

**THEORY OF MIND AND ITS  
RELATION TO SCHIZOTYPY**

**SOPHIE FYFE**

**D. Clin. Psy. 2006 Thesis (Volume 1)**

**University College London**

UMI Number: U591996

All rights reserved

INFORMATION TO ALL USERS

The quality of this reproduction is dependent upon the quality of the copy submitted.

In the unlikely event that the author did not send a complete manuscript and there are missing pages, these will be noted. Also, if material had to be removed, a note will indicate the deletion.



UMI U591996

Published by ProQuest LLC 2013. Copyright in the Dissertation held by the Author.  
Microform Edition © ProQuest LLC.

All rights reserved. This work is protected against  
unauthorized copying under Title 17, United States Code.



ProQuest LLC  
789 East Eisenhower Parkway  
P.O. Box 1346  
Ann Arbor, MI 48106-1346

## CONTENTS

<b>Acknowledgements</b>	<b>v</b>
<b>Overview</b>	<b>1</b>
<b>Literature Review: Is Atypical Mentalizing a Risk Factor for Psychosis?</b>	<b>2-61</b>
Abstract	3
Investigating Risk Factors for Psychosis	4
The Diathesis-Stress Model	5
Models of Vulnerability to Psychosis	5
The High-Risk Paradigm	7
Concept of Theory of Mind	9
Measuring Theory of Mind	13
Why Propose Abnormal Mentalizing as a Risk Factor for Schizophrenia?	15
1. <i>Theory of Mind and Schizophrenia</i>	15
2. <i>The Remission Literature</i>	23
3. <i>Links to Other Biological and Environmental Risk Factors</i>	27
Evidence For and Against a Trait-Based Account	31
1. <i>Longitudinal Studies</i>	31
2. <i>Cross-Sectional Relative Studies</i>	33
3. <i>Cross-Sectional Schizotypy Studies</i>	36
Conclusions	42
References	45

<b>Empirical Paper: Theory of Mind and its Relation to Schizotypy</b>	<b>62-114</b>
Abstract	63
Introduction	64
Method	73
Results	83
Discussion	100
References	107
<b>Critical Appraisal:</b>	<b>115-130</b>
Introduction	116
Planning the Study	116
Selecting and Recruiting Participants	119
Collecting the Data	120
Analysing the Results	123
Interpreting Findings	123
The Wider Context and Future Directions	124
References	128
<b>Appendices</b>	<b>131-175</b>
Appendix 1: Participant Information Sheet and Consent Form	132
Appendix 2: Letter of Ethical Approval	135
Appendix 3: Questionnaires, Measures and Scoring Criteria	138
Appendix 4: Correlations Between O-LIFE Scores and Control Variables	167
Appendix 5: Correlations Between Experimental and Control Variables	169
Appendix 6: Correlations Between Experimental Variables	173

## LIST OF TABLES AND FIGURES

Table 1:	Mean (standard deviation) scores on O-Life sub-scales	85
Table 2:	Normative data for O-Life sub-scales (Mean [standard deviation]; Mason & Claridge, 2006)	85
Table 3:	Means (standard deviations) of verbal IQ, performance IQ and Hayling scaled scores of high and low schizotypes	86
Table 4:	Means (standard deviations) of accuracy and response type scores of high and low schizotypes on the Stories Task	88
Table 5:	Means (standard deviations) of accuracy and response type scores of high and low schizotypes on the Triangles Task	89
Table 6:	Associations between O-LIFE sub-scale standard scores and reading meaning in randomness scores on the Stories Task	93
Table 7:	Associations between O-LIFE sub-scale standard scores and reading meaning in randomness scores on the Triangles Task	94
Figure 1:	Accuracy scores of high and low schizotypes in random condition of Triangles Task	98
Figure 2:	Reading meaning in randomness scores of high and low schizotypes in Triangles Task	98
Figure 3:	Agency responses of high and low schizotypes in random condition of Triangles Task	98
Figure 4:	Mental state responses of high and low schizotypes in physical condition of Triangles Task	98

## **ACKNOWLEDGEMENTS**

Thank you to Oliver Mason and Graham Pickup for their patience and support in supervising this project, to all those who participated for giving their time, to Claire Williams for bringing some fun to the enterprise and to my friends and family for generally being great.

## **OVERVIEW**

### **Literature Review: Is Atypical Mentalizing a Risk Factor for Psychosis?**

The literature review summarises models and rationale underpinning investigation of atypical mentalizing as a risk factor for psychosis, and reviews longitudinal and cross-sectional studies relating to this. It concludes that, although differences in social cognition can be demonstrated to be associated with risk for psychosis, findings to date are mixed, and a focus on the presence or absence of mentalizing skills has limited exploration of the nature of these putative differences.

### **Empirical Paper: Theory of Mind and its Relation to Schizotypy.**

This section reports an experimental comparison of the performance of high and low schizotypes on verbal and non-verbal measures of theory of mind. In the non-verbal domain, high schizotypes were significantly more likely than low schizotypes to read meaning in randomness and to impute agency or mental states where none were obviously implied. These tendencies were associated with positive schizotypy in particular. The findings are discussed in relation to Frith's (1992) cognitive model of schizophrenia and existing studies of theory of mind and schizotypy and schizophrenia.

### **Critical Appraisal:**

A critical review of the process of the above study is presented. Observations made during the planning, data collection, data analysis and interpretation stages of the project are described, and suggestions are made for future research.

**Literature Review:**

**Is Atypical Mentalizing a Risk Factor for**

**Psychosis?**



# IS ATYPICAL MENTALIZING A RISK FACTOR FOR PSYCHOSIS?

## ABSTRACT

*Investigation of risk factors for psychosis is currently pertinent with increasing focus being placed on early interventions for psychotic disorders. This review outlines the 'diathesis-stress model', models of vulnerability to psychosis and the 'high-risk paradigm' as concepts underpinning research into risk for psychosis. It discusses the concept of 'theory of mind' (ToM) or 'mentalizing' and presents reasons for proposing that an abnormality in this domain of functioning may be a risk factor for psychosis. Published literature reviews are relied on to summarise studies of ToM and schizophrenia pre-dating 2003 while more recent studies are discussed individually. Longitudinal and cross-sectional relative and schizotypy studies relevant to the relationship between mentalizing and vulnerability to psychosis are then reviewed. It is argued that ToM is a multi-faceted concept, which varies along continua both within and between clinical and non-clinical populations and, for some individuals at least, across time. Although there is evidence for atypical social cognition amongst those vulnerable to psychosis, existing studies report varied findings and, with their focus on the presence or absence of ToM abilities, may fail to fully capture the nature of putative mentalizing differences.*

## **INVESTIGATING RISK FACTORS FOR PSYCHOSIS**

There is a growing body of evidence that suggests that intervening early in the course of psychosis can improve treatment outcome (Garety et. al., 2006; Larsen et. al., 2001; Malla & Norman, 2002; Petersen et. al., 2005). Although controversy exists over the validity of this evidence (e.g. Warner, 2005), a general consensus in its favour has fuelled government commitment to ‘early intervention in psychosis’ (Department of Health, 2000, 2001).

Early intervention services offer psychosocial and pharmacological treatment to those who have experienced a first psychotic episode and, in some instances, to those with no history of psychosis who exhibit the sub-clinical signs and symptoms often cited as precursors to its development. However, many indicators of the so-called ‘prodrome’ are non-specific, overlapping considerably with affective disorders and with behavioural changes common in adolescence (e.g. problems with social functioning); and it is argued that early intervention runs the risk of negatively affecting those who score ‘false-positives’ on prodrome screens (Warner, 2005). Increasingly powerful and specific operational criteria are being developed for identifying those likely to develop psychosis (e.g. Phillips, Yung & McGorry, 2000; Yung, Phillips, Yuen & McGorry, 2004); however, there are clear benefits associated with broadening our understanding of trait markers of psychosis-proneness and of factors involved in the aetiology of psychosis.

## **THE DIATHESIS-STRESS MODEL**

The 'diathesis-stress model' is a widely accepted conceptualisation of the development of psychosis (e.g. see Gottesman, 1991). The model describes how multiple genetic, biological, psychological, social and environmental influences leave an individual vulnerable to the illness. Particular stressors then interact with this vulnerability to trigger the onset of a psychotic disorder. No single risk factor or stress is thought necessary or sufficient for psychosis to develop, rather the variables implicated are many and wide-ranging, including for example, pre-natal and post-natal complications and infections, abuse or neglect during childhood, low cognitive ability, aspects of familial environment, urbanicity, minority status and cannabis smoking (e.g. see Fergusson, Poulton, Smith & Boden, 2006; Isohanni et al., 2005; Read, van Os, Morrison & Ross, 2005; Semple, McIntosh & Lawrie, 2005; van Os, Krabbendam, Myin-Germeys & Delespaul, 2005; Walker, Kestler, Bollini & Hochman, 2004). The search for risk factors for psychosis is therefore immensely broad. For the purpose of the current discussion, 'risk factor' will refer to a characteristic occurring before an illness manifests, which is associated with an increased likelihood of becoming unwell (Fletcher, Fletcher & Wagner, 1996).

## **MODELS OF VULNERABILITY TO PSYCHOSIS**

In line with the diathesis-stress model, vulnerability to psychosis is sometimes described in terms of characteristics of individual difference that predispose a person towards

psychotic breakdown when adverse physical, social, or environmental triggers are encountered. There is variation in the extent to which this vulnerability is viewed to be continuous throughout the population in its distribution.

More orthodox psychiatric, 'quasi-dimensional' models (e.g. Meehl, 1962) argue for a continuum of vulnerability only within a subset of individuals who possess a particular schizophrenic genotype. This genotype underpins a nervous system dysfunction, which Meehl terms 'schizotaxia', manifest at the phenotypic level in 'schizotypal' personality characteristics and behaviours. This model implies that particular schizotypal attributes can be identified only within the vulnerable subset of the population (i.e. those with the at-risk genotype.)

Fully-dimensional models (e.g. Claridge, 1994; Johns & van Os, 2001) by contrast describe vulnerability to psychosis ('schizotypy') as occurring along one, or possibly several, continua on which all individuals vary. These continua are argued to be normally distributed, genetically loaded dimensions of personality traits and cognitive variables of which the clinical symptoms of psychosis are viewed as extreme expressions. The fully-dimensional model predicts continuity in vulnerability markers throughout the population.

Support for the fully-dimensional approach comes from evidence for psychotic-like experiences widely present in the normal population (Johns et al., 2004) and from studies employing questionnaire measures derived from the approach (e.g. Oxford Liverpool Inventory of Feelings and Experiences (O-LIFE: Mason, Claridge & Jackson,

1995); Schizotypal Personality Questionnaire (SPQ: Raine, 1991)). The distribution, factor structure, heritability and predictive power of scores on these scales (Chapman, Chapman, Kwapil, Eckblad & Zinser, 1994; Claridge et al., 1996; Claridge & Hewitt, 1987; Johns & van Os, 2001; Kendler et al., 1991; Kendler & Hewitt, 1992) provide supportive evidence for schizophrenia-like traits in the normal population predisposing individuals towards psychotic breakdown when adverse physical, social, or environmental triggers are encountered (see Claridge, 1994 for a review).

The fully-dimensional approach to psychosis-proneness provides a rationale for viewing attenuated forms of the cognitive and biological attributes associated with the psychotic state as potential markers of vulnerability (risk factors) for psychosis in the non-clinical population.

## **THE HIGH-RISK PARADIGM**

The 'high-risk paradigm' involves selecting individuals in the non-clinical population on the basis of some attribute hypothesised to put them at risk, and investigating whether particular characteristics in these 'at risk' individuals predict the likelihood of illness developing.

This approach can take the form of longitudinal follow-up of those identified as vulnerable at a young age. Most commonly such studies recruit children of adults with schizophrenia (hypothesised to be vulnerable on the basis of shared genetic and usually

environmental influences) as a high-risk sample, and matched control groups drawn from other populations. Possible associations are investigated between characteristics and experiences of the high-risk sample and later psychiatric outcome, to ascertain which of these constitute likely risk factors for the illness.

An alternative design again focuses on relatives as a high-risk group and uses cross-sectional comparisons between those with relatives who have schizophrenia and those without to establish whether the closeness of relation to a patient with schizophrenia is associated with particular putative vulnerability factors.

Alternatively, cross-sectional and longitudinal comparisons can be made between those who do and do not, according to some criteria, carry personality and cognitive traits that make them vulnerable to psychotic breakdown. This approach often draws on measures derived from the continuity models discussed above, such that individuals classed as high-risk are those who score highly on questionnaire measures of 'psychosis-proneness' (e.g. Chapman et al., 1994). The relationships of schizotypy scores to traits and experiences hypothesised to constitute risk factors for psychosis are investigated.

Although much of the high-risk research has focused on 'endophenotypic information', which lies between genetic and psychiatric indicators of schizophrenia (Claridge, 1994), the high-risk paradigm may guide the search for vulnerability factors that are either genetically or environmentally underpinned. Identified risk factors may play a role in the development of psychosis as part of its diathesis, its stress, or both, or may simply constitute markers of risk with no active role in the pathogenesis of the disorder.

Claridge (1994) describes high-risk studies in the psychosis literature conducted within the fields of cognitive psychology, psychophysiology and cerebral laterality research. One aspect of cognitive functioning that may vary with vulnerability to psychosis is ToM.

## **CONCEPT OF THEORY OF MIND**

‘Theory of mind’ is a term originally coined by Premack and Woodruff (1978). It refers to the ability to represent the mental states (thoughts, intentions and beliefs) of others and to use these representations to predict and understand behaviours (Premack & Woodruff, 1978). Frith, Morton and Leslie (1991) call this ability ‘mentalizing’. Impairments in ToM have been described in a variety of neuropsychiatric disorders, most extensively in autistic spectrum disorders (e.g. Baron-Cohen, Leslie & Frith, 1985), in adults with frontal lobe damage (e.g. Rowe, Bullock, Polkey & Morris, 2001; Stuss, Gallup & Alexander, 2001) and in schizophrenia (e.g. Frith, 1992).

There are two dominant broad conceptualisations of the psychological mechanisms underpinning mature ToM functioning, each of which has several variations (Carruthers & Smith, 1996). *Meta-representational* approaches (both ‘modular’ and ‘theory-theory’) (e.g. Perner, 1991; Scholl & Leslie, 1999) propose that mentalizing abilities rest on an implicitly held body of knowledge about mental states and rules of inference regarding these. *Simulation theorists* (e.g. Davies & Stone, 1995) by contrast, argue that ToM functioning is mediated by an ability to project oneself imaginatively into another

person's perspective. Further conceptualisations combine both simulation and meta-representational approaches, maintaining that some components of ToM are underpinned by simulation and others by theory.

