments, although these were associated with low IQ. Schizophrenic patients only showed ToM deficits on the second-order task. No impairments appeared on the matched control tasks which did not require ToM.

Conclusions. There is a clear association between ToM impairment and behavioural signs in schizophrenia. Deficits in paranoid patients are harder to detect with current tasks and may be compensated for by IQ-dependent problem-solving skills. ToM impairments in schizophrenia are less severe than in autism, but are specific and not a reflection of general cognitive deficits.

INTRODUCTION

It has been proposed (Frith, 1992) that many symptoms of schizophrenia reflect specific impairments in patients' ability to represent their own or other people's mental states ('meta-representation' or 'theory of mind', ToM). Representation of others' mental states has been widely researched in autism, and it is widely accepted that many autistic people have a specific impairment in this ability, and that this may reflect either absence, or delayed development, of a cognitive system subserving meta-representation (see Baron-Cohen *et al*. 2000, for a review).

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Representation of other people's mental states in schizophrenia

The present paper focuses on the ability of schizophrenic patients to represent other people's mental states, so from now on the term 'theory of mind' (ToM) will refer specifically to this skill. Frith (1992) made a distinction between the observable symptoms of schizophrenia (which he called 'behavioural signs') and the non-observable symptoms, which patients experience and report ('symptoms'). Frith's model makes clear predictions about the performance of subgroups of schizophrenic patients on ToM

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tasks, and these subgroups can be formed into a hierarchy of predicted severity. First, patients with any negative behavioural signs (e.g. avolition, poverty of speech, social withdrawal or flat affect) or positive behavioural signs (e.g. incoherent or inappropriate speech) should score very poorly on the tasks, showing a deficit of similar severity to that of autistic people, since they cannot represent any kind of mental state. Secondly, patients with paranoid symptoms (such as persecutory delusions, delusions of reference, or hearing other people's 'voices') but no behavioural signs should also be impaired on the tasks relative to controls, but their deficit should be less than that of patients with behavioural signs, as they are presumed still to represent others' mental states, but to make errors in the process. Finally, schizophrenic people with only passivity symptoms (e.g. delusions of control or thought insertion), or remitted patients with no current signs or symptoms, should score as well as controls on the tasks as they are presumed to represent others' mental states normally.

A number of studies have revealed ToM impairments in schizophrenia, and although all of the studies examined the relation between symptoms and task scores, only four (Corcoran *et al.* 1995, 1997; Corcoran & Frith, 1996; Frith & Corcoran, 1996) actually grouped patients into the symptom subgroups suggested by Frith's model. These studies found that on tasks requiring understanding of hints (Corcoran *et al.* 1995), conversational maxims (Corcoran & Frith, 1996), first- and second-order false belief and deception (Frith & Corcoran, 1996) and jokes (Corcoran *et al.* 1997), both behavioural signs and (to a lesser extent) paranoid symptoms were associated with impaired ToM. Sarfati and colleagues (Sarfati *et al.* 1997*a*, *b*, 1999; Sarfati & Hardy-Baylé, 1999) found that schizophrenic people were poorer than controls at choosing the most suitable card to complete comic strip stories that required an understanding of characters' intentions, desires or false beliefs. Performance was particularly poor for patients with high symptom ratings of 'thought and speech disorganization' (i.e. positive behavioural signs in Frith's terminology). Using a similar picture-sequencing task, Langdon *et al.* (1997) found that poor performance was associated with high ratings for negative behavioural signs but, contrary to Frith's model, there was no evidence that ratings of paranoid symptoms were associated with impaired ToM. Mitchley *et al.* (1998) investigated schizophrenic people's understanding of irony, as this skill is thought to require attribution of a speaker's intentions. Patients with high scores for negative behavioural signs were impaired on the irony task relative to psychiatric controls; again, however, there was no association between task performance and paranoid symptomatology. Doody *et al.* (1998) found that high ratings of negative behavioural signs or general symptomatology were associated with poor performance on a second-order false belief task in people with schizophrenia. Finally, Drury *et al.* (1998) showed that a group of schizophrenic patients with 'positive and negative symptoms' (similar to Frith's 'behavioural signs' subgroup) scored worse than non-schizophrenic 'deluded' patients and depressed controls on second-order false belief stories. Moreover, these task deficits disappeared when symptoms remitted. Contrary to Frith's model, there was again little evidence that patients with paranoid symptoms performed worse than controls on false belief tasks.

In summary, research to date has provided partial support for Frith's model, showing that impaired ToM is clearly associated with the behavioural signs of schizophrenia. However, evidence of an association with paranoid symptoms has differed across studies.

The present study aimed to clarify some of the findings in this area by: (1) examining the relationship between symptoms and performance on ToM tasks in more detail; (2) using tasks modelled on those used in the original studies of ToM in autistic children; and, (3) using a carefully designed control task to explore the specificity of the cognitive deficit to the ToM domain in schizophrenia.

METHOD

Subjects

Forty-one people with a DSM-IV diagnosis of schizophrenia (American Psychiatric Association, 1994) took part in this study. General inclusion criteria were competence in the English language, an age in the range 16 to 65, no history of leucotomy, neurological disability or drug/alcohol abuse, and a current IQ as measured by the Quick Test (Ammons & Ammons, 1962) of $\geqslant 70$. About half of the schizophrenic subjects were in-patients at psychiatric hospitals in London, and the other half lived in the community. All but one of the schizophrenic subjects were taking neuroleptic medication at the time of testing. The daily dose of neuroleptic was converted to chlorpromazine equivalents using Foster's (1989) data. Patients receiving anticholinergic medication (26% of the sample) were all taking 15 mg/day or less of procyclidine (mean daily dose was 10·0 mg, range 5–15 mg). Tamlyn *et al.* (1992) reported that in such doses, procyclidine does not affect memory performance in schizophrenic subjects. However, for the sake of rigour, the neuropsychological tasks in this study incorporated memory control questions to check that subjects were correctly encoding important aspects of the stories. Demographic and clinical details of the schizophrenic patients are shown in Table 1.

