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Theory of mind and psychoses

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ABSTRACT

Background. A cardinal feature of schizophrenia is the sufferer's difficulty in interacting appropriately within the social *milieu*. This deficit has recently been associated with the concept of theory of mind, more commonly construed as a working model to understand behavioural patterns in autistic children. In this paper the complex relationships between theory of mind, IQ and psychoses are addressed.

Methods. Five experimental groups were used; non-psychiatric controls, affective disorder, schizophrenia with normal pre-morbid IQ, schizophrenia with pre-morbid IQ in the mildly learning disabled range, and mild learning disability with no history of psychiatric illness. All subjects were given a first order Theory of Mind Task and if successful, a second order Theory of Mind Task was then administered. All subjects were rated using the Positive and Negative Symptom Scale (PANSS).

Results. Subjects with schizophrenia and subjects with mild learning disability show impaired ability on a second order theory of mind task. However, when patients who are unable to answer reality questions are removed from the analysis specific impairment of theory of mind is only seen in subjects with schizophrenia. Furthermore, this impairment is relatively specific to particular psychopathological clusters in subjects with schizophrenia. Even though the same clusters of psychopathology are also seen in patients with affective disorder, their presence is not associated with poor second order theory of mind performance.

Conclusions. Impaired theory of mind on second order tests is specific to schizophrenia when compared to mild learning disability and affective disorder control groups. Subjects with schizophrenia and pre-morbid mild learning disability show greater impairment than subjects with schizophrenia and a pre-morbid IQ within the normal range.

INTRODUCTION

Recently, there has been renewed interest (Corcoran *et al*. 1995; Frith & Corcoran, 1996; Pickup & Frith, 1996; Stephenson *et al*. 1996) in the specific difficulties that some patients with schizophrenia exhibit in their interactions with others. This phenomenon was first commented upon by Diamond (1956) who presented evidence supporting the theory that individuals with schizophrenia were unable adequately to internalize the points of view of others. Following his report there were, until now, relatively few studies involving psychotic patients and most work focused on autistic children. In the last decade there has been a specific interest in the inability of such children to develop a theory of mind.

The concept of theory of mind

It was the work of Premack & Woodruff (1978) in chimpanzees that first asked the question whether non-human primates have an ability to infer the intentions of others of the same species, thus coining the term, theory of mind. This alludes to the idea that individuals are able to predict correctly the wishes and intentions of others. Further studies in children (Wimmer & Perner, 1983), subsequently confirmed that in

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normal children the ability to represent the relationship between two or more person's mental states emerges and becomes firmly established around the ages of 4 to 6 years. Indeed, it has been suggested that a child's ability to pretend, as represented in play, hinges upon the development of early skills of a similar nature (Leslie, 1987).

Theory of mind ability may be an innately inherent ability that is genetically pre-determined, in which case the degree to which impairment is amenable to improvement is questionable. Alternatively, it may be a socially acquired skill akin to social problem solving, learnt by trial, error and self-reflection, which an individual gains from social encounters. It has been suggested that in the healthy infant theory of mind ability first becomes detectable at around 18 months of age. Baron-Cohen and colleagues (1985) first observed the poor performance of children with autism on tests requiring theory of mind relative to mental age matched groups of Down's syndrome children (of low IQ) and normal controls. They used a simple test, the Sally-Anne Experiment, similar to that used in the original Wimmer & Perner paradigm. A question still hotly debated (Bishop, 1993) concerns whether this theory of mind problem is specific or part of a more general neuropsychological defect associated with frontal lobe impairments with associated lack of initiative, inability to focus attention and concreteness in thought and language (Damasio & Maurer, 1978), or limbic system damage (Bachevalier, 1991).