With regard to the development of mentalizing abilities, theorists from both camps argue for some degree of genetic endowment. Amongst proponents of meta-representation, *modular* theorists argue for an innate, encapsulated, domain specific 'ToM mechanism', the development of which may pass through a number of intermediate theory-like stages and may depend on triggering experiences from the environment (e.g. Scholl & Leslie, 1999). *Theory-theory* accounts place more emphasis on learning through experience as theories about the nature of mentalizing are constructed and revised, but some innate basis for ToM acquisition is generally proposed. Within *simulation* theories, a less specific innate endowment is argued to underpin ToM development. This is generally characterised as, for example, the ability to imagine or to think counter-factually. An element of learning is then argued to be required for the acquisition of mature adult mentalizing.

Universal patterns are observed in the stepwise development of ToM abilities (Leslie, 1987) and the above perspectives attempt to account for these. Perner (1991), for example, argues that primary representations of the physical state of the world develop first and are a necessary pre-cursor to the subsequent development of secondary representations, which are representations of how things could be rather than how things are. Finally, the development of 'meta-representations', which is dependent on the



successful development of earlier stages, allows for scientific-like theorising about the mental states of others.

The above descriptions of ToM and its emergence focus on the information processing mechanisms underpinning a singular developmental path. Generally they refer to ToM as a specific faculty, separable from more general cognitive abilities such as executive function and general intelligence. Indeed, distinct, overlapping brain networks have been proposed to underpin ToM and empathy (Lee, Farrow, Spence & Woodruff, 2004).

In line with this, accounts of ToM dysfunction have traditionally focused on the presence or absence of either the conceptual abilities required to imagine or to consider mental states (e.g. representational skills), or of the processing capacities necessary for the successful application of these conceptual abilities (e.g. memory, access to stored information, inhibition of reality). Variation in the signs and symptoms of the range of disorders argued to arise from disruption to a ToM mechanism is accounted for in terms of differences in the age of onset of the disorder (and associated differences in learning prior to onset) and in the potential for additional cognitive deficits to give rise to further impairments (Frith & Frith, 1991). However, less consideration has been given to individual differences in normal ToM functioning and to variation across situations in the mentalizing abilities of any individual. Carpendale and Lewis (2004) point to the need for theories to account for the influence of social interaction on the development of normal ToM functioning.

The evidence for the significance of this influence is considerable (Carpendale & Lewis, 2004; de Rosnay & Hughes, 2006). For example, young children whose parents frequently give explanations referring to emotions when talking to them show better ability to identify and reason about emotional states than do children whose parents use such terms less often (Denham, Zoller & Couchoud, 1994) and family feeling-state talk at 33 months predicts children's emotion understanding and false-belief explanations at 40 months (Dunn, Brown, Slomkowski, Tesla & Youngblade, 1991). Fonagy, Gergely, Jurist and Target (2002) describe cross-sectional and longitudinal studies in which infants' attachment to their primary caregiver(s) has been shown to predict their current and future ability to reason about beliefs and desires. Finally, a large-scale twin study investigating genetic and environmental contributions to children's ToM found that, amongst 5 year-olds, genetic influences explained only 7% of the variance in ToM understanding, while shared environmental and non-shared environmental influences accounted for 48% and 45% of the variance respectively (Hughes et al., 2005).

Fonagy et al. (2002) refer to the capacity to "envison mental states in self and others" as 'reflective function' and argue that this capacity normally develops through an interpersonal process which provides the child with the experience of his/her mental states being reflected on. Multiple interacting, social, environmental and individual influences, including parenting style and the child's biological vulnerabilities, are posited to shape this development. The authors present a framework in which abnormalities of reflective function are central to the development of psychopathology, in particular borderline personality disorder. This framework points to variability in

reflective function within, and not solely between, psychiatric and non-clinical populations.

Furthermore Fonagy et al. (2002) argue that an individual's reflective function varies, like all cognitive abilities, across contexts, and that reflective capacity in one domain of interpersonal interaction does not necessarily generalize to others. Reflective function is conceptualised to develop as a skill tied to the task and domain where it is learned (e.g. within a specific category of relationship) and to vary with differences in affect and in the meaning and physical context of an interaction. Although normal development proceeds towards integration of abilities across contexts, unevenness is argued to remain into adulthood, and to develop in some cases as a means of avoiding physical and psychological pain in particular situations.

There are therefore grounds to argue that individual differences in ToM abilities exist across the population, and within individuals across contexts. On the basis of this perspective, a model describing a 'deficit' or absence of reflective function in particular individuals may well be an over-simplification.

## **MEASURING THEORY OF MIND**

Stone, Baron-Cohen, Calder, Keane and Young (2003) outline three types of ToM paradigm. Firstly there are those that measure *epistemic mental states* (mental states that refer to something in the world, such as knowledge, attention or belief.) The classic

measure of ToM, the ‘false-belief task’ (Dennet, 1978; Wimmer & Perner, 1983), falls into this category. False-belief tasks test an individual’s ability to infer another’s knowledge or belief about a situation usually by assessing understanding of stories, verbally or pictorially presented or acted out with puppets. These paradigms may measure ‘first-order false-beliefs’, which involve representation of the beliefs of a character, or more complex ‘second-order false-beliefs’, which reflect understanding of a character’s beliefs about the thoughts or beliefs of a third character. A second type of ToM task focuses on *intentions as mental states*. Examples of such tasks are those that measure understanding of hints or jokes where this relies on inferences being made about the intention of a character in a story or cartoon; and tasks that require participants to choose the most likely card to complete comic strip sequences where a judgement must be made about the character’s intention in order to do so. Paradigms that measure the ability to infer deceptive intent also fall into this category. The last of Stone et al.’s (2003) categories covers those tasks that measure understanding of *affective mental states* such as desire. Such tasks may require participants to infer how a character feels based on a story or on a picture of the character’s eyes.

Some ToM tasks measure more than one of these abilities (e.g. Fletcher et al.’s (1995) ‘Stories Task’) and further ToM paradigms that do not fit easily into this categorisation can be identified. One additional class of mentalizing task employed in schizophrenia research comprises measures of pragmatic comprehension of speech. Paradigms assessing understanding of language devices such as metaphor and irony, compliance with conventional speech maxims, and general conversational style fall into this category. Finally, the ability to identify another person’s visual perspective has been

argued to reflect mentalizing abilities and tests of this ability have been employed in ToM research.

Harrington, Siegert and McClure (2005) argue that the psychometric properties of these various ToM tasks have not been fully evaluated and suggest that discrepancies in findings across studies of ToM in schizophrenia may in part be a reflection of this. The majority of studies in this field use only one paradigm, precluding any evaluation of the extent to which they are indeed measures of the same construct.

## **WHY PROPOSE ABNORMAL MENTALIZING AS A RISK FACTOR FOR SCHIZOPHRENIA?**

### **1. Theory of Mind and Schizophrenia**

Frith (1992) proposed that a range of symptoms characteristic of schizophrenia could be explained in terms of an impairment in ToM. In Frith's (1992) account, compromised ability to represent one's own goals underpins disorders of 'willed action' (e.g. negative and disorganized symptoms), impaired ability to represent one's own intentions results in disorders of self-monitoring (e.g. delusions of control, voice-commenting hallucinations and thought insertion) and inability to represent the intentions of others leads to symptoms such as delusions of reference, paranoid delusions and third person hallucinations.

Frith's model draws on Perner's (1991) account of the progressive development of 'meta-representational' abilities discussed above. It distinguishes between the ability to represent one's own goals, awareness of one's own intentions and other mental states, and awareness of the mental states of others, and argues that these three abilities develop in succession. On the grounds of this distinction, patients with prominent negative or disorganized 'behavioural' symptoms are predicted to perform most poorly on ToM tasks because of their incapacity to represent mental states at all. Patients with paranoid symptoms are argued to be aware that other people have mental states, but impaired in accurately monitoring these as they struggle to use contextual information to make correct 'on-line' inferences about them. These patients are therefore expected to perform worse than healthy controls on measures of ToM. Patients with passivity symptoms, (delusions of alien control, and thought insertion) are predicted to perform normally on ToM tasks because they are impaired only in their ability to represent their own mental states, with their representations of those of other people being relatively preserved (Pickup & Frith, 2001).

### ***Studies published prior to 2003***

There have been two recent reviews of the pre-2003 literature pertaining to mentalizing abilities in schizophrenia, both of which conclude that there is good empirical evidence that ToM is impaired in people with schizophrenia relative to healthy controls (Brüne, 2005a; Harrington, Siegert et al., 2005). This impairment is evident across a range of verbal and non-verbal tasks and the reviewers agree that it is a specific deficit that cannot be accounted for purely in terms of impairment in executive or more general

cognitive functioning. Findings relating to the association between ToM impairment and particular symptoms of schizophrenia are however more equivocal.

Brüne (2005a) concludes that the evidence supports Frith's (1992) theory in that patients with negative behavioural symptoms such as avolition or social withdrawal, or positive behavioural symptoms such as incoherent or inappropriate speech, perform worst on ToM tasks across several studies (patients with prevailing negative symptoms are most severely impaired in ToM, particularly when their symptomatology resembles that of autism; Langdon et al., 1997). Patients who experience subjective symptoms of passivity such as thought insertion or delusions of alien control and patients in remission perform relatively normally on ToM tasks. However, Brüne (2005a) argues, evidence regarding the nature of the ToM deficit in paranoid patients is inconclusive with some studies providing support for such an impairment and others failing to do so.

Harrington, Siegert et al. (2005) point to the failure of the majority of studies to control for the presence of other symptoms and are more conservative about the conclusions they draw from current research at a symptom and symptom-cluster level. They summarise the evidence as indicating that, in line with Frith's account, the ToM deficit in schizophrenia is most consistently associated with behavioural signs, in particular thought disorder, and paranoid symptoms, and argue that the evidence is least convincing with regard to delusions and hallucinations.

### *Studies published since 2003*

More recent studies have produced findings consistent with the general conclusions of Brüne (2005a) and Harrington, Siegert et al. (2005). Patients with schizophrenia have been shown to be impaired relative to healthy controls on a ToM questionnaire and a picture-sequencing task (Brüne, 2005b; Brüne & Bodenstein, 2005), on a revised version of the 'Hinting Task' (Corcoran, Mercer & Frith, 1995; Marjoram et al., 2005) and on the 'Eyes Test', which requires mental states to be identified from photographs of eyes (Baron-Cohen, Wheelwright, Hill, Raste & Plumb, 2001; Kelemen, Erdélyi & Pataki, 2005). Again, there is less consistency in findings with regard to specific symptoms or symptom clusters; the studies by Brüne's research group did not look specifically at associations at this level, Marjoram et al. (2005) found positive symptomatology (specifically hallucinations and delusions) to predict ToM performance, and in Keleman et al.'s (2005) study, performance correlated significantly only with negative symptoms.

Two recent studies have focused on the relationship between persecutory/paranoid delusions and ToM and the findings of both broadly support the existence of an association. Craig, Hatton, Craig and Bentall (2004) found patients with persecutory delusions to perform worse than healthy controls and not significantly differently from those with Asperger's syndrome on both the Hinting Task and the Eyes Test and ToM performance was negatively related to scores on a measure of paranoia. Harrington, Langdon, Siegert and McClure (2005) measured performance on first- and second-order false-belief and deception stories and a non-verbal picture-sequencing task (Langdon & Coltheart, 1999). Patients with paranoid delusions performed significantly worse than both non-clinical controls and patients with non-paranoid schizophrenia on verbal ToM



tasks, and verbal ToM scores were negatively correlated with severity of paranoid delusions. When the effect of illness duration was partialled out, these relationships remained significant for second-order but not first-order verbal ToM scores.

### ***Accounting for inconsistent findings***

Harrington, Langdon et al. (2005) suggest that three factors are important in accounting for inconsistency in findings regarding the relationship between ToM and paranoid symptoms: (1) variation in tasks employed to measure ToM; (2) different methods of grouping the heterogeneous symptoms of schizophrenia and (3) variables other than ToM that are important in determining symptoms. All of these factors could equally account for the discrepancy in findings regarding the relationship of other symptoms or symptom clusters of schizophrenia to ToM impairment.

A further possible explanation, arising primarily out of the paranoia literature, relates to Frith's (1992) model in which paranoid symptoms are argued to be underpinned not by an inability to ascribe mental states to others but by a lack of capacity to use *contextual* information to make correct *on-line* inferences about these mental states. Frith (2004) elaborates on this theory suggesting that patients with paranoid symptoms tend to 'over-mentalize', imputing mental states excessively. Traditional ToM tasks do not look specifically at abnormalities in the nature of mentalizing abilities but focus on detecting the presence or absence of ToM per se. Nor do they take full account of the influence of context on mentalizing, or distinguish between on-line and off-line processes. Such tasks may therefore be too crude to fully explore differences in mentalizing style associated with particular symptoms of schizophrenia.

### ***The role of context***

The claim that patients with paranoid delusions have difficulty in drawing on contextual information in mentalizing gains support from the findings of a study comparing patients from different symptom groups and psychiatric and non-clinical controls in their understanding of pragmatics (Corcoran & Frith, 1996). In this study, patients with paranoid delusions were able to recognise appropriate use of conversational rules but were impaired relative to both control groups in recognising violations of politeness, which, it was argued, required reference to contextual information. Those with negative behavioural signs were impaired at recognising violations of both conversational rules and politeness. Beyond this, little attention has been paid to the possible influence of contextual information on mentalizing abilities.

### ***The on-line/off-line distinction***

ToM tasks generally assess off-line mentalizing. One recent study (McCabe, Leudar & Antaki, 2004) looked at on-line abilities by analysing the conversational style of patients with schizophrenia talking to mental health professionals. The patient group evidenced an ability to use ToM skills (i.e. showing an appreciation of others' mental states as distinct from their own). However, no comparisons were made between the conversational styles of patients with different symptoms and again the study focused more on detecting an absence of mentalizing than on looking for differences in mentalizing style. Frith (2004) accounts for the findings by suggesting that ToM impairment in schizophrenia might be specific to explicit (off-line), conscious reflection upon states of mind, citing the difficulty the group with schizophrenia had when confronted with the problem of how to change someone's belief as evidence. Beyond

this there has been little consideration of the on-line/off-line distinction in the ToM and schizophrenia literature.