In line with Frith's (1992) predictions about performance on ToM tasks, the schizophrenic patients were allocated to one of four groups according to their symptomatology as revealed by a Present State Examination (PSE; Wing *et al.* 1974) on the day of testing. These groups were the same as those used by Corcoran *et al.* (1995), Corcoran & Frith (1996), Frith & Corcoran (1996) and Corcoran *et al.* (1997). Allocation to groups was carried out in a hierarchical manner, so that patients with symptoms or signs from more than one group were allocated to the group for which poorer task performance was predicted. Thus, patients with behavioural signs and any other symptoms were allocated to the behavioural signs group, whereas patients with paranoid and passivity symptoms were allocated to the paranoid group. For the 41 schizophrenic patients, group membership was as follows.

Behavioural signs

There were 16 patients with negative or positive behavioural signs. This was not considered a large enough group to subdivide into positive and negative features.

Paranoid symptoms

Sixteen subjects described positive symptoms involving other agents but showed no behavioural signs.

Passivity experiences

Only one patient reported passivity symptoms in the absence of paranoid symptoms or behavioural signs.

Remission

Eight patients showed no behavioural signs and reported no positive symptoms on the day of testing.

Each schizophrenic patient was given a score for total number of symptoms based on the PSE interview. The means (S.D.) of these scores for the behavioural signs and paranoid groups did not differ significantly and were 5·7 (3·0) and 6·7 (3·4) respectively.

Two control groups were recruited for the study. The clinical controls consisted of 18 non-psychotic psychiatric patients with primary diagnoses of anxiety or unipolar depression. The group was a mixture of in-patients and out-patients and all subjects were taking anti-depressant or anxiolytic medication. The other control group comprised 35 normal volunteers, none of whom reported a history of psychiatric illness. Demographic details of controls are shown in Table 1.

The tasks

All subjects were given two first-order and one second-order false belief tests of theory of mind, and three corresponding 'non-mental' representation control tasks which had the same structure as the ToM tasks but did not require ToM. Tasks were read aloud and enacted by the experimenter, using 'Playmobil' characters or other props to aid subjects' concentration and comprehension. Most stories were set in a hospital, or involved familiar objects, in an attempt to increase the ecological validity for institutionalized schizophrenic patients. Memory control questions were asked throughout each task to check that subjects could remember key facts about the story. The 'test question' in each task was the measure of representational understanding.

First-order tasks (see Appendix 1)

There were two first-order false belief tasks. The first was a version of Wimmer & Perner's (1983) object transfer task, in which the subject must

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Table 1. *Demographic and clinical details of the subject groups*

	All schizophrenics	Behavioural signs	Paranoid symptoms	Passivity symptoms	Remitted patients	**Psychiatric controls**	**Normal controls**
Sex (M : F)	**29 : 12**	12 : 4	10 : 6	0 : 1	7 : 1	**7 : 11**	**19 : 16**
Age (years)							
Mean (S.D.)	**38·2 (12·4)**	37·3 (14·6)	40·9 (11·3)	22·0	36·4 (9·1)	**43·6 (9·5)**	**43·3 (13·3)**
Range	**17–60**	17–59	25–60		23–52	**26–60**	**23–62**
Ethnicity (White : Black)	**33 : 8**	14 : 2	12 : 4	1 : 0	6 : 2	**16 : 2**	**32 : 3**
Handedness (Right : Left)	**36 : 5**	14 : 2	15 : 1	1 : 0	6 : 2	**16 : 2**	**28 : 7**
Years of education							
Mean (S.D.)	**11·3 (1·6)**	11·1 (0·8)	10·8 (1·3)	13·0	12·5 (2·6)	**11·4 (1·4)**	**12·1 (1·7)**
Range	**9–17**	10–13	9–14		10–17	**10–14**	**11–17**
Percentage employed	**7·3**	0·0	6·3	0·0	25·0	**33·3**	**94·3**
Current IQ							
Mean (S.D.)	**92·9 (10·5)**	87·8 (8·6)	92·6 (8·9)	104·0	102·4 (11·2)	**90·1 (10·4)**	**102·8 (13·8)**
Range	**71–123**	71–100	77–116		92–123	**73–104**	**71–125**
Age at first psychotic episodes (years)							
Mean (S.D.)	**24·0 (8·8)**	20·4 (5·0)	29·0 (10·7)	19·0	24·3 (9·1)	—	—
Range	**13–57**	13–30	18–57		13–43		
Duration of illness (years)							
Mean (S.D.)	**14·6 (11·9)**	16·9 (12·7)	14·2 (11·3)	3·0	12·1 (11·8)	—	—
Range	**1–39**	1–38	1–35		1–39		
Percentage taking neuroleptics	**98**	100	94	100	100	—	—
Daily dose of neuroleptic (cpz equiv.)							
Mean (S.D.)	**888 (911)**	724 (470)	715 (439)	Not known	1561 (1773)	—	—
Range	**0–5000**	50–1600	0–1700		262–5000		
Percentage taking anticholinergics	**26**	20	20	0	50	—	—

Bold type indicates main subject groups by psychiatric diagnosis.

recognize that a story character has a false belief about the location of an object. The second was a variant of the 'Smarties task' (Perner *et al.* 1987), which requires attribution of a person's false belief about the identity of an object. Two first-order 'non-mental' representation tasks were also used. The first corresponded to the false belief object transfer task, and involved a map showing the location of an object in a room. The object was then moved, so the map became out-of-date and falsely represented the object's location. The subject had to say where the map showed the object to be (see Leslie & Thaiss, 1992). The second 'non-mental' task corresponded to the 'Smarties' paradigm: a drawing was made of an object, and this object was then swapped for a different object. As a result, the drawing became an out-of-date representation of the identity of the current object. The subject's task was to say which object the drawing depicted (Charman & Baron-Cohen, 1992).