It is known that autistic children show deficits on tests of frontal lobe function e.g. maze learning task, Wisconsin Card Sorting Test, Rey-Osterrieth Complex Figure (Prior & Hoffmann, 1990), Tower of Hanoi (Ozonoff *et al.* 1991) and intra-dimensional/extra-dimensional set shifting tasks (Hughes *et al.* 1994). In addition, functional neuroimaging points to the frontal cortex being involved in theory of mind tasks. Baron-Cohen and colleagues (1994) found that orbito-frontal cortex was activated during performance of a simple mental state recognition task and Fletcher and colleagues (1995) observed activity in medial prefrontal cortex when normal volunteers had to apply theory of mind to the understanding of simple stories.

The work of Leekham & Perner (1991), however, suggests that there is a specific social element in theory of mind processing. Autistic children are shown to be capable of making physical meta-representations, but not meta-representations involving individuals. In the light of such work, theory of mind ability cannot be simply subsumed within frontal lobe or executive functioning deficits.

Theory of mind and schizophrenia

Frith (1992) proposes that findings of cognitive impairment should be used to understand faulty processing mechanisms in schizophrenia rather than to define functional anatomical sites. With this in mind he proposes that schizophrenia may be primarily a disorder of self-awareness. In this case three principal abnormalities may be conceptualized as accounting for major signs and symptoms of the disease. These are disorders of willed action, disorders of self monitoring and disorders in monitoring the intentions of others i.e. theory of mind. The latter abnormality, if it develops after the first episode of illness (as opposed to autism where it may have been present since birth), could account for the emergence of paranoid delusions, delusions of reference and incoherent speech in schizophrenic patients.

More recently, Frith has argued that the theory of mind deficits seen in schizophrenic patients are relatively IQ independent, associated with paranoid symptomatology and remit when these symptoms resolve (Frith & Corcoran, 1996). In this study, theory of mind deficits were also seen in patients with negative features, but these deficits appeared to be associated with more general cognitive problems. This work is based on a study of schizophrenic patients with a pre-morbid IQ within the normal range and two control groups, both comprising non-psychotic subjects. No evidence of the specificity of theory of mind deficits to schizophrenia, relative to other functional psychoses, is currently available.

METHOD

Ninety-seven subjects were seen for this study. Five categories of patients were assessed: DSM-III-R (American Psychiatric Association, 1987) schizophrenia ($N = 28$); affective disorder (DSM-III-R major depressive disorder $N = 10$

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or DSM-III-R bipolar disorder, currently depressed, $N = 2$); mild learning disability (IQ 50–70, $N = 19$); subjects with a co-morbid diagnosis of both mild learning disability and DSM-III-R schizophrenia ($N = 18$); and a population of non-psychiatric controls ($N = 20$). None of the subjects had any known diagnosis of pervasive development disorder. The co-morbid subjects all had documented evidence of a lowered pre-morbid IQ and had attended remedial education.

All affective disorder subjects were depressed and psychotic, or recovering from a psychotic depressive episode when assessed. The schizophrenic subjects were out-patients or attending a psychiatric day-hospital; all had enduring features of longstanding psychosis. The co-morbid group were drawn from both in-patients and out-patient attenders.

An estimation of pre-morbid IQ was made using the National Adult Reading Test (NART; Nelson & O'Connell, 1978) in all subjects believed to have a normal pre-morbid IQ and non-psychiatric controls. The use of reading ability to estimate pre-morbid levels of intellectual functioning is a well established procedure (Crawford, 1989). In addition the Quick Test (Ammons & Ammons, 1962) was applied to the two learning disabled groups, to obtain an estimate of current IQ. This test does not give as robust a measure of current IQ as a standard test like the WAIS, but is much quicker to administer and more acceptable to patients. The Quick Test has been used previously to estimate current IQ by Gessler *et al.* (1989). Some evidence of its validity is provided by their observation that, in a normal control group, there was no discrepancy in IQs as estimated by the NART and the Quick Test, whereas there was a 12·8-point discrepancy in the chronic schizophrenic patients with current IQ estimate lower than the pre-morbid estimate. In another study of schizophrenia (Frith *et al.* 1991) the WAIS and the Quick Test were both applied to subset of the patients and gave very comparable results (WAIS 83·6, Quick Test 78·7, correlation between NART and Quick Test scores 0·91).