### *Difference versus deficit*

As mentioned above, few studies have attempted to distinguish between absence of mentalizing abilities and abnormalities in mentalizing style. Abu-Akel and Bailey (2000) distinguish three types of ToM deficit: having no representational understanding of mental states, having representational understanding of mental states but a deficit in application of this understanding and having representational understanding of mind but over-attributing mental states or over-generating hypotheses about mental life. Abu-Akel (1999) suggests that the positive symptoms of schizophrenia (specifically, paranoid delusions and positive thought disorder) may be explained by a 'hyper-mentalizing' account. This relates to Frith's (2004) suggestion that paranoid delusions might arise from a tendency to 'over-mentalize' and fits with the Garety, Hemsley and Wessely's (1991) theory of delusion formation as arising from a reasoning bias in which conclusions are reached on the basis of less information than in 'normal' reasoning.

Frith (2004) suggests that, although a detailed error analysis might reveal different kinds of error, over-mentalizing would be most clearly demonstrated if individuals could be shown to ascribe intentions to behaviour that most people would describe as mechanical or random. Blakemore, Sarfati, Bazin and Decety (2003) found that patients with delusions of persecution, but not patients without such delusions or non-clinical controls, tended to give an equal rating to the strength of relationship between the movement of two 'animate' shapes regardless of whether the movement was designed to be contingent

or non-contingent. They also tended to ascribe mental states to the shapes when describing these relationships. Evidently, there is a need for further studies that allow for investigation of the tendency of paranoid patients to over-mentalize.

### ***Conclusions on ToM & schizophrenia***

It is clear that some patients with schizophrenia are impaired relative to the non-clinical population on some measures of ToM. The nature of the mentalizing differences underpinning this is unclear; it would seem that while the majority of studies focus on the presence or absence of mentalizing abilities, such a dichotomy may be too simplistic to account for all the observed differences between psychotic patients and non-clinical controls and over-mentalizing may be implicated in some cases (e.g. in patients with paranoid delusions). Variation in mentalizing abilities appears likely to be dependent not only on the symptom profile of the individual patient but also on the context in which mentalizing is being observed, including the level of explicitness of mentalizing demanded by the task. This may relate to the fractionation of mentalizing abilities discussed by Fonagy et al. (2002). Nonetheless, the evidence points towards differences in mentalizing style associated with the psychotic state. It is therefore worth investigating abnormalities in ToM as a potential risk factor for psychosis in the non-clinical population.

## 2. The Remission Literature

An account that cites ToM differences as a risk factor for psychosis would predict such differences to be evident in remitted patients. Atypical mentalizing in remitted patients is not necessarily inconsistent with a view that mentalizing differences are solely a symptom of the psychotic state, as residual effects of changes initially arising as part of psychotic illness may remain when the illness is in remission; however, such differences are a requirement of trait-based accounts. Studies investigating the ToM abilities of patients with schizophrenia when in remission have produced mixed findings.

### *Evidence consistent with a trait-based account*

There is evidence to suggest that impaired mentalizing can be detected amongst remitted patients as compared to non-clinical controls, at least on some measures of ToM (Herold, Tényi, Lénárd & Trixler, 2002; Janssen, Krabbendam, Jolles & van Os, 2003; Kelemen et al., 2005). In Janssen et al.'s (2003) study, remitted patients with diagnoses of schizophrenia or schizo-affective disorder performed worse on the Hinting Task than non-psychotic first-degree relatives of psychotic patients, who in turn performed worse than healthy controls, even after controlling for general cognitive ability, neuropsychological measures (executive functions, episodic memory, verbal fluency, speed and attention) and sub-clinical psychopathology. On a first-order false-belief task, a non-significant trend was seen towards a similar relationship. The authors suggest that these findings reflect the lesser sensitivity of the false-belief task, as compared to the Hinting Task, in detecting ToM impairment. This argument is supported by the superior performance of the sample as a whole on the false-belief task relative to the Hinting

Task, which suggests that the latter task may have been easier (although the authors do not report whether this difference was significant.)

Herold et al. (2002) used four measures to compare ToM in patients with paranoid schizophrenia in remission and non-psychiatric controls matched for sex, age, ethnic origin, and socio-economic and educational status. There was a non-significant trend towards worse performance on a first- and a second-order false-belief task amongst remitted patients as compared with controls, and no significant group difference in scores on a task requiring understanding of metaphor (a ceiling effect may have prevented detection of group differences on this measure.) On an irony task, however, remitted patients performed significantly worse than controls. Decoding irony requires consideration of the mental representations of the speaker about those of another, so that sense can be made of an utterance that blatantly contradicts the conversational context. In this way, the irony task is argued to relate to second-order ToM abilities.

Kelemen et al. (2005) also detected a mentalizing deficit in remitted patients relative to healthy controls using a sophisticated measure of ToM. The task employed was the Eyes Test, which has been shown to be sensitive enough to detect mild ToM impairments in high functioning patients with autism and Asperger syndrome (Baron-Cohen et al., 2001). One strength of Kelemen et al.'s (2005) study is that the remitted patient group were unmedicated for four weeks prior to testing, ensuring that differences in performance were not due to the effects of medication. The findings of this study, and of that of Herold et al. (2002), are limited by failure to control for sub-clinical psychopathology; however, when these are taken together with Janssen et al.'s (2003)

findings, the evidence indicates that mentalizing differences between remitted patients and healthy controls can be detected when tests of more sophisticated ToM abilities are employed.

### ***Evidence specific to paranoia***

The reports of Randall, Corcoran, Day and Bentall (2003) and Drury, Robinson and Birchwood (1998) provide evidence more specifically for an association between paranoid symptoms and ToM impairment in remission. In the former study, the performance of remitted paranoid patients on first- and second-order false-belief tasks was comparable to that of acute paranoid patients, with both groups performing significantly worse than healthy controls. No comparison group of psychotic patients without paranoid symptoms was included in the study. Drury et al.'s (1998) longitudinal study, by contrast, included both paranoid and non-paranoid patients. These researchers found that, while all patients differed from non-schizophrenic psychiatric controls in their performance on second-order false-belief tasks when in the acute phase of illness, when the same patients were in remission the difference persisted only for those with persecutory delusions. Sub-clinical psychopathology was not controlled for in either of these studies.

### ***Evidence against a trait-based account***

A series of experiments by Corcoran, Frith and colleagues are unresponsive of any abnormalities in mentalizing amongst patients with schizophrenia in remission (Corcoran et al., 1995, 1996, 1997; Frith & Corcoran, 1996; Pickup & Frith, 2001). These studies employed a range of ToM tasks and each included a remitted group

alongside patient and healthy control groups. None found evidence for ToM impairment amongst remitted patients relative to controls. Harrington, Siegert et al. (2005) suggest that the strength of this evidence is equivocal, as the make-up of the schizophrenic subgroups appears to have been very similar across each of the studies, raising the possibility that samples comprised many of the same participants.

A further possible explanation for the discrepancies between the various findings discussed above is that the number of remitted patients included in the studies of Corcoran and Frith's research group was too small for an effect to be detected. In two studies (Corcoran et al., 1997; Corcoran & Frith, 1996) remitted patients were incorporated into a single group with those with atypical symptoms in isolation and in the remaining three studies the remitted group consisted of only eight or nine participants (Corcoran et al., 1995; Frith & Corcoran, 1996; Pickup & Frith, 2001.) This contrasts to a group of 20 remitted patients in Herold et al.'s (2002) study, 17 in Kelemen et al.'s (2005) study and 43 in that of Janssen et al. (2003). The equivalent sample size in the Randall et al. (2003) and Drury et al. (1998) studies, both of which found evidence for ToM differences associated with paranoid symptoms in remission only, is 14. It may therefore be that the effect size of the deficit seen in remitted patients is smaller than that seen in those in the acute phase of illness and that the sample sizes in the studies by Corcoran and Frith's research group were too small to detect an effect.



### ***Conclusions on the remission literature***

Taken together, the evidence suggests that differences in ToM between remitted patients and controls may be identifiable when tests of more sophisticated mentalizing abilities are used, most markedly in those whose illness includes paranoid symptoms. However, the effect size is likely to be smaller than that seen in patients in the acute phase of illness. It is important to note that in most of the above studies patients continued to be on medication when in remission and in this way effects of any trait marker are confounded with possible effects of medication. Furthermore, as discussed above, a ToM deficit consistently seen in remitted patients does not exclude the possibility that mentalizing differences arise as a result of the psychotic experience or associated distress. This is a particular consideration given that many of the remitted patients in the above studies were experiencing sub-clinical psychopathology and most of the studies did not control for this. The observation of persistent ToM deficits in paranoid patients in particular may reflect the fact that paranoid psychopathology leaves a more prominent shadow in the remission phase than do other symptoms. Therefore, evidence from the remission literature does not contradict a risk/trait marker view of the role of mentalizing differences in psychosis but neither does it provide any firm support for such a view.

### **3. Links to Other Biological and Environmental Risk Factors**

Associations between known biological and environmental risk factors for psychosis and the atypical development of ToM provide additional reason to speculate a link between mentalizing style and vulnerability to psychosis.

Frith and Frith (1991) discuss the relationship between psychosis and autism, noting similarities between social and communicative impairments symptomatic of both. It is on the basis of these similarities that Frith (1992) proposes that abnormalities in ToM, posited to underpin the triad of social, imaginative and communicative deficits definitive of autism (Frith, Morton & Leslie, 1991; Wing & Gould, 1979), might also explain psychotic symptoms, with differences between the two disorders explained primarily in terms of difference in age of onset.

Autism is generally accepted to arise from a biological dysfunction, one potential candidate being a disturbance in the dopamine system (Damasio & Maurer, 1978). Dopamine dysfunction has been implicated in schizophrenia and blockade of the D2 receptor is a necessary and sufficient condition for antipsychotic activity (e.g. see Kapur, Mizrahi & Li, 2005; Walker et al., 2004). Although it is likely that a wide variety of biological causes are implicated in both disorders and epidemiological and genetic studies point to differences in the aetiology of the two (Frith & Frith, 1991), it is possible that commonalities also exist. The considerable co-morbidity and diagnostic overlap between autism and schizophrenia (Brereton & Bruce, 2002; Konstantareas & Hewitt, 2001) further indicates that this might be the case.

As discussed above, studies of ToM abilities in schizophrenia have found a mentalizing deficit to be most consistently associated with the more autistic features of the disorder (Langdon et al., 1997) and a distinction has been drawn in the literature between an autistic-like ToM deficit associated with negative symptoms and a more specific deviation in on-line mentalizing underpinning paranoia (e.g. Corcoran & Frith, 1996;

Frith, 2004). Negative symptoms in particular are associated with abnormalities in social functioning in childhood, prior to the onset of schizophrenic disorder (e.g. Hollis, 2003). It therefore seems there are grounds to postulate that the negative symptoms of schizophrenia specifically may be associated with a deficit in ToM arising from an autistic-like biological vulnerability present from birth.

Associations between environmental risk factors for psychosis and the abnormal development of ToM suggest a second possible route through which abnormal mentalizing might develop in the psychosis-prone. Risk factors related to early social environment and disrupted attachment are of particular relevance here. Separation from parents at a young age is predictive of positive symptoms of psychosis (Mednick, Parnas & Schulsinger, 1987), and children who report a negative relationship with their parents are especially likely to develop schizophrenia symptoms in general (Schiffman et al., 2002). Unwantedness of pregnancy (Myhrman, Rantakallio, Isohanni, Jones & Partanen, 1996), ante-natal depression, poor mothering (Jones, Rodgers, Murray & Marmot, 1994) and early parental loss (Agid et al., 1999) have all been associated with increased risk of schizophrenia; and there is a growing body of evidence for a relationship between physical abuse, sexual abuse or neglect and the later development of psychosis, and especially hallucinations, even after controlling for confounding variables at baseline (Bebbington et al., 2004; Janssen et al., 2004; Read, 1997; Read, van Os, Morrison & Ross, 2005; Whitfield, Dube, Felitti & Anda, 2005).

As discussed above, there is also considerable evidence for the influence of the early social environment on ToM development. In particular, insecurely attached children

have been shown to be impaired relative to their securely attached peers in their ability to reason about mental states in both longitudinal and cross-sectional studies (e.g. Fonagy, Redfern & Charman, 1997; Fonagy, Steele, Steele & Holder, 1997; Meins, Fernyhough, Russell & Clark-Carter, 1998). Fonagy et al. (2002) describe how abusive early parenting can lead to the suppression of mentalizing abilities as in this context the mental states of others are terrifying and unbearable to consider. Therefore it is possible to see how abnormal mentalizing may play a mediating role between early experiences of neglect, abuse and disrupted attachment and the later development of psychosis and perhaps positive symptoms in particular.

The possible impact of anxiety on mentalizing is also worth consideration. There is evidence that aspects of cognitive functioning vary with anxiety (Braunstein-Bercovitz, Rammsayer, Gibbons & Lubow, 2002) and it is therefore a possibility that mentalizing abilities can be affected when an individual becomes anxious. Stressful life events are implicated in both the onset of initial psychotic symptomatology and in the return of psychotic episodes (Bebbington et al., 1996; Day, 1981; Ventura, Nuechterlein, Lukoff & Hardesty, 1989) and psychotic symptoms and the treatment protocols commonly encountered by those experiencing them (e.g. seclusion and involuntary treatment) are both associated with high levels of distress (Shaw, McFarlane, Bookless & Air, 2002). It is possible that a decline in mentalizing associated with the anxiety provoked by these stressful experiences becomes problematic for those with existing atypical mentalizing styles, precipitating a psychotic breakdown. Additionally or alternatively, it is possible that distress associated with the experience of psychosis itself (further) impairs ToM abilities once a psychotic episode has set in.

## **EVIDENCE FOR AND AGAINST A TRAIT-BASED ACCOUNT**

### **1. Longitudinal Studies**

If atypical mentalizing is indeed a risk factor for psychosis, ToM abnormalities in childhood will be predictive of the later development of psychosis. A single longitudinal study has looked at ToM as a predictor of later diagnostic outcome (Schiffman et al., 2004a).

In Schiffman et al.'s (2004a) study, a large sample of high-risk children (with at least one parent with a diagnosis of schizophrenia) and matched controls (children with a parent with a diagnosis of other psychopathology and children with no parental records of psychiatric hospitalisation) aged ten to thirteen were administered Feffer's 'Role-Taking Task' (Feffer, 1959). This task requires participants to retell stories taking the perspective of one of the story characters. The scoring criteria ascribe higher scores to responses indicating greater ability to differentiate the perspectives of various story characters with the most points awarded to answers incorporating inference of feelings from observation of external events. This measurement captures the ability to infer mental states of others and is therefore argued by the authors to approximate typical conceptualisations of ToM.