Previous studies suggest that the order of memory control and test questions does not affect performance on these types of task (see Leslie & Thaiss, 1992). However, for the sake of rigour, the test question was given first in one of the false belief and one of the 'non-mental' tasks, and last in the other two tasks.

Second-order tasks (see Appendix 2)

The second-order false belief task was a modified version of Perner & Wimmer's (1985) 'ice-cream van' story, where the subject must attribute a story character's false belief about another character's belief. The second-order 'non-mental' task was developed specially for this study and involved a map showing the location of an object in a room. A drawing was then made of the map, so that when the object was subsequently moved (and the map changed), the drawing became an out-of-date representation of the map (i.e. a false representation of a representation, hence second-order). The subject's task was to say where, in the drawing of the map, the map showed the object to be.

Subjects were tested individually in a quiet room and all were paid £5 for taking part. All gave written, informed consent to take part in the study, which was approved by the Research Ethics Committees of the relevant hospital trusts. Before completing the above tasks, every participant was given the Quick Test, Form 2 (Ammons & Ammons, 1962) to provide an estimate of current IQ. This involves word-to-picture matching, and a table of equivalents is provided by the authors, which can be used to convert its raw scores into approximate WAIS full-scale IQ scores. Handedness was assessed using Annett's (1970) criteria. The false belief and 'non-mental' tasks were then presented in the order shown in Appendices 1 and 2.

RESULTS

Demographic and clinical variables (see Table 1)

The single schizophrenic patient describing only passivity symptoms was treated as a single case and is described later. This left three schizophrenic symptom subgroups. As there were wide differences in variance, Kruskal–Wallis one-way analyses of variance (ANOVA) were used to compare these subgroups on duration of illness, daily dose of neuroleptic and anticholinergic medication, and age of onset of illness. Subgroup differences were only found for age of onset, with the patients with behavioural signs having a significantly earlier age of onset ($P < 0{\cdot}02$) than those with paranoid symptoms.

The three schizophrenic subgroups and two control groups were then compared on demographic variables, and all five groups were found to be matched on sex, age, handedness and ethnicity. The normal control group had significantly more years of education ($P < 0{\cdot}05$) than the paranoid schizophrenic group, and when compared to all other groups, normal subjects were significantly more likely to be employed (Kruskal–Wallis: $\chi^2(4) = 58{\cdot}8$; $P < 0{\cdot}0001$).

Current IQ scores were normally distributed, so were compared using parametric ANOVA. This revealed a highly significant group difference ($F(4, 88) = 7{\cdot}31$; $P < 0{\cdot}0001$), and *post hoc* multiple comparisons using Tukey's HSD test showed the normals to have a significantly higher current IQ than psychiatric controls and schizophrenics with behavioural signs or paranoid symptoms. The schizophrenic patients in remission also had a higher current IQ than those with behavioural signs. As discussed later, any possible confounding effects of IQ on task performance were investigated using subsamples of subjects matched on current IQ.

Table 2. *Percentage of subjects passing test questions on the tasks*

Subject group	First-order tasks 'Non-mental'	First-order tasks ToM	Second-order tasks (% scoring 3/3) 'Non-mental'	Second-order tasks (% scoring 3/3) ToM
Schizophrenics with behavioural signs	83·9	100·0	50·0	0·0
Schizophrenics with paranoid symptoms	89·6	100·0	100·0	38·5
Remitted schizophrenics	87·5	100·0	83·3	87·5
Psychiatric controls	93·5	97·2	83·3	84·6
Normal controls	97·1	100·0	90·0	85·3

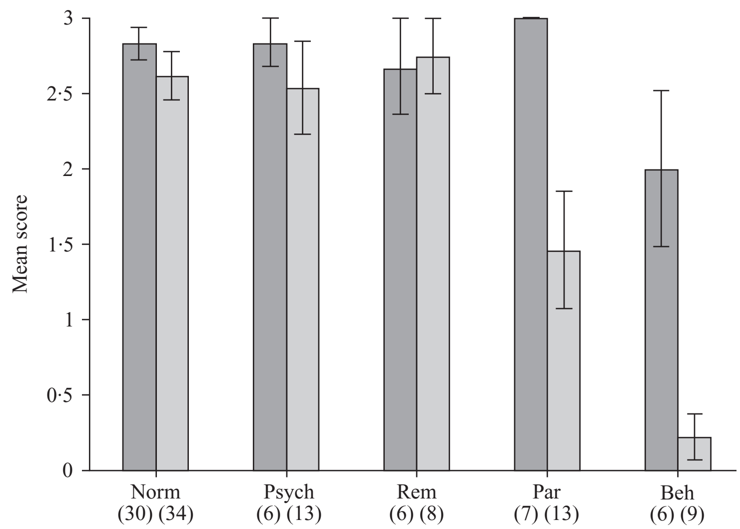

FIG. 1. Mean test scores (max = 3) on the second-order tasks (▩, non-mental task; ▧, theory of mind task). (Beh, negative or positive behavioural signs; Par, paranoid symptoms; Rem, schizophrenic patients in remission; Psych, non-psychotic psychiatric controls; Norm, normal controls.)