A note of past psychiatric history and current medication was made from the patients case-notes where applicable.

All subjects were rated using the Schedule for Affective and Schizophrenic Disorders – Life-time Version (SADS-L; Endicott & Spitzer, 1978) to confirm their diagnosis. The SADS-L has been validated for the diagnosis of schizophrenia in the mildly handicapped population (Meadows *et al.* 1991). The Positive and Negative Symptom Scale (PANSS; Kay *et al.* 1987) was used in all groups to assess psychopathology at the time of assessment.

Two theory of mind tasks were administered to each subject. Initially a first order task was performed using illustrative dolls and props (Appendix 1). This was the Sally-Anne Task (Wimmer & Perner, 1983; Baron-Cohen *et al.* 1985; Frith, 1989). A second order theory of mind task was then given to all subjects. This was the Ice-Cream Van (ICV) Test (Perner & Wimmer, 1985; Baron-Cohen, 1989), an illustrative map and dolls were again used to aid comprehension (Appendix 2). Scoring for both tasks was rated according to the following schema: 0 = unable to complete task due to failure of comprehension, or getting lost as evidenced by an inability to correctly answer the reality questions; 1 = clearly able to follow task, correctly answers all reality questions, but fails critical theory of mind question; 2 = able to follow and complete task correctly, hence showing evidence of theory of mind ability.

RESULTS

The age and sex distributions of subjects by group is shown in Table 1. The non-psychiatric controls were much younger than the other groups. Groups were otherwise matched well for age, but not sex. All subjects, except one, in the affective group were female.

IQ scores

No significant differences were found between mean pre-morbid IQ scores of schizophrenic and affective subjects, using the NART (mean scores 107·5, S.D. = 10·8 and 107·8, S.D. = 11·3, respectively). Similarly, no significant differences were found between mean morbid IQs as rated by the Quick Test, in the co-morbid group and learning disabled group (mean scores 62·3, S.D. = 11·4 and 65·5, S.D. = 14·8, respectively).

Theory of mind tasks

The scores of all groups on the first and second order theory of mind tasks are shown in Table 2. In terms of the first order theory of mind task,

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Table 1. *Age, sex and IQ distribution of subjects by group*

	Average age (years) Mean (S.D.)	Sex ratio M:F	NART IQ Mean (S.D.)	Quick IQ Mean (S.D.)
Non-psychiatric controls ($N = 20$)	20·4 (0·9)	9:11	108·6 (9·3)	—
Affective disorder ($N = 12$)	42·3 (15·0)	1:11	107·8 (11·3)	—
Co-morbid group ($N = 18$)	50·4 (11·4)	10:8	—	62·3 (11·4)
Schizophrenia ($N = 28$)	46·3 (13·5)	17:11	107·5 (10·8)	—
Learning disability ($N = 19$)	50·7 (11·5)	7:12	—	65·5 (14·8)

Table 2. *Results of first and second order theory of mind tasks in all groups*

	Co-morbid (SCZ + L.D.) $N = 18$ % (N)	SCZ $N = 28$ % (N)	AFF. $N = 12$ % (N)	L.D. $N = 19$ % (N)	Controls $N = 20$ % (N)
First order task					
0 – (Lost)	5·6 (1)	0·0 (0)	0·0 (0)	5·3 (1)	0·0 (0)
1 – (No T.O.M.)	22·2 (4)	0·0 (0)	0·0 (0)	26·3 (5)	0·0 (0)
2 – (Correct)	72·2 (13)	100·0 (28)	100·0 (12)	68·4 (13)	100·0 (20)
Second order task					
0 – (Lost)	55·6 (10)	10·7 (3)	8·3 (1)	31·6 (6)	0·0 (0)
1 – (No T.O.M.)	27·8 (5)	32·1 (9)	16·7 (2)	21·0 (4)	5·0 (1)
2 – (Correct)	16·7 (3)	57·1 (16)	75·0 (9)	47·4 (9)	95·0 (19)

only two subjects were unable to comprehend the task, one with mild learning disability and one with co-morbidity. All subjects in the schizophrenia group, affective group and control group were able to complete the task. However, 22·2% of the co-morbid group and 26·3% of the learning disability group showed evidence of an impaired theory of mind ability on the first order task.