At follow-up, 31 years later, diagnostic outcomes were obtained from interviews and/or hospital records. Children who later developed schizophrenia spectrum disorders (excluding schizophrenia) and those who later developed schizophrenia were found to

have significantly lower role-taking task scores than those with an outcome of no mental illness and this association remained after controlling for age and verbal IQ. No significant difference was found between the schizophrenia spectrum disorder group and the 'other psychopathology' control group in role-taking task scores. However, the scores of the other psychopathology group fell between the scores of the schizophrenia spectrum and no mental illness outcome groups. The authors argue that, given the small sample size, a lack of power may have contributed to null findings in the comparison between schizophrenia spectrum and other psychopathology groups.

Two longitudinal studies looking at social functioning in general (to which ToM abilities contribute) as a predictor of psychiatric outcome are of some relevance here (Done, Crow, Johnstone & Sacker, 1994; Schiffman et al., 2004b). In the cohort studied by Done et al. (1994) individuals who had received a diagnosis of schizophrenia by the age of 28 were significantly impaired relative to non-clinical controls on teacher-rated measures of social adjustment taken at ages 7 and 11, although there were differences between the sexes in the form this maladjustment took. Similarly, Schiffman et al. (2004b) found that ratings on a measure of sociability derived from analysis of videotaped interactions of 11 to 13 year-old children were lower for those who had received diagnoses of schizophrenia 20 years later than for those who had developed other psychiatric disorders or no psychiatric disorder at all. There is therefore evidence for social impairment manifest long before illness develops in those vulnerable to psychosis.

These findings support the hypothesis that abnormalities in ToM and in social functioning in general are a pre-existing trait marker of vulnerability to schizophrenia. However, both sets of findings are preliminary and there is a need for replication of the former using more conventional measures of ToM. A further limitation of Schiffman et al.'s (2004a) study is its failure to control for executive function deficits, which have been shown to be associated with psychosis-proneness (e.g. Raine, Sheard, Reynolds & Lencz, 1992) and may account for the poorer performance of high-risk individuals on the perspective-taking task.

## **2. Cross-Sectional Relative Studies**

The existence of mentalizing differences in relatives of those with schizophrenia (who share genetic and usually environmental influences with patients diagnosed with schizophrenia) as compared to those without a relative with psychosis would support the hypothesis that ToM deficits seen in patients with schizophrenia are rooted in characteristics of the psychosis-prone state. The few existing cross-sectional relative studies report inconsistent findings.

Two studies provide support for differences in ToM amongst healthy relatives of patients with schizophrenia. Wykes, Hamid and Wagstaff (2001) report preliminary findings of significantly poorer performance amongst non-psychotic siblings of people with schizophrenia as compared to healthy controls on a range of ToM tests, even after controlling for executive function. Similarly, Janssen et al.'s (2003) study (discussed

above) found that first-degree relatives of patients with schizophrenia were impaired relative to non-psychotic controls on the Hinting Task, after controlling for executive functions, episodic memory, verbal fluency, performance speed, attention and sub-clinical psychopathology. The relative group in this study also made more errors than controls on a false-belief task but this association was not significant.

Related to these findings are those of a number of studies which do not directly examine mentalizing differences in those at risk for schizophrenia but which show abnormalities in the natural speech of non-psychotic relatives of patients with schizophrenia (Docherty, 1993; Docherty, Miller & Lewis, 1997; Docherty, Rhinewine, Labhart & Gordinier, 1998). For example, Docherty et al. (1998) compared speech samples from healthy parents of patients with schizophrenia to those of patients with schizophrenia, and of control participants with no history of psychiatric hospitalisation in themselves and with offspring with no psychotic illness. The parent group scored significantly lower than the control group on five out of the six types of referential communication disturbance that were rated. They scored no differently from the patient group on all but one referential communication disturbance type. Correct usage of referential terms is dependent on accurate representation and consideration of the mental state of the other. These findings are therefore consistent with the hypothesis that mentalizing style is abnormal in those at risk for schizophrenia.

At odds with the findings of the above studies are those of Kelemen, Kéri, Must, Benedek and Janka (2004). These researchers found no evidence for impaired ToM in unaffected first-degree relatives of schizophrenia patients. Their study employed the



Eyes Test as a measure of ToM and controlled for age, IQ and sex. The sample size was large comprising 65 unaffected relatives and 40 healthy controls. This compares to 41 non-psychotic first-degree relatives and 43 healthy controls in Janssen et al.'s (2003) study above, and 17 remitted patients and 30 healthy controls in a study by Kelemen et al. (2005) that found a significant difference in performance on the same Eyes Test between remitted patients and healthy controls. It is therefore unlikely that the failure of this study to find an effect was due to a lack of power.

The findings from relative studies are preliminary; there is some indication that differences in mentalizing can be detected, on some ToM paradigms, between non-psychotic relatives of patients with schizophrenia and healthy controls, supporting the case for an association between vulnerability to schizophrenia and some differences in mentalizing. However, the differences do not seem to be detectable on all measures of ToM and studies to date give no indication as to which symptoms or symptom clusters are associated with differences in ToM function amongst relatives.

It is important to note that, in both longitudinal and cross-sectional studies involving relatives of individuals with schizophrenia, the influence of living in a family with a psychotic relative on characteristics of individual difference is confounded with that of possible predisposing traits. Observed differences in mentalizing ability may arise from the effects of living in an environment with a psychotic family member, or they may constitute markers of risk associated with shared genetic and environmental influences, or both may be the case. Studies that draw on schizotypy scores to discriminate between high- and low-risk groups avoid this confound to some extent.

### **3. Cross-Sectional Schizotypy Studies**

Trait-based accounts of the ToM differences seen in schizophrenia predict an association between schizotypy scores and performance on tests of ToM. In this field also, the few relevant studies have produced mixed findings.

A series of experiments by Langdon and Coltheart employing a single participant group (Langdon & Coltheart, 1999, 2001) found associations between high schizotypy scores (categorised according to a median split of total scores on the SPQ) and mentalizing performance. In two experiments within Langdon and Coltheart's (1999) study, high schizotypes scored lower than low schizotypes in the ToM condition of a picture-sequencing task. The two groups performed comparably on control conditions involving reasoning about social scripts and mechanical scenarios, and on a more difficult condition in which they had to avoid being misled by cognitively salient but irrelevant information. They also performed comparably on a measure of executive planning. The poorer performance of low schizotypes on the ToM condition was not therefore explicable in terms of general difficulty in reasoning, understanding social scripts, disengaging from salient distracters or entertaining states that run counter to reality.

Langdon and Coltheart (2001) found differences between high and low schizotypes in how alternative perspectives were considered. In a perspective-taking task, high schizotypes, but not low schizotypes, were significantly faster and more accurate at making judgements about the appearance of a rotated array than they were at making judgements about the appearance of the array by imagining an alternative viewing

perspective. Furthermore, high schizotypes tended to be slower and less accurate than low schizotypes at making judgements that involved considering an alternative viewing position, but faster and more accurate at making array rotation decisions (although these differences were not significant). Performance under viewer rotation but not array rotation instruction tended to predict mentalizing ability as measured by Langdon and Coltheart (1999).

In terms of associations between individual schizotypal traits and ToM impairment, the two separate experiments within Langdon and Coltheart's (1999) study produced inconsistent findings. Traits associated with negative symptoms of schizophrenia were associated with poorer performance in one experiment and those analogous to positive symptoms were associated with poorer performance in the other. Langdon and Coltheart (2001) found a non-significant tendency towards an association between high ratings of cognitive-perceptual and disorganised schizotypal traits and greater response times in judging the appearance of an array from an alternative viewing perspective.

There is also evidence for differences in language usage and understanding associated with total schizotypy scores (Docherty, 1993; Docherty et al., 1998; Langdon & Coltheart, 2004). Docherty et al.'s (1998) study (discussed above) found that, amongst the healthy parents of children with schizophrenia, those scoring highly on the Schedule of Schizotypal Personalities (Baron, Asnis & Gruen, 1981) evidenced significantly greater communication deviance (e.g. use of ambiguous referents) in their expressive language than did low scorers, perhaps indicating less accurate representation of the mental states of interlocutors amongst high schizotypes.

In Langdon and Coltheart's (2004) study high-schizotypal adults were impaired relative to low schizotypal adults (categorised on the basis of a median split of total SPQ scores) at identifying appropriate ironical speech acts. This pattern persisted after controlling for the ability to integrate and recall story information. As discussed above, decoding irony relies on consideration of mental states and so these findings can be taken to support an association between schizotypy and abnormalities in mentalizing. However, this study also produced the unexpected finding that high schizotypes were relatively poor at judging the appropriateness of literal statements. This result is difficult to account for.

In contrast to the above findings, three studies have found no evidence for an association between total schizotypy score and poorer performance on mentalizing tasks (Lippett, 2004; Pickup, 2006; Young & Mason, 2006). Young and Mason (2006) found no difference in the performance of those high or low in either total schizotypy or in any of its dimensions (categorised by a median split of O-LIFE scores) on any of three tasks: the picture sequencing task used by Langdon and Coltheart (1999), the 'Faux Pas Task' (Gregory et al., 2002) and the Eyes Test (Baron-Cohen et al., 2001). Between them, these tasks tap all three of the mental state attribution abilities identified by Stone et al. (2003). The sample size in this study (N=60) was larger than that in Langdon and Coltheart's (1999, 2001) experiments making it unlikely that null findings are explicable purely in terms of a lack of power.

Pickup (2006) found no significant association between total schizotypy score and mentalizing ability and no group difference in ToM between high and low schizotypes

(categorised according to a median split on schizotypy scores), using the O-LIFE questionnaire as a measure of schizotypy and assessing ToM using Fletcher et al.'s (1995) Stories Task. At the level of symptom related traits, however, Pickup (2006) found scores on the ToM condition of the Stories Task to be significantly predicted by the 'Unusual Experiences' dimension of the O-LIFE which measures aspects of schizotypy associated with the positive symptoms of schizophrenia. This association remained after controlling for both verbal IQ and executive function and was independent of scores on a control condition testing reasoning about physical causation rather than mental states.

The sample size in Pickup's study was 62 (larger than that of both Langdon and Coltheart's (1999, 2001) studies) and a novel sampling strategy was used, employing a screening questionnaire to ensure that high and low schizotypes were well represented in the sample. It therefore seems unlikely that the failure to detect a significant difference between the mentalizing abilities of high and low schizotypes was due to lack of power arising from too small a sample. However, Pickup suggests that the effect size may have been greater had the stories been read aloud to participants so that scenarios had to be processed on-line. This would constitute a more sensitive test of ToM than the paradigm employed in his study, which permitted participants to take as much time as they needed to read and understand the stories.

In a study which allowed for the identification of differences in mentalizing style beyond a simple deficit, Lippett (2005) compared the performance of 23 low and 17 high schizotypes with STA scores at least one standard deviation below or above the mean

respectively on Abell et al.'s (2000) 'Triangles Task'. (STA scores represent a composite measure of schizotypy that can be derived from the O-LIFE questionnaire.) In this task, participants are asked to describe what is happening in animations involving two geometric shapes. The movement of the shapes is either random, or suggestive of a mechanical relationship between the two ('goal-directed' condition) or designed to elicit an explanation that refers to mental states ('ToM' condition). Lippett found performance of high and low schizotypal groups to be comparable in ToM and goal-directed conditions. However, in the 'random' condition, the responses of high schizotypes were less accurate than those of low schizotypes and there was a significant tendency for those with high scores on the cognitive perceptual factor of the SPQ (the subscale closest to positive symptoms of psychosis) to give less appropriate responses. In this condition the responses of high schizotypes tended to refer to some kind of purposeful interaction, and were thought to be suggestive of a "tendency to impute social meaning when there is none". Unlike Pickup (2006), Lippett (2005) did not control for either IQ or executive function, both of which may affect ToM performance.

It therefore seems that although abnormalities of mentalizing can be demonstrated in high as compared to low schizotypes on some tasks, they cannot be detected on all measures of ToM, and a simple deficit in ToM associated with psychosis-proneness alone or with any trait related to a particular schizophrenic symptom or symptom cluster may be too simplistic to account for the data. It seems that a tendency to over-mentalize may characterise the thinking of some high schizotypes, at least in some contexts.

It is notable that other areas of vulnerability research have produced evidence for associations between schizotypy and differences rather than deficits in aspects cognitive style. Most notably, there is considerable evidence for a positive relationship between psychosis-proneness and creative thinking (e.g. Burch, Pavelis, Hemsley & Corr, 2006; Eysenck & Furnham, 1993; Green & Williams, 1999). Green and Williams (1999), for example, assessed creativity using a divergent thinking task and found a positive association between the number of 'original' responses generated in this task and overall score on the STA. Folley and Park (2005) found high schizotypes (identified on the basis of scores on the SPQ) to perform better than low schizotypes (and patients with schizophrenia) on an alternative measure of divergent thinking and, furthermore, demonstrated a neurological underpinning to this difference in performance. Across all participants, divergent thinking was associated with enhanced bilateral prefrontal cortical activity; however, the superior creative thinking seen in high schizotypes was associated with activation of the right prefrontal cortex particularly.

Differences in cognitive style associated with schizotypy have also been evidenced in reasoning tasks (Young & Mason, in press; Sellen, Oaksford & Gray, 2005). Furthermore, in Young and Mason's (in press) study, evidence was found for the context dependence of differences in reasoning style. High scorers on the 'Introverted Anhedonia' subscale of the O-LIFE measure of schizotypy were compromised in deductive reasoning specifically when reasoning about personally relevant emotional statements. Future studies of the relationship between psychosis-proneness and mentalizing could usefully investigate further the possibility of differences rather than deficits in mentalizing style and variability in these across contexts.

## CONCLUSIONS

A clear rationale for considering differences in ToM as a possible marker of risk for psychosis is presented in terms of the diathesis-stress model, continuity models of vulnerability to psychosis, evidence for ToM deficits in patients with schizophrenia, and associations between factors involved in the aetiology of schizophrenia and those implicated in abnormal ToM development in other disorders.

The evidence that ToM is impaired in those diagnosed with schizophrenia is convincing; however, the nature of the impairment is unclear and is likely to be dependent not only on the symptom profile of the individual patient but also on the context in which mentalizing is being observed, including the level of explicitness of mentalizing demanded by the task.