Performance on false belief and 'non-mental' representation tasks

First-order tasks

In all of these tasks there was no effect of the order in which questions were asked. Subjects performed comparably on the two first-order tasks in both the false belief and 'non-mental' domains, so within domains scores were combined for analysis. All groups showed equally good memory in both the false belief (mean = 98·1 % correct) and non-mental (mean = 97·9 %) domains. A percentage score for performance on the test questions in each domain was calculated for each subject, with tasks omitted for which the subject had failed memory questions. This ensured that test question failure reflected impaired representational understanding rather than poor memory. All groups performed equally well on the test questions in both domains (see Table 2). On the false belief location change task, there were no significant differences between groups in the percentage of subjects giving a physical explanation (e.g. 'Andrew left his book there') or a mental state explanation (e.g. 'Andrew doesn't know it's been moved').

Second-order tasks

Memory control questions

All groups scored equally well on the memory control questions on the two second-order tasks. Within-subjects analysis of scores for the normal controls showed that the tasks were matched on memory load (McNemar test of change, bi-

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nomial, $P = 0{\cdot}13$, two-tailed), although at the one-tailed level there was a trend for the 'non-mental' task to have higher memory demands than the false belief task. Ten data points were missing on the 'non-mental' task (always given at the end of the battery) because four psychiatric controls and six schizophrenic patients did not wish to complete it.

Test and explanation questions

As with the first-order analysis, subjects were only given a test score for a task if they passed all memory control questions on that task. This reduced subject numbers somewhat, so that nine and six schizophrenics with behavioural signs had test scores on the false belief and 'non-mental' tasks respectively, while the corresponding numbers for the paranoid group were 13 and seven, for the remitted group eight and six, for the psychiatric controls 13 and six, and for the normal controls 34 and 30. Responses were scored using the following points system: 3 = correct answer to test question with correct explanation; 2 = correct answer to test question with explanation that was accurate in content but lacked explanatory power, e.g. one explanation given on the false belief task was 'The nurse moved the TV' (only two subjects scored 2 points); 1 = correct answer to test question with incorrect explanation (seven subjects scored 1); 0 = incorrect answer to test question.

Responses were independently scored by a second rater, with 100% agreement between raters. At this stage, explanations in the false belief task which were correct yet failed to use mental state terms such as 'thinks', 'knows' etc., were considered just as valid as those which used mental state language. This is because it was possible for subjects to employ ToM without necessarily using mental state terms in their speech. Use of mental state language will be examined later in this section. The percentage of subjects in each group having the maximum test score of 3 on each task is shown in Table 2. Mean values of test score by group for the two tasks are shown in Fig. 1, where error bars represent the standard error of the mean.

Within-subjects analysis of scores for the normal controls confirmed that the two tasks were matched for difficulty of test and explanation questions (Wilcoxon signed ranks test, $P = 0{\cdot}11$, two-tailed), although at the one-tailed level there was a trend for the false belief task to be harder than the 'non-mental' task.

As data were non-parametric, group differences in scores on the two tasks were analysed using Kruskal–Wallis one-way ANOVA. There were no significant differences on the 'non-mental' task, but on the false belief task, a highly significant group difference appeared ($\chi^2(4) = 32{\cdot}0$; $P < 0{\cdot}0001$). *Post hoc* analyses showed this to be due to the schizophrenic patients with behavioural signs scoring significantly worse than normal and psychiatric controls and schizophrenics in remission. Scores of patients with paranoid symptoms showed a trend to be lower than those of normal controls at $P < 0{\cdot}10$, one-tailed.

Any confounding effects of group differences in current IQ were investigated using IQ-matched subsamples of subjects. These were formed by removing the normal controls and schizophrenics in remission with the highest IQs, until all groups were matched. This left 17 normals (mean (S.D.) of current IQ in this subsample was 92·0 (9·7)) and six remitted schizophrenics (mean (S.D.) IQ = 96·7 (3·9)). Subject numbers in the other groups were unchanged. With IQ-matching, the highly significant group difference in false belief test score remained ($\chi^2(4) = 22{\cdot}6$; $P = 0{\cdot}0001$). *Post hoc* analyses confirmed that the schizophrenics with behavioural signs scored significantly worse than normal and psychiatric controls and schizophrenics in remission. The trend for paranoid patients to score more poorly than normals now disappeared.

Use of mental state terms in explanations

Subjects' use of mental state language (e.g. 'thinks', 'knows') in their explanations on the second-order false belief task was now analysed for all individuals who passed the memory control questions on that task. Following criteria adopted by Bowler (1992), explanations that referred to neither story character's mental state were coded as zero-order, while those that referred to either character's mental state (or to both mental states in parallel) were coded as first-order. Explanations which embedded one character's mental state within the other's (e.g. 'he thinks that she thinks'), were second-order. All responses fell clearly within one of these categories (see Fig. 2).