Regarding the second order theory of mind task, a proportion of all groups, with the exception of the control group were unable to successfully comprehend the task. This was evidenced by an inability to answer reality questions correctly. The largest percentage of subjects becoming lost during the administration of the task was seen in the co-morbid group where 55·6% of subjects became muddled. Three schizophrenic patients were unable to comprehend the second order task. One patient with affective disorder did not comprehend the second order task.

Many of the cells shown in Table 2 have small numbers and analysis using the χ^2 test was considered inappropriate. Instead the likelihood ratio method (Kullback, 1968; Robbins, 1977) was used to generate an information statistic (2i), which is distributed as χ^2, this method also allows the total variance in the table to be partitioned. First, a 4×3 contingency table was constructed from the four groups; co-morbid, schizophrenia, learning disability and control and the three levels of performance on the second order task. This analysis of frequencies took into account the fact that the three levels of performance are ordered rather than categorical. There was a highly significant difference between the groups overall ($2i = 34{\cdot}8$, $df = 6$, $P < 0{\cdot}001$). Partitioning the variance showed that this was due to a significant effect of schizophrenia ($2i = 8{\cdot}2$, $df = 2$, $P < 0{\cdot}05$) and a significant effect of learning disability ($2i = 20{\cdot}1$, $df = 2$, $P < 0{\cdot}001$). There was no interaction between schizophrenia and learning disability.

Secondly, a 3×3 contingency table was constructed from the three groups with normal IQ (schizophrenia, affective disorder, control) and the three levels of performance. There was a significant overall difference between these groups ($2i = 10{\cdot}6$, $df = 4$, $P < 0{\cdot}05$). Subsequent pairwise comparisons showed that the schizophrenic patients were worse than the controls ($2i = 10{\cdot}4$, $df = 2$, $P < 0{\cdot}01$). There was no difference between the affective patients and the controls ($2i = 3{\cdot}3$).

These analyses concern general ability to

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understand the ICV story. A more strict analysis was applied only to the data for those subjects who did not get lost and who could answer the reality questions (i.e. the first row of the contingency table, the subjects who got lost, was omitted). Such an analysis provides evidence more specific to theory of mind ability. The 4×2 contingency table again showed an overall effect ($2i = 12{\cdot}0$, df = 3, $P < 0{\cdot}01$). This was due to an effect of schizophrenia ($2i = 6{\cdot}2$, df = 1, $P < 0{\cdot}05$), but there was no effect of learning disability ($2i = 2{\cdot}9$). The 3×2 contingency table also showed an overall effect ($2i = 7{\cdot}2$, df = 1, $P < 0{\cdot}01$). The schizophrenic patients were worse than the controls ($2i = 7{\cdot}1$, df = 1, $P < 0{\cdot}01$). The affective patients did not differ from the controls ($2i = 1{\cdot}3$).

Psychopathology in co-morbid, schizophrenia and affective disorder groups

The affective subjects might be expected to be more acutely clinically unwell than the schizophrenic group, as they were drawn from an hospital in-patient population. However, there was no difference in terms of overall severity in terms of total PANSS scores. The results of the PANSS ratings in the co-morbid, schizophrenia and affective subjects are shown in Table 3.