ToM deficits can also be observed in some patients with schizophrenia when in remission. Such deficits are not evident in all cases or on all measures of ToM and this variability needs to be accounted for. However, the remission literature does not rule out the possibility that atypical mentalizing may constitute a risk factor predisposing an individual to psychosis, rather than a symptom of the psychotic state.

The high-risk paradigm provides a structure for investigating risk factors for psychosis; the evidence from longitudinal relative studies, cross-sectional relative studies and cross-sectional schizotypy comparisons is reviewed.



Longitudinal studies provide evidence in support of atypical mentalizing, and problems in social functioning in general, amongst those at risk for psychosis prior to illness onset; however, this evidence is preliminary and findings specific to ToM must be interpreted cautiously in view of limitations associated with the tasks employed.

Evidence from cross-sectional relative studies is again preliminary and is mixed. While there is some indication that differences in mentalizing can be detected, on some ToM paradigms, between non-psychotic relatives of patients with schizophrenia and healthy controls, these differences do not seem to be detectable on all measures of ToM.

Both cross-sectional and longitudinal high-risk studies drawing on relative groups suffer from the limitation that the possible influence of living in an environment with a psychotic relative cannot be separated from the existence of differences in mentalizing as a risk factor in their own right. Studies that draw on schizotypy scores to discriminate between high and low risk groups avoid this confound to some extent.

The evidence from the schizotypy literature indicates that differences in mentalizing can be detected in high as compared to low schizotypes; however, again these differences are not apparent on all tasks. Furthermore, there is mixed evidence pertaining to the associations between particular symptom-related traits and mentalizing abilities. One study in particular suggests that, as is the case with other aspects of cognitive function in the psychosis-prone, a deficit approach may be too simplistic. There is a need for further studies investigating other aspects of ToM difference, in particular the tendency to over-mentalize.

Related to this point, consideration must be given to the conceptualisation of ToM and its measurement that underpins research into ToM and schizophrenia/psychosis-proneness. Generally, mentalizing is approached as if it is a unitary construct, which can be assessed with a wide array of measures. However, Harrington, Langdon et al. (2005) point out that this is unlikely to be the case. Not only is ToM a broad construct, but also variation in its nature is likely to exist between individuals in the non-clinical population and within individuals across contexts. The majority of studies to date fail to take account of these ideas. There is a need to investigate the relationship between mentalizing and psychosis-proneness using a range of ToM tasks, both verbal and non-verbal, with attention paid to the extent to which tasks are ecologically valid and tap on-line abilities in real time.

A number of notable questions relating to ToM and psychosis-proneness remain. If mentalizing differences do exist in non-psychotic individuals at risk of schizophrenia, there is a need to account for the discrepancy between these differences and the ToM impairment associated with the psychotic state. Possible explanations lie in the decline in other cognitive capacities, such as executive function, that might accompany the onset of schizophrenia. Alternatively, or in addition, a decline in mentalizing abilities associated with anxiety may contribute to further changes in ToM once illness manifests, as the experience of psychosis and its treatment is distressing.

Finally, the possible role of ToM in the pathogenesis of psychotic illness requires further investigation. Atypical mentalizing may play a mediating role in the development of the psychotic state, or may constitute no more than a marker of those at risk.

## REFERENCES

- Abell, F., Happé, F. & Frith, U. (2000). Do triangles play tricks? Attribution of mental states to animated shapes in normal and abnormal development. *Cognitive Development*, 15, 1-16.
- Abu-Akel, A. (1999). Impaired theory of mind in schizophrenia. *Pragmatics and Cognition*, 7, 247-282.
- Abu-Akel, A. & Bailey, A.L. (2000). Correspondence, *Psychological Medicine*, 30, 735-738.
- Agid, O., Shapira, B., Zislin, J., Ritsner, M., Hanin, B., Murad, H., Troudart, T., Bloch, M., Heresco-Levy, U. & Lerer, B. (1999). Environment and vulnerability to major psychiatric illness: a case control study of early parental loss in major depression, bipolar disorder and schizophrenia. *Molecular Psychiatry*, 4, 163-172.
- Baron, M., Asnis, L. & Gruen, R. (1981). The Schedule for Schizotypal Personalities (SSP): A diagnostic interview for schizotypal features. *Psychiatry Research*, 4, 213-228.
- Baron-Cohen, S., Leslie, A.M., & Frith, U. (1985). Does the autistic child have a “theory of mind”? *Cognition*, 21, 37-46.
- Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y. & Plumb, I. (2001). The ‘Reading the mind in the eyes’ test revised version: a study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry*, 42, 241-251.

Bebbington, P., Bhugra, D., Brugha, T., Singleton, N., Farrell, M., Jenkins, R., Lewis, G. & Howard, M. (2004). Psychosis, victimization and childhood disadvantage: evidence from the second British national Survey of Psychiatric Morbidity. *British Journal of Psychiatry*, 185, 220-226.

Bebbington, P., Wilkins, S., Sham, P., Jones, P., van Os, J., Murray, R., Toone, B. & Lewis, S. (1996). Life events before psychotic episodes: Do clinical and social variables affect the relationship? *Social Psychiatric Epidemiology*, 31, 122-128

Blakemore, S.-J., Sarfati, Y., Bazin, N. & Decety, J. (2003). The detection of intentional contingencies in simple animations in patients with delusions of persecution. *Psychological Medicine*, 33, 1433-1441.

Braunstein-Bercovitz, H., Rammsayer, T., Gibbons, H. & Lubow, R.E. (2002). Latent inhibition deficits in high-schizotypal normals: symptom-specific or anxiety-related? *Schizophrenia Research*, 53, 109-121.

Brereton, A.V. & Bruce, J.T. (2002). Autism and related disorders in adults. *Current Opinion in Psychiatry*, 15, 483-487.

Brüne, M. (2005a). "Theory of mind" in schizophrenia: A review of the literature. *Schizophrenia Bulletin*, 31, 21-42.

Brüne, M. (2005b). Emotion recognition, 'theory of mind' and social behaviour in schizophrenia. *Psychiatry Research*, 133, 135-147.

Brüne, M. & Bodenstein, L. (2005). Proverb comprehension reconsidered – ‘theory of mind’ and the pragmatic use of language in schizophrenia. *Schizophrenia Research*, 75, 233-239.

Burch, S-J., Pavelis, C., Hemsley, D.R. & Corr, P.J. (2006). Schizotypy and creativity in visual artists. *British Journal of Psychology*, 97, 177-190.

Carpendale, J.I.M. & Lewis, C. (2004). Constructing an understanding of mind: the development of children’s social interaction with social interaction. *Behavioural and Brain Sciences*, 27, 79-151.

Carruthers, P. & Smith P.K. (1996). Theories of theories of mind. Cambridge University press, Cambridge, MA

Chapman, L.J., Chapman, J.P., Kwapil, T.R., Eckblad, M. & Zinser, M.C. (1994). Putatively psychosis-prone subjects 10 years later. *Journal of Abnormal Psychology*, 103, 171-183.

Claridge, G. (1994). Single indicator of risk for schizophrenia: Probable fact or likely myth? *Schizophrenia Bulletin*, 20, 151-168.

Claridge, G. & Hewitt, J.K. (1987). A biometric study of schizotypy in a normal population. *Personality and Individual Differences*, 8, 303-312.

Claridge, G., McCreery, C., Mason, O., Bentall, R., Boyle, G., Slade, P. & Popplewell, D. (1996). The factor structure of ‘schizotypal’ traits: a large replication study. *British Journal of Clinical Psychology*, 35, 103-115.

Corcoran, R., Cahill, C. & Frith, C.D. (1997). The appreciation of visual jokes in people with schizophrenia: a study of 'mentalizing' ability. *Schizophrenia Research*, 24, 319-327.

Corcoran, R. & Frith, C.D. (1996). Conversational conduct and the symptoms of schizophrenia. *Cognitive Neuropsychiatry*, 1, 305-318

Corcoran, R., Mercer, G. & Frith, C.D. (1995). Schizophrenia, symptomatology and social inference: Investigating "theory of mind" in people with schizophrenia. *Schizophrenia Research*, 17, 5-13.

Craig, J.S., Hatton, C., Craig, F.B. & Bentall, R.P. (2004). Persecutory beliefs, attributions and theory of mind: comparison of patients with paranoid delusions, Asperger's syndrome and healthy controls. *Schizophrenia Research*, 69, 29-33.

Damasio, A.R. & Maurer, R.G. (1978). A neurological model for childhood autism. *Archives of Neurology*, 35, 777-786.

Davies, M., & Stone T. (1995). *Folk psychology: The theory of mind debate*. Oxford: Blackwell.

Day, R. (1981). Life events and schizophrenia: the "triggering" hypothesis. *Acta Psychiatrica Scandinavica*, 64, 97-122

de Rosnay, M. & Hughes, C. (2006). Conversation and theory of mind: Do children talk their way to socio-cognitive understanding? *British Journal of Developmental Psychology*, 24, 7-37.

Denham, S.A., Zoller, D. & Couchoud, E.A. (1994). Socialization of preschoolers' emotion understanding. *Developmental Psychology*, 30, 928-936.

Dennett, D.C. (1978). Beliefs about beliefs. *Behaviour and Brain Sciences*, 4, 568-570.

Department of Health (2000). *The NHS plan. A plan for investment. A plan for reform.* London: Department of Health.

Department of Health (2001). *The mental health policy implementation guide.* London: Department of Health.

Docherty, N.M. (1993). Communication deviance, attention and schizotypy in parents of schizophrenic patients. *Journal of Nervous and Mental Disease*, 181, 750-756.

Docherty, N.M., Miller, T.N. & Lewis, M.A. (1997). Communication disturbances in the natural speech of schizophrenic patients and non-schizophrenic parents of patients. *Acta Psychiatrica Scandinavica*, 95, 500-507.

Docherty, N.M., Rhinewine, J.P., Labhart, R.P. & Gordinier, S.W. (1998). Communication disturbances and family psychiatric history in parents of schizophrenic patients. *Journal of Nervous and Mental Disease*, 186, 761-768.

Done, D.J., Crow, T.J., Johnstone, E.C. & Sacker, A. (1994). Childhood antecedents of schizophrenia and affective illness: social adjustment at age 7 and 11. *British Medical Journal*, 309, 699-703.

Drury, V.M., Robinson, E.J. & Birchwood, M. (1998). 'Theory of mind' skills during an acute episode of psychosis and following recovery. *Psychological Medicine*, 28, 1101-1112.

Dunn, J., Brown, J.R., Slomkowski, C., Tesla, C., & Youngblade, L. (1991). Young children's understanding of other people's feelings and beliefs: Individual differences and their antecedents. *Child Development*, 62, 1352-1366.

Eysenck, H.J. & Furnham, A. (1993). Personality and the Barron-Welsh art scale. *Perceptual and Motor Skills*, 76, 837-838.

Feffer, M. (1959). The cognitive implications of role-taking behaviour. *Journal of Personality*, 27, 152-168.

Fergusson, D.M., Poulton, R., Smith, P.F. & Boden, J.M. (2006). Cannabis and psychosis. *British Medical Journal*, 332, 172-176.

Fletcher, R.H., Fletcher, S.W. & Wagner, E.H., (1996). *Clinical epidemiology: The essentials* (3<sup>rd</sup> ed.). Baltimore, MD: Williams & Wilkins.

Fletcher, P.C., Happé, F., Frith, U., Baker, S.C., Dolan, R.J., Frackowiak, R.S.J. & Frith, C.D. (1995). Other minds in the brain: a functional imaging study of 'theory of mind' in story comprehension. *Cognition*, 57, 109-128.

Folley, B.S. & Park, S. (2005). Verbal creativity and schizotypal personality in relation to prefrontal hemispheric laterality: A behavioural and near-infrared optical imaging study. *Schizophrenia Research*, 80, 271-282.



Fonagy, P., Gergely, G., Jurist, E. & Target, M. (2002). *Affect regulation, mentalization, and the development of the self*. New York: Other Press.

Fonagy, P., Redfern, S., & Charman, A. (1997). The relationship between belief-desire reasoning and a projective measure of attachment security (SAT). *British Journal of Developmental Psychology*, *15*, 51-63.

Fonagy, P., Steele, H., Steele, M. & Holder, J. (1997). Attachment and theory of mind: overlapping constructs? *Association for child Psychology and Psychiatry, Occasional papers*, *14*, 31-40.

Frith, C.D. (1992). *The cognitive neuropsychology of schizophrenia*. Hove, UK: Lawrence Erlbaum associates.

Frith, C.D. (2004). Schizophrenia and theory of mind. *Psychological Medicine*, *34*, 385-389.

Frith, C.D. & Corcoran, R. (1996). Exploring 'theory of mind' in people with schizophrenia. *Psychological Medicine*, *26*, 521-530.

Frith, C.D. & Frith, U. (1991). Elective affinities in schizophrenia and childhood autism. In Bebbington, P. (Ed.), *Social psychiatry*. New Brunswick NJ: Transactions press.

Frith, U., Morton, J. & Leslie A.M. (1991). The cognitive basis of a biological disorder: autism. *Trends in Neuroscience*, *14*, 433-438.

Garety, P.A., Craig, T.K.J., Dunn, G., Fornells-Ambrojo, M. Colbert, S., Rahaman, N., Reed, J. & Power, P. (2006). Specialised care for early psychosis: symptoms, social functioning and patient satisfaction. *British Journal of Psychiatry*, 188, 37-45.

Garety, P.A., Hemsley, D.R., & Wessely, S. (1991). Reasoning in deluded schizophrenic and paranoid patients. *Journal of Nervous and Mental Disease*, 179, 194-201.

Gottesman, I.I. (1991). *Schizophrenia Genesis*. New York: W.H. Freeman.

Green, M.J. & Williams, L.M. (1999). Schizotypy and creativity as effects of reduced cognitive inhibition. *Personality and Individual Differences*, 27, 263-276.

Gregory, C., Lough, S., Stone, V., Erzinclioglu, S., Martin, L., Baron-Cohen, S. & Hodges, J.R. (2002). Theory of mind in patients with frontal variant fronto-temporal dementia and Alzheimer's disease: Theoretical and practical implications. *Brain*, 125, 752-764.

Harrington, L., Langdon, R., Siegert, R.J. & McClure, J. (2005). Schizophrenia, theory of mind and persecutory delusions. *Cognitive Neuropsychiatry*, 10, 87-104.

Harrington, L., Siegert, R.J. & McClure, J. (2005). Theory of mind in schizophrenia: A critical review. *Cognitive Neuropsychiatry*, 10, 249-286.