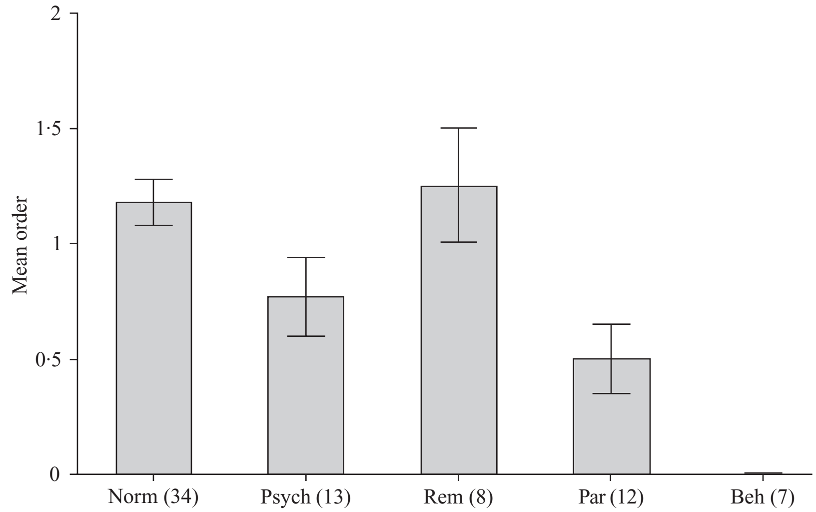

FIG. 2. Mean order of explanation (max = 2) on the second-order ToM task. See Fig. 1 for group code.

With Kruskal–Wallis one-way ANOVA, there was a highly significant group difference in order of explanation ($\chi^2(4) = 25{\cdot}9$; $P < 0{\cdot}0001$), with *post hoc* analyses showing that the schizophrenics with behavioural signs gave significantly lower order explanations than normal controls and schizophrenics in remission. The paranoid schizophrenic group also scored significantly lower than normals. With IQ-matched subsamples, the group difference was still highly significant ($\chi^2(4) = 18{\cdot}5$; $P = 0{\cdot}001$), and with *post hoc* comparisons all effects remained significant except for the difference between the paranoid schizophrenics and normal controls, which now disappeared.

Composite scores

To assess subjects' overall competence in the ToM and 'non-mental' domains, composite scores were calculated using data from the two first-order and one second-order tasks within each domain (see Table 3).

There were no significant group differences on the 'non-mental' composite, but a highly significant group difference appeared on the ToM composite ($\chi^2(4) = 34{\cdot}2$; $P < 0{\cdot}0001$). Schizophrenic patients with behavioural signs scored significantly lower than normal and psychiatric controls and schizophrenics in remission. The schizophrenic group with paranoid symptoms scored significantly lower than normals and remitted schizophrenics. With IQ-matched subgroups, the significant group difference remained ($\chi^2(4) = 24{\cdot}6$; $P = 0{\cdot}0001$), as did all differences between the behavioural signs group and other groups. Differences between the paranoid schizophrenics and other groups were now reduced to a trend ($P < 0{\cdot}10$, one-tailed).

Single case with passivity symptoms

As discussed earlier, one schizophrenic patient reported passivity symptoms in the absence of any paranoid or behavioural features. Her demographic and clinical details are shown in Table 1. She had a ToM composite score of 7/8 and a 'non-mental' composite of 5/5.

Symptom ratings as predictors of ToM impairment

The above analyses grouped patients into the symptom subgroups suggested by Frith's (1992) model. In this section, the relationship between patients' ToM composite scores and their symptom ratings will be explored using logistic regression. The PSE interviews were used to give a score between 0 and 10 for each schizophrenic patient on each of four dimensions: (1) passivity symptoms; (2) paranoid symptoms; (3) negative behavioural signs; and (4) positive behavioural signs. Thus, while a patient with, say, five paranoid symptoms and only two behavioural signs would have been classified in earlier analyses into the behavioural signs subgroup (in accord with Frith's model), the present technique

Table 3. *Mean* (S.D.) *composite scores in the 'non-mental' and ToM domains*

Subject group	'Non-mental' (max = 5)	ToM (max = 8)
Schizophrenics with behavioural signs	3·7 (1·8)	2·3 (0·5)
Schizophrenics with paranoid symptoms	5·0 (0·0)	4·1 (1·8)
Remitted schizophrenics	4·3 (0·8)	6·5 (1·7)
Psychiatric controls	4·8 (0·6)	5·3 (1·4)
Normal controls	4·8 (0·4)	6·1 (1·3)

Table 4. *Hierarchical addition of predictors of intact ToM into the regression model*

	Model			Block			
Predictor	χ^2	df	*P*	χ^2	df	*P*	Nagelkerke R^2
Current IQ	11·3	1	0·0008				0·41
Current IQ + neg beh	16·4	2	0·0003	5·1	1	0·02	0·55
Current IQ + neg beh + pos beh	22·1	3	0·0001	5·7	1	0·02	0·68
Current IQ + neg beh + pos beh + paranoid	23·1	4	0·0001	1·0	1	0·31 NS	0·70
Current IQ + neg beh + pos beh + paranoid + passivity	24·9	5	0·0001	1·8	1	0·18 NS	0·74

neg beh, Negative behavioural signs; pos beh, positive behavioural signs.
NS, Not significant.

had the potential to reveal whether that patient's paranoid symptomatology also contributed significantly to any ToM impairment.

For dimension 1, five passivity symptoms were rated. Each of these was scored between 0 and 2, where 0 = symptom absent; 1 = 'partial delusions' expressed with doubt; and 2 = 'full delusions' of which the subject was fully convinced with no insight (see Wing *et al*. 1974). The rated passivity symptoms were: thought insertion; thought echo; thought block or withdrawal; delusions of control; and delusional explanations in terms of physical forces. For dimension 2, five paranoid symptoms were each rated between 0 and 2. These were: delusions of thoughts being read by other people; delusions of reference; delusional misinterpretation or misidentification; delusions of persecution; and delusions concerning hypnotism or telepathy from others. For dimension 3, five negative behavioural signs were each rated between 0 and 2, where: 0 = feature absent; 1 = feature present and fairly severe, or very severe but intermittent; and 2 = very severe and almost continuous during interview (see Wing *et al*. 1974). The rated signs were: social withdrawal; self-neglect; slowness and underactivity; blunt affect; and poverty of speech. Finally, for dimension 4, five positive behavioural signs were each rated between 0 and 2. These were: irreverent or embarrassing behaviour; stereotypy; incongruous affect; incoherent speech or flight of ideas; and poverty of content of speech. For the whole schizophrenic sample, the mean (S.D.) ratings for each dimension were: 1, 0·8 (1·5); 2, 2·6 (2·6); 3, 1·2 (1·8); and 4, 0·4 (0·9).