Table 3. *Mean PANSS symptom cluster score between groups*

	Co-morbid $N = 18$ Mean (S.D.)	SCZ $N = 28$ Mean (S.D.)	AFF. $N = 12$ Mean (S.D.)
Positive (range 7–49)	10·7 (3·7) (range 7–19)	16·5 (6·5) (range 7–27)	9·4 (4·0) (range 7–19)
Negative (range 7–49)	24·7 (8·2) (range 15–36)	23·3 (9·2) (range 9–42)	20·3 (9·9) (range 7–42)
General (range 16–112)	30·3 (8·9) (range 18–57)	31·8 (9·0) (range 17–47)	44·8 (16·8) (range 16–75)
Total score (range 30–210)	65·6 (20·3) (range 45–127)	71·7 (20·2) (range 42–110)	74·0 (28·6) (range 30–136)

The Mann–Whitney *U* test was used to compare the mean values of symptom clusters between experimental groups. The schizophrenic group had significantly more positive symptoms than both the affective group ($P < 0{\cdot}001$) and the co-morbid group ($P < 0{\cdot}01$). No significant differences were found between mean values of negative symptoms in the three rated groups.

The relationship between symptom clusters, IQ and second order theory of mind scores

Table 4 illustrates performance on the second order theory of mind task (ICV), relative to symptom clusters, as measured using the PANSS, and IQ for each of the four abnormal groups. All second order test results were included in this analysis, scored from 0 to 2 as described above. The group being assessed was divided into three on the basis of theory of mind performance. The symptom or IQ scores of these three subgroups were then examined using the Kruskal–Wallis test.

In the co-morbid and learning disabled groups, second order test results are seen to vary with morbid IQ. There is no effect of IQ on second order task performance in the schizophrenic group or the affective group. Second order theory of mind performance in the subjects with schizophrenia is related to all three symptom clusters, however in the subjects with affective disorder there is no such relationship.

Table 4. *Overall ICV performance, symptom clusters and IQ (Kruskal–Wallis one-way ANOVA)*

	Positive	Negative	General	IQ
Co-morbid	NS	NS	NS	* $P = 0{\cdot}05$ (Quick)
Schizophrenia	* $P = 0{\cdot}07$	* $P = 0{\cdot}05$	* $P = 0{\cdot}01$	NS (NART)
Affective	NS	NS	NS	NS (NART)
Learning disability	—	—	—	* $P = 0{\cdot}02$ (Quick)

DISCUSSION

Although recent studies concur that schizophrenic subjects show impairment of theory of mind ability in second order tasks (Frith & Corcoran, 1996; Pickup & Frith, 1996; Stephenson *et al.* 1996), the reasons for this are far from clear. Confounding variables such as IQ, attention and concentration, medication effects and selective memory impairment, have all been acknowledged as potentially contributing to results. This study has attempted to explore the contribution of some of these variables.

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The role of IQ

The concept of IQ, as defined by psychometric parameters, remains controversial in many respects. The existence of a factor of general intelligence, or Spearman's *g*, has recently been equated with fluid intelligence or an ability for novel problem solving (Duncan *et al.* 1995). This work focuses on patients who have sustained frontal lobe injuries, and retain a high IQ score as measured by the WAIS-R but show impaired novel problem-solving ability. The authors, therefore, suggest that *g* may in part be a reflection of frontal lobe functions.

Today, it is widely believed that schizophrenia is associated with cognitive impairment. Many researchers have commented upon possible relationships between the neuropsychological deficits seen in schizophrenic patients and clinical and neurobiological dimensions – with particular reference to the frontal lobes. However, the consistent failure to find one or more distinct neuropsychological profiles that characterize schizophrenia, continues to confound work in this area (Elliott & Sahakian, 1995). There remains controversy regarding whether the cognitive impairment seen in schizophrenia is of a generalized or specific form (Saykin *et al.* 1991; Blanchard & Neale, 1994) and whether it is progressive, or static in nature (Goldberg *et al.* 1993*a*; Hyde *et al.* 1994; Harrison, 1995).

Stephenson and colleagues (1996) conclude that 'deficits in theory of mind in schizophrenia reflect generalized cognitive impairment'. However, Frith & Corcoran (1996) state that the extent to which general intellectual abilities determine performance on these mentalizing stories is unclear.