Herold, R., Tényi, T., Lénárd, K. & Trixler, M. (2002). Theory of mind deficit in people with schizophrenia during remission. *Psychological Medicine*, 32, 1125-1129.

Hollis, C. (2003). Developmental precursors of child- and adolescent-onset schizophrenia and affective psychoses: diagnostic specificity and continuity with symptom dimensions. *British Journal of Psychiatry*, *182*, 37-44.

Hughes, C., Happé, F., Taylor, A., Jaffee, S.R., Caspi, A., & Moffitt, T.E. (2005). Origins of individual differences in theory of mind: From nature to nurture? *Child Development*, *76*, 356-370.

Isohanni, M., Lauronen, E., Moilanen, K., Isohanni, I., Kemppainen, L., Koponen, H., Miettunen, J., Mäki, P., Räsänen, S., Veijola, J., Tienari, P., Wahlberg, K.E. & Murray, G.K. (2005). Predictors of schizophrenia: Evidence from the northern Finland 1966 birth cohort and other sources. *British Journal of Psychiatry*, *187* (suppl. 48), s4-s7.

Janssen, I., Krabbendam, L., Bak, M., Hanssen, M., Vollebergh, W., de Graaf, R. & van Os, J. (2004). Childhood abuse as a risk factor for psychotic experiences. *Acta Psychiatrica Scandinavica*, *109*, 38-45.

Janssen, I., Krabbendam, L., Jolles, J. & van Os, J. (2003). Alterations in theory of mind in patients with schizophrenia and non-psychotic relatives. *Acta Psychiatrica Scandinavica*, *108*, 110-117.

Johns, L.C. & van Os, J. (2001). The continuity of psychotic experiences in the general population. *Clinical Psychology Review*, *21*, 1125-1141.

Johns, L.C., Cannon, M., Singleton, N., Murray, R.M., Farrell, M., Brugha, T., Bebbington, P., Jenkins, R. & Meltzer, H. (2004). Prevalence and correlates of self-

reported psychotic symptoms in the British population. *The British Journal of Psychiatry*, 185, 298-305.

Jones, P., Rodgers, B., Murray, R. & Marmot, M. (1994). Childhood developmental risk factors for schizophrenia in the British 1946 birth cohort. *Lancet*, 344, 1398-1402.

Kapur, S., Mizrahi, R. & Li, M. (2005). From dopamine to salience to psychosis – linking biology, pharmacology and phenomenology of psychosis. *Schizophrenia Research*, 79, 59-68.

Kelemen, O., Erdélyi, R. & Pataki I. (2005). Theory of mind and motion perception in schizophrenia. *Neuropsychology*, 19, 494-500.

Kelemen, O., Kéri, S., Must, A., Benedek, G. & Janka, Z. (2004). No evidence for impaired ‘theory of mind’ in unaffected first-degree relatives of schizophrenia patients. *Acta Psychiatrica Scandinavica*, 110, 146-149.

Kendler, K.S. & Hewitt, J.K. (1992). The structure of self-report schizotypy in twins. *Journal of Personality Disorders*, 6, 1-17.

Kendler, K.S., Ochs, A.L., Gorman, A.M., Hewitt, J.K., Ross, D.E. & Mirsky, A.F. (1991). The structure of schizotypy: A pilot multi-trait twin study. *Psychiatry Research*, 36, 19-36.

Konstantareas, M.M. & Hewitt, T. (2001). Autistic disorder and schizophrenia: Diagnostic overlaps. *Journal of Autism and Developmental Disorders*, 31, 19-28.

- Langdon, R. & Coltheart, M. (1999). Mentalizing, schizotypy, and schizophrenia. *Cognition*, 71, 43-71.
- Langdon, R. & Coltheart, M. (2001). Visual perspective taking and schizotypy: Evidence for a simulation-based account of mentalizing in normal adults. *Cognition*, 82, 1-26.
- Langdon, R. & Coltheart, M. (2004). Recognition of metaphor and irony in young adults: the impact of schizotypal personality traits. *Psychiatry Research*, 125, 9-20.
- Langdon, R., Michie, P.T., Ward, P.B., McConaghy, N., Catts, S.V., & Coltheart, M. (1997). Defective self and/or other mentalizing in schizophrenia: A neuropsychological approach. *Cognitive Neuropsychiatry*, 2, 167-193.
- Larsen, T.K., Friis, S., Haahr, U., Joa, I., Johannessen, J.O., Melle, I., Opjordsmoen, S., Simonsen, E., Vaglum, P. (2001). Early detection and intervention in first-episode schizophrenia: a critical review. *Acta Psychiatrica Scandinavica*, 103, 323-334.
- Lee, K.H., Farrow, T.F.D., Spence, S.A. & Woodruff, P.W.R. (2004). Social cognition, brain networks and schizophrenia. *Psychological Medicine*, 34, 391-400.
- Leslie, A. (1987). Pretence and representation: The origins of 'theory of mind.' *Psychological Review*, 94, 412-426.
- Lippett (2004). *An investigation of the interaction between schizotypy and cognitive monitoring processes*. Doctoral Thesis.

- Malla, A.K., & Norman, R.M.G. (2002). Early intervention in schizophrenia and related disorders: advantages and pitfalls. *Current Opinion in Psychiatry*, *15*, 17-23.
- Marjoram, D., Gardner, C., Burns, J., Miller, P., Lawrie, S.M. & Johnstone, E.C. (2005). Symptomatology and social inference: A theory of mind study of schizophrenia and psychotic affective disorder. *Cognitive Neuropsychiatry*, *10*, 347-359.
- Mason, O. & Claridge, G. (2006). The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE): Further description and extended norms. *Schizophrenia Research*, *82*, 203-211.
- Mason, O., Claridge, G., & Jackson, M. (1995). New scales for the assessment of schizotypy. *Personality and Individual Differences*, *18*, 7-13.
- McCabe, R., Leudar, I., & Antaki, C. (2004). Do people with schizophrenia display theory of mind deficits in clinical interactions? *Psychological Medicine*, *34*, 401-412.
- Mednick, S.A., Parnas, J. & Schulsinger, F. (1987). The Copenhagen high-risk project, 1962-1986. *Schizophrenia Bulletin*, *13*, 485-495.
- Meehl, P.E. (1962). Schizotaxia, schizotypy, schizophrenia. *American Psychologist* *17*, 827-838.
- Meins, E., Fernyhough, C., Russell, J.A., & Clark-Carter, D. (1998). Security of attachment as a predictor of symbolic and mentalizing abilities: a longitudinal study. *Social Development*, *7*, 1-24.

Myhrman, A., Rantakallio, P., Isohanni, M., Jones, P.B. & Partanen, U. (1996). Does unwantedness of a pregnancy predict schizophrenia? *British Journal of Psychiatry*, 169, 637-640.

Perner, J. (1991). *Understanding the representational mind*. Cambridge, MA: MIT Press.

Petersen, L., Jeppesen, P., Thorup, A., Abel, M.B., Øhlenschläger, J., Christensen, T. Ø., Krarup, G., Jørgensen, P. & Nordentoft, M. (2005). A randomised multi-centre trial of integrated versus standard treatment for patients with a first episode of psychotic illness. *British Medical Journal*, 331, 602-605.

Phillips, L.J., Yung, A.R. & McGorry, P.D. (2000). Identification of young people at risk of psychosis: validation of Personal Assessment and Crisis Evaluation Clinic intake criteria. *Australian and New Zealand Journal of Psychiatry*, 34 (suppl.), s164-s169.

Pickup, G. (2006). Theory of mind and its relation to schizotypy. *Cognitive Neuropsychiatry*, 11, 177-192.

Pickup, G. & Frith, C.D. (2001). Theory of mind impairments in schizophrenia: symptomatology, severity and specificity. *Psychological Medicine*, 31, 207-220.

Premack, D. & Woodruff, G. (1978). Does the chimpanzee have 'a theory of mind'? *Behavioural and Brain Sciences*, 4, 515-526.

Raine, A. (1991). The SPQ: a scale for the assessment of schizotypal personality based on DSM-III-R criteria. *Schizophrenia Bulletin*, 17, 55-64.

Raine, A., Sheard, C., Reynolds, G.P. & Lencz, T. (1992). Prefrontal structural and functional deficits associated with individual differences in schizotypal personality. *Schizophrenia Research*, 7, 237-247.

Randall, F., Corcoran, R., Day, J. & Bentall, R.P. (2003). Attention, theory of mind, and causal attributions in people with persecutory delusions: A preliminary investigation. *Cognitive Neuropsychiatry*, 8, 287-294.

Read, J. (1997). Child abuse and psychosis: a literature review and implications for professional practice. *Professional Psychology: Research and Practice*, 28, 448-456.

Read, J., van Os, J., Morrison, A.P. & Ross, C.A. (2005). Childhood trauma, psychosis and schizophrenia: a literature review with theoretical and clinical implications. *Acta Psychiatrica Scandinavica*, 112, 330-350.

Rowe, A.D., Bullock, P.R., Polkey, C.E. & Morris, R.G. (2001). 'Theory of mind' impairments and their relationship to executive functioning following frontal lobe excision. *Brain*, 124, 600-616.

Schiffman, J., LaBrie, J., Carter, J., Tyrone, C., Schulsinger, F., Parnas J. & Mednick S. (2002). Perception of parent-child relationships in high-risk families, and adult schizophrenia outcome of offspring. *Journal of Psychiatric Research*, 36, 41-47.

Schiffman, J., Lam, C.W., Jiwatram, T., Ekstrom, M., Sorensen, H., & Mednick, S. (2004a). Perspective-taking deficits in people with schizophrenia spectrum disorders: A prospective investigation. *Psychological Medicine*, 34, 1581-1586.



Schiffman, J., Walker, E., Ekstrom, M., Schulsinger, F., Sorensen, H. & Mednick, S. (2004b). Childhood videotaped social and neuromotor precursors of schizophrenia: a prospective investigation. *American Journal of psychiatry*, *161*, 2021-2027.

Scholl, B.J. & Leslie, A. (1999). Modularity, development and 'theory of mind.' *Mind and Language*, *14*, 131-153.

Sellen, J.L, Oaksford, M. & Gray, N.S. (2005). Schizotypy and conditional reasoning. *Schizophrenia Bulletin*, *31*, 105-116.

Semple, D.M., McIntosh, A.M. & Lawrie, S.M. (2005). Cannabis as a risk factor for psychosis: systematic review. *Journal of Psychopharmacology*, *19*, 187-194.

Shaw, K., McFarlane, A.C., Bookless, C. & Air, T. (2002). The aetiology of post-psychotic posttraumatic stress disorder following a psychotic episode. *Journal of Traumatic Stress*, *15*, 39-47.

Stone, V.E., Baron-Cohen, S., Calder, A., Keane, J. & Young, A. (2003). Acquired theory of mind impairments in individuals with bilateral amygdala lesions. *Neuropsychologia*, *41*, 209-220.

Stuss, D.T., Gallup, G.G. Jr., & Alexander, M.P. (2001). The frontal lobes are necessary for 'theory of mind.' *Brain*, *124*, 270-286.

van Os, J., Krabbendam, L., Myin-Germeys, I. & Delespaul, P. (2005). The schizophrenia envirome. *Current Opinion in Psychiatry*, *18*, 141-145.

- Ventura, J., Nuechterlein, K.H., Lukoff, D. & Hardesty, J.P. (1989). A prospective study of stressful life events and schizophrenic relapse. *Journal of Abnormal Psychology, 98*, 407-411.
- Walker, E., Kestler, L., Bollini, A. & Hochman, K.M. (2004). Schizophrenia: Etiology and Course. *Annual Review of Psychology, 55*, 401-430.
- Warner, R. (2005). Problems with early and very early intervention in psychosis. *British Journal of Psychiatry, 187* (suppl. 48), s104-s107.
- Whitfield, C., Dube, S., Felitti, V., Anda, R. (2005). Adverse childhood experiences and hallucinations. *Child Abuse and Neglect, 29*, 797-810.
- Wimmer, H. & Perner, J. (1983). Beliefs about beliefs: Representation and constraining function of wrong beliefs in young children's understanding of deception. *Cognition, 13*, 103-128.
- Wing, J.K. & Gould, J. (1979). Severe impairments of social interaction and associated abnormalities in children: epidemiology and classification. *Journal of autism and Developmental Disorders, 9*, 11-79.
- Wykes, T., Hamid, S. & Wagstaff, K. (2001). Theory of mind and executive functions in the non-psychotic siblings of patients with schizophrenia. [Abstract]. *Schizophrenia Research, 49* (suppl 1), 148.
- Young, E. & Mason, O. (2006). *Is there really a theory of mind deficit in psychosis proneness?* Manuscript submitted for publication.

Young, E. & Mason, O. (in press). Psychosis-proneness and socially relevant reasoning. *Psychiatry Research*.

Yung, A.R., Phillips, L.J., Yuen, H.P., McGorry, P.D. (2004). Risk factors for psychosis in an ultra high-risk group: psychopathology and clinical features. *Schizophrenia Research*, 67, 131-142.

**Empirical Paper:**  
**Theory of Mind and its Relation to**  
**Schizotypy**

## THEORY OF MIND AND ITS RELATION TO SCHIZOTYPY

### ABSTRACT

*There is good evidence to support Frith's (1992) model of impaired theory of mind (ToM) in those diagnosed with schizophrenia. However, it is unclear whether abnormal ToM constitutes a symptom of the psychotic state or a trait characteristic evident before illness manifests. This study was designed to replicate and extend previous findings of an association between ToM and psychosis-proneness. Sixty-two healthy volunteers completed a schizotypy questionnaire (the Oxford-Liverpool Inventory of Feelings and Experiences; O-LIFE), two ToM tasks (one verbal, one non-verbal), a measure of executive function, a test to estimate verbal and non-verbal IQ, and additional measures for which results are reported by Williams (unpublished thesis). No evidence was found for impaired ToM accuracy in high vs. low schizotypes on either ToM task. However, in the non-verbal task, high schizotypes performed less accurately than low schizotypes in a random condition ( $p=0.007$ ); they were more likely to 'read meaning in randomness' ( $p=0.002$ ) and to attribute agency to randomly moving shapes ( $p=0.046$ ). There was also a trend towards high schizotypes attributing more mental states in the non-verbal physical condition ( $p=0.077$ ). In the non-verbal task, 'reading meaning in randomness', attributing agency in the random condition and imputing mental states in the physical condition were associated with the 'Unusual Experiences' (UE) dimension of schizotypy ( $p=0.004$ ,  $p=0.046$ ,  $p=0.040$  respectively). This study therefore provides evidence for a tendency to 'over-mentalize' associated with positive schizotypy in particular.*

'Theory of mind' refers to the ability to represent the mental states (thoughts, intentions and beliefs) of others and to use these representations to predict and understand behaviours (Premack & Woodruff, 1978). Frith, Morton and Leslie (1991) term this ability as 'mentalizing'.