The ToM composite variable was not normally distributed, so scores were dichotomized into 'deficit' and 'non-deficit' categories for logistic regression analysis. The criterion for deficit was a composite greater than two standard deviations below the normal control mean of 6·12 (S.D. 1·34). Of the 31 schizophrenic patients who provided a ToM composite, 16 fell into the 'deficit' category and 15 into the 'non-deficit' category. Logistic regression was performed using sign and symptom ratings and current IQ as predictors of intact ToM. Overall the model was significant ($\chi^2(3) = 22{\cdot}1$; $P = 0{\cdot}0001$; Nagelkerke $R^2 = 0{\cdot}68$; see Table 4), with current IQ and ratings for negative (neg beh) and positive (pos beh) behavioural signs emerging as predictors of ToM ability. Ratings for paranoid or passivity symptoms were not significant predictors.

The optimal regression equation was:

$$\ln(\text{odds}) = 0{\cdot}1703\ (\text{current IQ}) - 1{\cdot}3879\ (\text{neg beh}) - 10{\cdot}0538\ (\text{pos beh}) - 14{\cdot}9673.$$

Thus, a 1-point increase in neg beh multiplied the odds of intact ToM by $\exp(-1{\cdot}3879) = 0{\cdot}25$. A 1-point increase in current IQ multiplied the odds of intact ToM by 1·19.

DISCUSSION

Symptomatology and ToM in schizophrenia

The first aim of this study was to further explore the relationship between ToM and schizophrenic symptomatology. On the basis of Frith's (1992) model, it was predicted that schizophrenic patients with behavioural signs would have impaired ToM relative to controls. It was expected that remitted schizophrenics, and those with only passivity symptoms, would have intact ToM. These predictions were supported by both symptom subgroup and regression analyses. A subgroup of patients with behavioural signs scored significantly worse than controls and remitted schizophrenics on a second-order ToM task. They also produced lower order explanations on that task, and had a lower ToM composite score. The subgroup of remitted schizophrenics scored as well as controls on these measures, and a single case with only passivity symptoms had intact ToM. These findings are consistent both with Frith's (1992) model and with the earlier studies of ToM in schizophrenia which grouped patients in this way (Corcoran *et al.* 1995, 1997; Corcoran & Frith, 1996; Frith & Corcoran, 1996). Regression analysis showed that ToM ability in schizophrenia was predicted by ratings of positive and negative behavioural signs (and current IQ). Ratings for passivity symptoms did not predict ToM. These findings are again consistent with Frith's (1992) model, and with the results of Langdon *et al.* (1997), Sarfati *et al.* (1997*a*, *b*), Drury *et al.* (1998), Mitchley *et al.* (1998), Sarfati *et al.* (1999) and Sarfati & Hardy-Baylé (1999), who all examined correlations between symptom ratings and ToM.

The symptom subgroups of patients in the present study were matched on illness duration and medication dosage, and all groups were matched on gender, age, handedness and ethnicity. Current IQ differences were also carefully controlled, so we can argue strongly that ToM deficits were related to symptomatology. The behavioural signs and paranoid subgroups of patients did not differ in total number of symptoms, so it is unlikely that differences in task performance between these subgroups simply reflected differences in severity of illness. Frith & Corcoran (1996) suggested that the poor performance of their patients with behavioural signs on false belief tasks reflected general cognitive impairments. In the present study, however, the behavioural signs group showed a ToM deficit even when memory and IQ were controlled, suggesting a specific ToM impairment in this group.

On the basis of Frith's (1992) model and studies by Corcoran *et al.* (1995), Corcoran & Frith (1996) and Frith & Corcoran (1996), it was expected in the present study that the paranoid symptoms of schizophrenia would be associated with impaired ToM, but to a lesser extent than behavioural signs. Only weak support was found for this using a symptom subgroup analysis. Patients with paranoid symptoms and no behavioural signs had a significantly lower ToM composite, and gave lower order explanations, than controls. However, these effects reduced to a trend or disappeared when IQ was controlled. All effects were only observed at the one-tailed level of significance, and it was apparent that the effect size for the paranoid patients was much smaller than that for patients with behavioural signs. It is likely that small sample sizes considerably reduced the power of these analyses, so the results should be viewed as preliminary findings which require replication with larger numbers of patients.

One interpretation of these data is that paranoid patients did have subtle ToM impairments, but that those subjects with higher IQ could compensate by solving ToM tasks using general problem-solving skills rather than ToM (e.g. U. Frith *et al.* 1991). In the present study, the stories were interrupted at intervals so that memory control questions could be asked. This may have given subjects extra time to solve the problems without necessarily using ToM. Frith & Corcoran (1996) read their stories straight through, giving all questions at the end. Their paranoid patients performed more poorly than those in the present study, and this may be because they did not have the option of using problem-solving strategies, but had to employ ToM to understand the story 'on-line' as they would a real-life situation. Future researchers should use a battery of ToM tasks with minimal memory demands and high ecological validity.

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We would predict that schizophrenic patients with paranoid symptoms would perform poorly on such tasks.