Comprehension of the second order task

There was an influence of both IQ and psychosis on comprehension of the second order task. The learning disabled group performed worse than normal controls suggesting an effect of IQ, while the schizophrenics with normal pre-morbid IQ also performed worse than the normal controls suggesting an effect of psychosis. However, as the control group was not age matched to the subject groups these results should be interpreted with caution. The marked difficulty manifested by the co-morbid group in comprehending the second order task may be viewed in terms of the cumulative effects of lowered IQ and psychosis.

Second order theory of mind ability

Benson *et al.* (1993) have shown that adolescents with learning disabilities perform poorly on second order theory of mind tasks, relative to adolescents with no learning disabilities. In our study people with learning disability performed poorly on the second order theory of mind test as a whole. However, for those subjects who answered the reality questions correctly, our study has shown that individuals with mild learning difficulties do not differ from controls on second order theory of mind tasks. There was, however, a marked deficit in performance for patients with schizophrenia in comparison to control groups. In addition, patients with affective disorder did not differ from controls on this task. Since these patients were similar in their symptomatology, this results suggests a degree of specificity of poor theory of mind performance to a diagnosis of schizophrenia that cannot be explained by the effect of IQ alone.

The role of psychosis and psychopathology

The co-morbid and affective subjects in our study have fewer positive symptoms, as rated by the PANSS, than the schizophrenic patients. There are no statistically significant differences in the severity of negative symptoms seen between these three groups. Performance on the second order theory of mind task is seen to vary with positive, negative and general symptomatology in the schizophrenic group, but with no symptom clusters in the other groups.

The lack of a significant effect of positive symptoms on second order task performance in the co-morbid group and the affective group may be due to the low level and small range of these symptoms seen in these two groups.

It has already been recognized (Nelson *et al.* 1990; Addington *et al.* 1991) that cognitive deficits (as rated by IQ) in schizophrenic patients are associated with higher negative symptom ratings than positive symptom ratings. In the schizophrenic group there was a significant association between negative features and poor performance on the second order task. This relationship might reflect the general cognitive deficits associated with negative features. The severity of negative features in the affective

group was equal to that of the schizophrenic group, but they were not impaired on the second order task. This suggests a lack of association between negative features and theory of mind in the affective group. Goldberg and colleagues (1993*b*) also observed, on the basis of an extensive neuropsychological test battery, that schizophrenia and affective disorder are qualitatively distinguishable, in neuropsychological terms, by associations between cognitive performance and psychopathology. In the present study, there is evidence of an association with the second order theory of mind test and psychopathology in schizophrenic patients, but not in affective subjects. It, therefore, seems that this association is relatively specific to schizophrenia. It is possible that the negative features associated with depression relate more to depressed mood than to impaired cognition.

The co-morbid group

The co-morbid subjects in this study have provided a unique opportunity to explore the neuropsychology of schizophrenia in the mildly learning disabled population. As we have shown, IQ varies with second order theory of mind ability in both the co-morbid and learning disabled groups.

By inclusion definition, the co-morbid group have been cognitively impaired since their schooldays, having all received remedial education. The age of symptom onset in the co-morbid group is no different to the schizophrenic group. We, therefore, assume that learning disability predates the onset of illness. However, Turner (1989) has estimated that the point prevalence of schizophrenia in people with mild learning disability is approximately three times that of the normal population. Perhaps what is being described in these individuals is not learning disability predating schizophrenic symptoms, but a form of schizophrenia which manifests in childhood with cognitive impairment prior to the onset of psychotic symptomatology. Such a hypothesis is consistent with current neuro-developmental theories of schizophrenia and lends support to a specific cognitive impairment of a non-progressive nature being associated with the disease.

Jones *et al.* (1993), retrospectively identified pre-morbid social underachievement as present in a schizophrenic cohort. This would be consistent with an impaired ability to infer the intentions of others being present in schizophrenic subjects from an early age. In another retrospective cohort study, Offord & Cross (1971), have shown that adult schizophrenic patients show scholastic under-achievement during their childhood when compared to their well siblings. Both these studies lend further support to the hypothesis that the deficits in theory of mind and IQ seen in the co-morbid group may be intrinsically linked to the schizophrenic process.