### **Frith's (1992) Cognitive Model of Schizophrenia**

Frith (1992) proposed that a range of symptoms characteristic of schizophrenia could be explained in terms of impaired ToM. In Frith's (1992) account, compromised ability to represent one's own goals underpins disorders of 'willed action' (e.g. negative and disorganized symptoms of schizophrenia), impaired ability to represent one's own intentions results in disorders of self-monitoring (e.g. delusions of control and voice-commenting hallucinations and thought insertion) and inability to represent the intentions of others leads to symptoms such as delusions of reference, paranoid delusions and third person hallucinations. This account predicts that patients with schizophrenia showing 'behavioural signs' will be most impaired on tests of ToM, while those with only paranoid symptoms will perform better but will still be impaired relative to controls (Pickup & Frith, 2001).

## **Research into Theory of Mind and Schizophrenia**

Recent reviews of the literature conclude that there is good empirical evidence that ToM is impaired in people with schizophrenia relative to healthy controls (Brüne, 2005; Harrington, Siegert & McClure, 2005). However, a number of more specific questions remain unanswered.

There is inconsistency across studies employing different ToM paradigms regarding which particular symptoms or symptom clusters are associated with mentalizing impairment. Studies addressing this question have employed a wide range of ToM measures and there has been little systematic investigation of relationships between them. The nature of the ToM deficit is also unclear. Most tasks assess only the presence or absence of ToM abilities and do not facilitate identification of other differences in mentalizing. It may be that some symptoms of schizophrenia at least are associated with a tendency to 'over-mentalize' (i.e. to infer mental states when none are obviously suggested; Abu-Akel, 1999; Abu-Akel & Bailey, 2000; Blakemore, Sarfati, Bazin & Decety, 2003; Frith, 2004) and there is a need to further investigate this possibility. Another area of controversy relates to whether mentalizing impairment is symptomatic of the psychotic state or a trait marker of vulnerability evident before psychosis manifests.

## **Vulnerability Research**

There is some indication from longitudinal and cross-sectional relative studies that an abnormality in social functioning generally, and mentalizing specifically, may be evident as a trait characteristic in those vulnerable to developing schizophrenia (Done, Crow, Johnstone & Sacker, 1994; Schiffman et al., 2004; Wykes, Hamid & Wagstaff, 2001; Janssen, Krabbendam, Jolles & van Os, 2003; Docherty, Rhinewine, Labhart & Gordinier, 1998). However, not all studies have found supportive evidence (Kelemen, Kéri, Must, Benedek & Janka, 2004).

An alternative approach to investigating vulnerability to psychosis draws on continuity models of psychosis proneness and the concept of 'schizotypy'. This approach has been used by previous researchers to evaluate Frith's (1992) model, avoiding the possible confounding effects of factors associated with psychiatric illness (e.g. deficits in motivation or attention, anti-psychotic medication) on ToM performance.

## **The Schizotypy Paradigm**

Schizotypy refers to personality traits in the normal population that are described by psychosis-related behaviours and experiences and of which the clinical symptoms of psychosis are viewed as extreme expressions. Such traits are argued to predispose a person towards psychotic breakdown when adverse physical, social, or environmental



triggers are encountered. 'Fully-dimensional' models of vulnerability to psychosis argue for continuity in these traits throughout the population.

Support for the fully-dimensional approach comes from evidence for psychotic-like experiences widely present in the normal population (Johns et al., 2004) and from studies employing questionnaire measures derived from the approach (e.g. Oxford Liverpool Inventory of Feelings and Experiences (O-LIFE: Mason, Claridge & Jackson, 1995); Schizotypal Personality Questionnaire (SPQ: Raine, 1991)). The distribution, factor structure, heritability and predictive power of scores on these scales (Chapman, Chapman, Kwapil, Eckblad & Zinser, 1994; Claridge et al., 1996; Claridge & Hewitt, 1987; Johns & van Os, 2001; Kendler et al., 1991; Kendler & Hewitt, 1992) provide supportive evidence for schizophrenia-like traits in the normal population predisposing individuals towards psychotic breakdown when stressors are encountered (see Claridge, 1994 for review).

### **Studies of Theory of Mind and Schizotypy**

Experimental studies looking at the relationship between ToM task performance and schizotypy have produced mixed findings. A series of experiments by Langdon and Coltheart found associations between high schizotypy scores and poorer performance on ToM conditions of a picture-sequencing task (Langdon & Coltheart, 1999) and on a perspective-taking task (Langdon & Coltheart, 2001). The former study comprised two experiments with inconsistent findings with respect to which schizotypal traits were

associated with poorer ToM performance. Traits analogous to negative symptoms of schizophrenia were associated with poorer performance in one experiment and those analogous to positive symptoms were associated with poorer performance in the other. Langdon and Coltheart (2001) found a non-significant tendency towards an association between poorer ability to judge the appearance of an array from an alternative viewing perspective and high scores on sub-scales measuring cognitive-perceptual and disorganised schizotypal traits.

There is also evidence for differences in language usage and understanding associated with total schizotypy scores (Docherty et al., 1998; Langdon & Coltheart, 2004). Docherty et al.'s (1998) study found that, amongst the healthy parents of children with schizophrenia, those scoring highly on the Schedule of Schizotypal Personalities (Baron, Asnis & Gruen, 1981) showed significantly poorer use of referential terms in their expressive language than did low scorers, perhaps indicating less accurate representation of the mental states of interlocutors amongst high schizotypes. In Langdon and Coltheart's (2004) study, high-schizotypal adults were impaired relative to low schizotypal adults at identifying appropriate ironical speech acts. As consideration of the mental representations of the speaker is required to understand why an ironical statement, which obviously contradicts the conversational context, might be appropriate, these findings can be taken to support an association between schizotypy and abnormalities in mentalizing.

In contrast to the above findings, three studies have found no evidence for an association between total schizotypy score and poorer performance on mentalizing tasks (Lippett,

2004; Pickup, 2006; Young & Mason, 2006). Young and Mason (2006) found no difference in the performance of those high or low in either total schizotypy or in any of its dimensions on any of three mentalizing tasks: the 'Picture-Sequencing Task' used by Langdon and Coltheart (1999), the 'Faux Pas Task' (Gregory et al., 2002) and the 'Eyes Test' (Baron-Cohen, Wheelwright, Hill, Raste & Plumb, 2001). The sample size in this study was larger than that in Langdon and Coltheart's (1999, 2001) experiments making it unlikely that null findings were due to a lack of power alone.

In Pickup's (2006) study, mentalizing ability was measured using Fletcher et al.'s (1995) 'Stories Task', which requires participants to answer questions about two categories of stories: those requiring consideration of mental states for events to be understood and those requiring consideration of physical causality for events to be understood. Although scores on the ToM condition of this task were not associated with mentalizing ability, they were predicted more specifically by schizotypal traits associated with the positive symptoms of schizophrenia. Pickup suggests that the effect size in his study may have been greater had the stories been read aloud to participants so that scenarios had to be processed 'on-line'. This would constitute a more sensitive test of ToM than the paradigm he used, which permitted participants to take as much time as they needed to read and understand the stories, and may have allowed for an association between overall schizotypy score and ToM performance to be detected.

Lippett (2004) employed the 'Triangles Task' (Abell, Happé & Frith, 2000) in which participants are asked to describe what is happening in animations in which geometric shapes move in formations designed to elicit particular attributions (either of actions or

of interactions or of mental states). The performance of high and low schizotypes was comparable in the 'ToM' and 'goal-directed' conditions, where the movement of the shapes was designed to elicit mental state and interaction explanations respectively. However, in the 'random' condition, high schizotypes were significantly less accurate than low schizotypes. Poorer performance on this condition was associated with high scores on the Cognitive Perceptual factor of the SPQ (which corresponds to the positive symptoms of schizophrenia) and Lippett (2004) reports that the responses of high schizotypes tended to refer to some kind of purposeful interaction, and were suggestive of a "tendency to impute social meaning when there is none".

This interesting finding (that high schizotypes, and particularly those scoring highly on traits analogous to positive symptoms of schizophrenia, tend to infer mental states more readily than do low schizotypes) requires further investigation. It relates to the suggestion of Abu-Akel (1999) that the positive symptoms of schizophrenia may be associated with a tendency to 'hyper-mentalize' (to over-attribute mental states). In contrast to Pickup (2006), Lippett (2004) did not control for either executive function, which has been shown to vary with schizotypy (e.g. Raine, Sheard, Reynolds & Lencz, 1992) or general intellectual ability (IQ).

Taken together the literature pertaining to the relationship between ToM and schizotypy indicates that abnormalities in mentalizing can be detected in high as compared to low schizotypes; however, these differences are not apparent on all tasks. In parallel to the evidence from the schizophrenia literature, there is inconsistency in findings regarding relationships between particular symptom-related traits and mentalizing abilities. Again,

a range of ToM measures have been employed with little systematic comparison between them. The majority of these tasks focus on identifying the presence or absence of mentalizing abilities and may thus be too crude to fully explore the nature of the differences in how mental states are attributed and understood. Lippett's (2004) study is evidence that a deficit approach may be too simplistic.

There is clearly a need for further studies investigating the possibility of an abnormality in mentalizing style associated with vulnerability to psychosis. These studies should include multiple measures of ToM, with formats as ecologically valid as possible, and designed to tap a range of mentalizing skills, both verbal and non-verbal. They must also allow for aspects of difference in mentalizing style beyond a simple deficit to be identified, in particular the tendency to over-mentalize. According to Frith (2004) over-mentalizing can be clearly demonstrated only by showing that particular individuals attribute mental states in situations agreed by others to constitute purely mechanical occurrences.

### **Aims and Hypotheses**

The current study aimed to explore differences in mentalizing associated with schizotypy using two tasks, one non-verbal and one verbal, in a between groups design. The Triangles Task employed by Lippett (2004) and the Stories Task used in Pickup's (2006) study constituted non-verbal and verbal measures respectively. The Stories Task was extended to include a 'random stories' condition, to parallel the random condition in

the Triangles Task. In line with Pickup's (2006) suggestions, stories were read aloud to participants, rather than being presented visually, in order to obtain a more on-line, and hence more ecologically valid and perhaps more sensitive, measure of ToM. As an extension to Lippett's (2004) study, IQ and executive function were controlled for.

In accordance with Frith's (1992) theoretical predictions, high schizotypes were expected to perform significantly less accurately than low schizotypes in the ToM condition of both the non-verbal (triangles) and the verbal (stories) task.

In line with Lippett's (2004) findings, the high schizotypy group were also expected to perform less accurately than the low schizotypy group in the random condition of each task. They were predicted to show a greater tendency to 'read meaning in randomness' and, in line with Abu-Akel's (1999) and Frith's (2004) ideas, to 'over-mentalize', and give more 'social cognition' responses in the random conditions of both tasks and in the physical/goal-directed conditions, which can be fully described in mechanical terms. The tendency to read meaning in randomness and impute social cognition in physical and random conditions was expected to be particularly associated with the UE dimension of schizotypy, which relates to the positive symptoms of schizophrenia. This would be consistent with Abu-Akel's (1999) suggestion that these symptoms are associated with 'hyper-mentalizing' in patients with schizophrenia, Frith's (2004) proposal that paranoid symptoms may be associated with over-mentalizing and Lippett's (2004) finding of an association between scores on the Cognitive Perceptual factor of the SPQ and less accurate performance on the random condition of the Triangles Task.

This study also allowed for some investigation of the extent to which different ToM paradigms tap the same underlying construct. In line with the general assumption that this is the case, it was predicted that ToM accuracy scores on the Stories and Triangles Tasks would be significantly associated with each other. It was also predicted that accuracy scores in the random conditions of the two task would be correlated, and that the tendencies to read meaning in randomness and to impute social cognition in random and physical conditions of one task would be associated with the same tendencies in the other.

## **METHOD**

### **Participants**

Participants were recruited through posters displayed around University College London and by word of mouth through associates of the researcher. General inclusion criteria included age between 18 and 50 years, English as a first language and no history of serious mental illness or head injury. In order to ensure that a broad range of schizotypy was represented within the participant group, the sampling method employed by Pickup (2006) was utilised. This involved using the Schizotypal Personality Scale (STA) of the Claridge and Broks (1984) Schizotypy Questionnaire (STQ), as a screen to select participants. Incorporated into this questionnaire was the 12 item 'Lie' scale from the Short Form of the Eysenck Personality Questionnaire – Revised (EPQ-R; Eysenck & Eysenck, 1991). These items assess the respondent's tendency to answer untruthfully in

a socially desirable way. Those scoring more than one standard deviation above the population mean for their age-group and sex on the 'lie scale' (Eysenck & Eysenck, 1996) were excluded from further participation on the rationale that their responses to other questionnaire items were unreliable. Three respondents were excluded from the study on the basis of their scores on this social desirability index. Respondents were then selected on the basis of their STA scores in an attempt to recruit roughly equal numbers of 'high', 'low' and 'medium' schizotypes. Medium schizotypes were those scoring within one standard deviation of the population mean quoted by Claridge and Broks (1984) while high schizotypes scored at least one standard deviation above this mean and low schizotypes scored at least one standard deviation below this mean.

Previous research has demonstrated that significant group differences in ToM between high and low schizotypes can be detected with a total sample of 36 participants (Langdon & Coltheart, 2004) and group differences in the tendency to over-mentalize can be obtained with a sample of 40 (Lippett, 2004). The final sample in this study consisted of 62 participants in total, 17 'low schizotypes', 22 'medium schizotypes' and 23 'high schizotypes'.



## **Ethics**

Ethical approval to undertake this study was obtained from the University College London ethics committee on non-NHS human research. All participants were assured that any information they gave would remain confidential and all provided written, informed consent. Following the experiment, participants were given the opportunity to discuss the procedure and whether they had found any aspect of it distressing. In the event, no participants reported any distress. Copies of the information sheet provided to participants, the consent form they each signed and the letter granting the study ethical approval are shown in Appendices 1 and 2.

## **Procedure**

Participants were administered the measures described below in the order listed (although the order in which the two questionnaires were completed was not specified). Testing took place on one occasion, in a quiet room, and the session lasted for approximately an hour and a quarter. Participants received £10 as reimbursement for their time and travel. Copies of the questionnaires and the Stories Task, and examples of scoring criteria for experimental measures are given in Appendix 3. Data collection was carried out by myself and one other researcher, who was collecting data for the purpose of a study comparing the performance of high and low schizotypes on a further computer animation task. Decisions regarding the design of the study were made jointly by my co-researcher and myself.