As discussed earlier, many studies have found no correlation between ToM ability and ratings of paranoid symptoms (Langdon *et al.* 1997; Sarfati *et al.* 1997*a*, *b*; Drury *et al.* 1998; Mitchley *et al.* 1998; Sarfati *et al.* 1999; Sarfati & Hardy-Baylé, 1999). It is possible that correlational analyses fail to detect any association between paranoid symptoms and ToM because of the comparatively larger effect of the presence of behavioural signs, and because many patients show co-morbidity of behavioural signs and paranoid symptoms. An effect of paranoid symptoms may only be revealed in symptom subgroup analyses (i.e. the studies by Corcoran *et al.* 1995; Corcoran & Frith, 1996; Frith & Corcoran, 1996).

Severity of the ToM impairment in schizophrenia

Frith & Corcoran (1996) found that schizophrenic patients scored poorly on both first- and second-order false belief tasks, whereas Doody *et al.* (1998) found intact performance on first-order tasks and impairments only at the second-order level. These studies differed in methodology – Frith & Corcoran read their stories aloud and asked questions at the end of each story, whereas Doody *et al.* read aloud and enacted their stories using props, and asked memory control questions at intervals during the stories. In the present study, Doody *et al.*'s methodology was used and their findings were replicated, with schizophrenic patients showing clear evidence of second-order, but not first-order ToM deficits. The present methodology is similar to that used in many studies of autistic people, where both first- and second-order ToM deficits were found (e.g. Baron-Cohen *et al.* 1985; Baron-Cohen, 1989). These results, and those of Doody *et al.* therefore suggest that the ToM impairment in schizophrenia is less severe than that in autism. It remains possible that the schizophrenic patients in the present study solved the first-order ToM tasks using IQ-dependent general problem-solving skills rather than ToM, and that they did in fact have a first-order ToM impairment. This is unlikely, however, as Baron-Cohen *et al.*'s (1985) autistic subjects had similar IQs to the schizophrenic patients here, yet most of the autistic people still failed a first-order ToM task.

A possible reason for the differences in severity of the ToM impairments in autism and schizophrenia lies in age of onset of the disorders. Autism is present from a very early age (DSM-IV; APA, 1994), which suggests that autistic people may have had impaired development of the ability to represent mental states. Schizophrenia usually manifests between the ages of 20 and 35 years (e.g. McKenna, 1994), so schizophrenic people may have experienced normal development of meta-representational ability, with impairments only occurring at illness onset (Frith & Frith, 1991). This means that many schizophrenic patients have a long history of successfully using ToM, so are likely to have residual skills (e.g. at the first-order level) even at chronic stages of their illness. Murray *et al.* (1992) suggested that there is a 'neurodevelopmental' subgroup of schizophrenic people who present early in life with an autistic-like picture, and then go on to show an early-onset schizophrenic illness with mainly negative features. These people may have had impaired metarepresentational development, so may be the one subgroup of schizophrenic people who would fail first-order ToM tasks. This should be investigated in future work in which patients' pre-morbid functioning is thoroughly assessed.

Specificity of the ToM impairment in schizophrenia

The present study used ToM and equally difficult 'non-mental' control tasks to explore the specificity of ToM impairments. Schizophrenic patients were impaired in the ToM, but not the 'non-mental' domain, suggesting that ToM deficits in schizophrenia are specific and not a function either of general cognitive impairment (e.g. Chapman & Chapman, 1973) or difficulty understanding representation *per se*. Future work could usefully test schizophrenic patients on the ToM and 'physical' stories developed by Fletcher *et al.* (1995). We would expect schizophrenic patients to perform poorly on the ToM stories relative to the 'physical' stories.

In summary, this study supported predictions from Frith's (1992) model that impaired ToM in schizophrenia is associated with behavioural signs, and that remitted patients or those with only passivity symptoms have intact ToM.

Symptom subgroup analysis provided weak evidence that patients with paranoid symptoms and no behavioural signs have ToM impairments, although there was an IQ effect in this group. Doody *et al.*'s (1998) findings of a second-order, but not first-order, ToM deficit in schizophrenia were replicated, and it was argued that ToM impairments in schizophrenia may be less severe than in autism because of the different age of onset of these disorders. A matched-tasks paradigm showed that ToM deficits in schizophrenia are specific, and not simply a reflection of general cognitive impairment. The present results are consistent with Frith's (1992) hypothesis that ToM deficits are part of the psychopathology of schizophrenia; they are specific state-dependent impairments linked to particular signs and symptoms of the disorder.

APPENDIX 1

The four first-order tasks used in the study

False belief, location

The subject was shown a card depicting an office, common room and dining room in a hospital. A toy character (Andrew), who was a patient in the hospital, was introduced. The following story was then read aloud and enacted:

Andrew is in the common room, and has a book with him. Now he is going for lunch into the dining room, and has left his book in the common room.

Memory control question 1 Where is Andrew's book?

While Andrew is away, the nurse comes into the common room, picks up the book, and puts it into her office for safe-keeping.

Memory control question 2 Where did Andrew leave his book?

Memory control question 3 Where is the book now?

Test question Where does Andrew think his book is?

Explanation question Subjects were asked to explain their answer to the test question.

False belief, identity

The subject was shown a cigarette packet, and asked:

Memory control question 1 What does this contain?

The packet was then opened, revealing that it contained a pencil. The experimenter showed this to the subject, replaced the pencil in the box, and closed the lid.

Test question If someone came in now, who had not seen this box before, and I showed it to them with the lid closed, what would they think is in here?

Memory control question 2 When I showed you this box in the beginning, what did you say was in here?

Memory control question 3 What is really inside the box?