CONCLUSION

This study has shown that schizophrenic subjects show evidence of second order theory of mind impairment, relative to a normal control group. Subjects with a co-morbid diagnosis of schizophrenia and mild learning disability are likely to fail the second order test as a result of an inability to follow the storyline of the test. However, those who do complete the task are also likely to show a demonstrable lack of theory of mind. The problems with comprehension seen in the co-morbid group are hypothesized to be due to the cumulative effects of a lowered IQ and presence of psychotic symptomatology.

Impairment of second order theory of mind varies with specific clusters of signs and symptoms in schizophrenic patients. Such signs and symptoms are identifiable in affective disorder patients, but do not show any degree of variance with second order theory of mind ability. Therefore, this association between symptom clusters and impaired theory of mind ability is specific to schizophrenia.

Finally, it is suggested that the relationship between theory of mind ability and IQ seen in the co-morbid group may be indicative of the schizophrenic disease process *per se* rather than generalized cognitive impairment. As such, both an impaired ability to infer the intentions of others and a degree of cognitive impairment may be seen to be present in a proportion of schizophrenic patients in childhood, prior to the manifestation of overt psychotic symptomatology in later years. This is consistent with current neurodevelopmental theories of schizophrenia (e.g. Jones *et al.* 1993) and implies that a specific cognitive impairment of a non-

progressive nature may be identified in pre-schizophrenics from an early age.

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APPENDIX 1
FIRST ORDER THEORY OF MIND TASK

The Sally-Anne Task (after Wimmer & Perner, 1983; Baron-Cohen *et al*. 1985; Frith, 1989)

This is Mary and this is John. Mary has a basket and John has a box. Mary has a ball. She is going to put her ball in the basket to keep it safe when she goes out. But while Mary is out John takes her ball out of the basket and puts it in the box.

Where is the ball really? (REALITY QUESTION)	box
Where did Mary put the ball in the beginning? (REALITY QUESTION)	basket
When Mary comes back where will she think her ball is? (FIRST ORDER THEORY OF MIND QUESTION)	basket

APPENDIX 2
SECOND ORDER THEORY OF MIND TASK

The Ice-Cream Van Task (after Perner & Wimmer, 1985; and Baron-Cohen, 1989 with permission of Cambridge University Press)

This is John and this is Mary. They live in this village. Here they are together in the park. Along comes the ice-cream man. John would like to buy an ice-cream, but he has left his money at home. He is very sad. 'Don't worry', says the ice-cream man, 'you can go home and get your money and buy some ice-cream later. I'll be here in the park all the afternoon'. 'Oh good', says John, 'I'll be back in the afternoon to buy an ice-cream'.

Where did the ice-cream man say to John he would be all afternoon? (REALITY QUESTION)	Park

So John goes home, …, he lives in this house. Now, the ice-cream man says 'I'm going to drive my van to the church to see if I can sell my ice-creams outside there'.

Where did the ice-cream man say he was going? (REALITY QUESTION)	Church
Did John hear that? (REALITY QUESTION)	No

So the ice-cream man drives over to the church. On his way he passes John's house. John sees him and says 'Where are you going?'. The ice-cream man says 'I'm going to sell some ice-cream outside the church'. So off he drives to the church.

Where did the ice-cream man tell John he was going? (REALITY QUESTION)	Church
Does Mary know that the ice-cream man has talked to John? (REALITY QUESTION)	No

Now Mary goes home. She lives in this house. Then she goes to John's house – she knocks on the door and says 'Is John in?'. 'No', says John's mother, 'He has gone out to buy an ice-cream'.

Where does Mary think that John has gone to buy an ice-cream? (SECOND ORDER THEORY OF MIND QUESTION)	Park
Why?	
Where did John really go to buy his ice-cream? (REALITY QUESTION)	Church

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