'Non-mental' representation, location

The subject was presented with a cardboard model room containing three items of toy furniture: a dresser, a table and an armchair. A diagrammatic map was then introduced. This had a black border to represent the three walls of the room, and two blue crosses to represent the windows. Coloured outlines of shapes represented the positions of the dresser (a circle), table (a square) and armchair (a triangle) in the room. Leslie & Thaiss' (1992) pre-training procedure was then carried out.[1]

A toy cat was then introduced and placed on the table in the model room.

Memory control question 1 Where is the cat?

The experimenter took a sticker, emphasizing that it 'meant' the cat, and told the subject that he was putting the sticker in the right place on the map 'to show where the cat is'. The sticker was placed on the map in such a way that the subject could not see it. The map was then turned face down, and the cat was moved from the table to the armchair.

Memory control question 2 Where was the cat when I put the sticker on the map?

Memory control question 3 Where is the cat now?

Test question In the map, where is the cat?

'Non-mental' representation, identity

Following Charman & Baron-Cohen (1992), two trials were run in this task: in one, the experimenter did the drawing, and in the other the subject did the drawing. The order of these trials was counter-balanced across subjects.

At the start of a trial, the subject was presented with an object (e.g. an orange), and was asked:

Memory control question 1 What is this?

The object was then drawn, and the drawing put to one side, face down. The object was removed and replaced with a second object (e.g. a cup), and the experimenter said, 'I'm putting this cup here in place of the orange'. The drawing was retrieved, still face down, and the subject was asked:

Test question What is in the drawing?

Memory control question 2 What object was here before?

Memory control question 3 What object is here now?

The objects used in the other trial were a pen and a spoon.

[1] In pre-training, the subject was told for each feature of the map that it 'meant' its corresponding feature in the room. A toy glass was then introduced, together with a sticker that 'meant' the glass. The glass was placed on the dresser, and the subject had to place the sticker on the map 'to show where the glass is in the room'. All subjects passed the pre-training first time.

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APPENDIX 2

The two second-order tasks used in the study

False belief

The subject was shown a card depicting a hospital lounge and dining room. The toy story characters (Ann and Stephen) were introduced, and a model television set was placed in the lounge. The following text was read out and enacted:

Ann and Stephen are two patients on the same hospital ward. One day they are watching television together in the lounge.

Memory control question 1 Which room is the television in?

Ann says, 'I'm going for a walk outdoors', and she leaves the lounge. Stephen is now alone in the lounge.

Memory control question 2 Where is Stephen?

A nurse comes in and tells Stephen that she is going to move the TV into the dining room downstairs, to make more space in the lounge for chairs.

Memory control question 3 Which room is the TV going to be taken to?

Now, Ann doesn't know that the nurse has talked to Stephen.

Stephen stays in the lounge, but the nurse leaves with the TV set. Just as she is taking it into the dining room downstairs, she passes Ann who is still on her way out for her walk. The nurse says to Ann, 'The TV will be in the dining room from now on', and she wheels it into the dining room. Ann then goes out for her walk.

Memory control question 4 Which room has the nurse put the TV in?

Now, Stephen doesn't know that the nurse has talked to Ann.

An hour later, Stephen is on the ward looking for Ann. One of the other patients says to Stephen, 'I've only just seen Ann. She has just come back from a walk, and said that she was going to watch television'. Stephen hurries off to find Ann.

Test question Which room does Stephen think Ann has gone to to watch television?

Explanation question Subjects were asked to explain their answer to the test question.

Memory control question 5 Where has Ann really gone to watch television?

Memory control question 6 Where was the television at the beginning of the story?

'*Non-mental*' *representation*

The model room used in the first-order map task was reintroduced. This time, it contained only two items of furniture – a fireplace (against one of the walls) and a dresser. Two maps were presented; these both showed the positions of the walls, windows and furniture in the room diagrammatically, and differed only in that one was coloured white and the other blue. Each feature of the maps was pointed out, and the subject was told for each feature that it 'meant' its corresponding feature in the room. Blue and white envelopes were then introduced, with the explanation that each map would be placed later into its corresponding coloured envelope.

A toy feather was placed on the dresser in the room, and was pointed out to the subject. The experimenter took a sticker, emphasizing that it 'meant' the feather, and told the subject that he was going to put the sticker in the right place on the white map 'to show where the feather is'. The sticker was placed on the white map without the subject being able to see it, and the map was turned face down. The experimenter now said, 'I'm now going to draw a picture of this white map, as it looks now, with the sticker on it'. This was done so that the subject could not see the drawing; the drawing was then turned face down, and the white map was placed face down in the white envelope. The experimenter took another sticker, emphasizing that it 'meant' the feather, and told the subject that he was going to put it in the right place on the blue map 'to show where the feather is'. The sticker was placed on the blue map without the subject being able to see it, and the blue map was turned face down. The blue map and the drawing of the white map were placed together face down into the blue envelope. The subject was then asked:

Memory control question 1 Where is the feather in the room?

Memory control question 2 In the blue map, where is the feather?

The feather was now moved onto the fireplace, and the subject was asked:

Memory control question 3 Where has the feather been moved to?

The experimenter said, 'I will now change the blue map so that it shows where the feather is at the moment'. This was done without the subject seeing the map, and the map was replaced in its blue envelope. The same was done with the white map, so that once replaced in its envelope it showed the true location of the feather. The subject was then asked:

Memory control question 4 Where is the feather now in the room?

Test question I will now take out the drawing that I did earlier. In this drawing of the white map, where does the white map show the feather is?

Explanation question Subjects were asked to explain their answer to the test question.

Memory control question 5 Where does the real white map show the feather is?

Memory control question 6 Where was the feather at the beginning of the story?

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