## Measures

### 1. The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE)

The O-LIFE is a self-report measure of schizotypy devised by Mason, Claridge and Jackson (1995). It is based on the four schizotypy factors found by Claridge et al. (1996) and reflecting this, its four scales are labelled 'Unusual Experiences' (UE), 'Cognitive Disorganisation' (CD), 'Impulsive Non-conformity' (IN) and 'Introvertive Anhedonia' (IA). The questionnaire comprises 24 to 30 questions on each of these scales. The items are based on an extensive study of 'schizotypal' traits, which involved factor analysis of fifteen psychosis-proneness scales in over 1000 subjects (Claridge et al., 1996). The scale was constructed with a focus on trait rather than symptom features of psychosis and is in this way argued to be well suited to addressing issues such as risk for psychosis in non-clinical populations (Mason & Claridge, 2006). Mason et al. (1995) report high internal consistency for each of the scales (for UE  $\alpha = 0.89$ ; for CD  $\alpha = 0.87$ ; for IA  $\alpha = 0.82$ ; and for IN  $\alpha = 0.77$ .) These results have since been confirmed by Rawlings and Freeman (1997: 0.77, 0.81, 0.85 and 0.72). Test-retest reliability has also been found to be high ( $>0.70$ ) for all four scales (Burch, Steel & Hemsley, 1988) and Mason and Claridge (2006) quote studies across many research domains in which the construct validity of the scale as a measure of schizotypal traits has been clearly established.

Questionnaires were scored and raw scores standardised using Mason and Claridge's (2006) population norms, derived from a sample of 1926 participants. This was

necessary because schizotypy is known to vary with sex and age (e.g. Claridge & Hewitt, 1987).

## **2. The Stories Task**

The Stories Task used in Pickup's study comprises 16 passages developed by Fletcher et al. (1995) for use with normal adults. There are eight 'ToM' and eight 'physical' stories and each is followed by a question. The ToM stories were originally designed by Happé (1994) to test ToM in high-functioning autistic children. They describe scenarios including double bluff, white lie and persuasion. Participants must infer the mental state of a story character in order to answer the question correctly. Happé (1994) found these stories to discriminate between autistic participants who passed standard false-belief tasks and non-autistic controls. The physical stories were designed by Fletcher et al. (1995) as a control for ToM stories for use in a functional imaging study of ToM; they were matched for difficulty to ToM stories in a non-clinical adult sample. As in the ToM condition, the stories involve people, and participants are required to integrate story information to infer an answer. However, in order to answer physical story questions correctly, no consideration of mental states is required. Rather an inference must be made about physical causation (e.g. to give a reason for taking an x-ray after a fall). Fletcher et al.'s stories have been used to identify superior ToM abilities in elderly individuals, and ToM impairments in those who have experienced a right hemisphere stroke (Happé, Brownell & Winner, 1999; Happé, Winner & Brownell, 1998).

An additional eight 'random stories' were developed for the purpose of this study. These were matched in length to the original stories; they were based around comparable themes and involved the same numbers of story characters. The passages describe a series of unrelated events and are followed by a question, for which no obvious answer can be inferred from the story. The random stories were piloted with six associates of the researcher. In this pilot trial, respondents gave a range of responses to each item.

In line with Pickup's suggestions, stories were read out loud to participants once only so that ToM could be assessed 'on-line'. All 24 passages and their accompanying questions were recorded onto audiotape, read by an associate of the researcher at an even pace. Participants were played one practice story and question, followed by the test stories and questions. The ToM, physical and random passages were presented in a pseudo-random order. Participants' responses were recorded onto audiotape for later transcription, and accuracy was scored using standard criteria (Fletcher et al., 1995). Responses were also categorised according to type ('random', 'physical' or 'mentalizing'). Scoring was carried out blind to the schizotypy score of the participant and a second rater, who was blind to the study hypotheses, scored a sub-set of 20 data sets. Agreement between raters was good for both accuracy (83%) and description type (90%).

### **3. The Wechsler Test of Adult Reading (WTAR<sup>UK</sup>)**

The WTAR<sup>UK</sup> (Wechsler, 2001) is a well-established test, which can be used to provide an estimate of verbal intelligence (VIQ) and performance intelligence (PIQ). It was

thought important to control for both VIQ and PIQ in the current study as the measures of ToM employed tap both verbal and non-verbal skills. The WTAR<sup>UK</sup> requires participants to read a list of 50 words that have atypical grapheme to phoneme translations. The test has been co-normed with the WAIS-III<sup>UK</sup> test of general intelligence, enabling effective prediction of full-scale IQ and its components, taking account of age and demographic data. VIQ and PIQ were calculated from the Wechsler (2001) normative data and conversion tables. Scores derived from these data have been shown to correlate well with WAIS-III<sup>UK</sup> measures of VIQ and PIQ (Wechsler, 2001:  $r=0.70$  and  $r=0.53$  respectively for the UK sample). The WTAR has been demonstrated to have good internal consistency, with coefficients ranging from 0.87-0.95 for different age groups in a UK sample. Test-retest reliability for different age groups has been shown to range from 0.90 to 0.94.

#### **4. The Triangles Task**

This task was originally developed by Castelli, Happé, Frith & Frith (2000) in an attempt to design a measure that selectively evoked mental state attributions without taxing other capacities such as executive functions and inhibitory control, and that tapped more on-line, ecologically valid ToM skills than standard false-belief tasks (perhaps the best established measure of ToM). It has been shown to be sensitive to ToM impairment amongst high-functioning children with autism, differentiating even those autistic children who pass false-belief tasks from non-clinical controls and those with general intellectual impairment (Abell et al., 2000).

The task comprises twelve, short, computer-presented animations showing one large, red and one small, blue triangle moving around the screen. There are three conditions: 'random', 'goal-directed' and 'ToM'. In the random animations, the triangles do not interact with each other and move about purposelessly. The goal-directed animations involve one triangle responding to the other's behaviour, there is no implication that either triangle is reading the other's 'mind' and the animations are likely to evoke direct descriptions of interaction (e.g. fighting or dancing). The 'ToM' sequences, by contrast, show one triangle reacting to the other's mental state (e.g. trying to persuade the other to let it free) and are designed to provoke explanations which refer to these mental states. For the purpose of this study, the 'goal-directed' condition will be referred to as the 'physical' condition.

Participants were first shown two practice items, one physical and one ToM, followed by the test animations, presented in a pseudo-random order. After each presentation, participants were asked to describe what they perceived to be happening in the animation.

Responses were recorded onto audiotape, transcribed, and scored according to the standard criteria (Abell et al., 2000). Descriptions were also categorised according to type ('random', 'interaction/goal-directed' or 'mentalizing'). Scoring was carried out blind to the schizotypy score of the participant. A second rater, who was blind to the study hypotheses, scored a sub-set of data sets. Agreement between raters was again good for both accuracy (85%) and response type (90%).

## **5. The Hayling Test**

This task, developed by Burgess and Shallice (1997), is a short sentence completion test measuring ability to generate and inhibit responses. The nature of responses on both the Triangles Task and the Stories Task might be expected to be affected by these aspects of executive function and the task was included in the study to enable their influence to be controlled for. The test is in two parts. In the first ('sensible completion') task participants are asked to provide a word to complete each of 15 sentences, which are read aloud by the tester. The second ('unconnected completion') task requires participants to give a word that does not fit at the end of each of 15 sentences. Participants are asked to respond as quickly as possible and response times are recorded. Raw scores for total response time on each subtest and total number of errors in the test as a whole (unconnected responses in the sensible completion task or connected sentence completions in the unconnected task) were recorded and converted to scaled scores using Burgess and Shallice's (1997) normative data. The scaled score for the task as a whole (a composite of standard scores for time taken on sensible completion and unconnected completion tasks and for errors on the latter task) was used in analyses as an overall measure of executive function. The test-retest reliability of this measure has been shown to be good ( $>0.70$ ), and those with frontal lobe injuries (which are associated with impairment in executive function) obtain significantly lower overall scaled scores than those with posterior lesions (Burgess & Shallice, 1997).

## **Data Analyses**

Participants were sub-grouped into high and low schizotypes using a median split of the O-LIFE total standard score. Scores on the Triangles and Stories Tasks could then be analysed in an independent group design. Regressions were also carried out using the whole sample to explore associations between scores on experimental measures and on O-LIFE sub-scales. Data was analysed using the computer package SPSS version 11.5. There was no missing data.



## **RESULTS**

### **Participants**

Of the 62 participants 29 (46.8%) were male and 33 (53.2%) were female. Participants' ages ranged from 18-42 years, with a mean age of 24.23 and a standard deviation of 4.62.

### **Questionnaire Measures**

Scores on the STA ranged from 0 to 36 with a mean (standard deviation) of 17.6 (9.57). Scores on the 'Lie Scale' items ranged from 0 to 5 with a mean (standard deviation) of 1.85 (1.54).

The mean and standard deviation of scores on the O-LIFE sub-scales are shown in Table 1. These compare well with the normative data for the scales, shown in Table 2, particularly in the 21-30 age group for which the current sample is largest. As would be predicted given the sampling method employed, the standard deviations of sub-scale scores in the current sample are slightly larger than those in the general population. When the sample as a whole is looked at, mean scores on three of the four sub-scales are slightly higher than those in Mason and Claridge's (2006) norms. This is likely to be due to the younger age range in the current sample. Mason and Claridge's (2006) norms indicate that scores on these three scales decrease with age, while those on the

'Introvertive Anhedonia' scale (on which the current sample scored slightly higher than the population norms) increase with age. A wide range of scores was represented on each sub-scale. Analysis of the skewness and kurtosis of O-LIFE sub-scale standard scores found all but IA (which was negatively skewed) to meet conditions for normality to be assumed. Total O-LIFE scores (calculated by summing sub-scale standard scores) were not significantly skewed or kurtotic.

### **Median Split Analysis**

Participants were sub-grouped into 31 low schizotypal and 31 high schizotypal subjects using a median split of the O-LIFE total standard score (median=1.02). There were 14 males and 17 females in the low schizotypy group and 15 males and 16 females in the high schizotypy group. A Chi-squared test showed no significant group difference in gender,  $\chi^2(1, N=62)=0.065, p=0.80$ . The mean (standard deviation) age was 24.13 (3.49) in the low schizotypy group and 24.32 (5.58) in the high schizotypy group. There was no significant group difference in age,  $t(60)=-0.16, p=0.87$ .

Table 1: Mean (standard deviation) scores on O-Life sub-scales

	Age under 22		Age 21-30		Age 31-40		Age 41-50	Total sample Age 18-42 (n=62)	Range
	Female (n=6)	Male (n=11)	Female (n=25)	Male (n=15)	Female (n=2)	Male (n=2)	Male (n=1)		
<b>O-LIFE sub-scale</b>									
<b>UE</b>	17.33 (8.87)	14.09 (7.85)	9.28 (8.25)	9.47 (7.51)	5.50 (0.71)	16.50 (3.54)	17.00 (0)	<b>11.19 (8.16)</b>	<b>0-29</b>
<b>CD</b>	16.67 (6.12)	13.18 (8.08)	12.84 (6.84)	11.80 (6.58)	13.00 (4.24)	16.50 (3.54)	17.00 (0)	<b>13.23 (6.74)</b>	<b>0-24</b>
<b>IA</b>	9.83 (8.47)	6.18 (4.40)	4.32 (3.88)	5.53 (4.97)	10.00 (9.90)	6.00 (1.41)	10.00 (0)	<b>5.81 (5.07)</b>	<b>0-20</b>
<b>IN</b>	12.50 (3.02)	10.91 (5.65)	9.40 (3.83)	11.07 (2.60)	8.00 (1.41)	13.00 (1.41)	9.00 (0)	<b>10.44 (3.85)</b>	<b>1-18</b>

Table 2: Normative data for O-Life sub-scales (Mean [standard deviation]; Mason & Claridge, 2006)

	Age under 22		Age 21-30		Age 31-40		Age 41-50	Total sample Age 17-85 (n=1926)
	Female (n=237)	Male (n=159)	Female (n=250)	Male (n=152)	Female (n=233)	Male (n=53)	Male (n=65)	
<b>O-LIFE sub-scale</b>								
<b>UE</b>	10.21 (6.40)	10.08 (6.16)	9.72 (6.55)	9.83 (6.36)	8.67 (6.22)	8.11 (5.94)	7.72 (5.88)	<b>8.82 (6.16)</b>
<b>CD</b>	12.68 (5.71)	11.96 (5.66)	11.74 (5.70)	11.05 (5.73)	10.55 (5.56)	9.68 (6.73)	9.66 (6.16)	<b>10.73 (5.87)</b>
<b>IA</b>	5.03 (4.02)	6.06 (3.97)	5.15 (3.85)	6.26 (4.97)	5.96 (4.00)	6.68 (5.25)	7.48 (4.73)	<b>6.38 (4.49)</b>
<b>IN</b>	9.27 (3.90)	9.80 (4.41)	8.86 (3.86)	10.26 (3.84)	7.62 (3.86)	8.48 (3.91)	7.94 (4.11)	<b>7.69 (4.12)</b>

## Control Tasks

Descriptive statistics for the verbal IQ, performance IQ and Hayling total scaled score for low and high schizotypy groups and for the sample as a whole are shown in Table 3 below.

Table 3: Means (standard deviations) of verbal IQ, performance IQ and Hayling scaled scores of high and low schizotypes

	Low schizotypes		High schizotypes		Total sample	
<b>Hayling</b>	6.58	(1.09)	6.29	(1.10)	6.44	(1.10)
<b>WTAR: VIQ</b>	110.81	(5.20)	108.94	(4.75)	109.87	(5.03)
<b>WTAR: PIQ</b>	111.39	(4.62)	109.71	(4.23)	110.55	(4.47)

The skewness and kurtosis of all these variables permitted approximation to normality. There were no significant differences between groups in verbal IQ,  $t(59)=1.53$ ,  $p=0.13$ ; performance IQ,  $t(59)=1.54$ ,  $p=0.13$ ; or executive function score,  $t(60)=1.04$ ,  $p=0.30$ . Although executive function (as measured by Hayling overall standard score) correlated significantly with total O-LIFE score and with O-LIFE CD standard score (see Appendix 4), none of the correlations between control variables (verbal IQ, performance IQ or executive function) and experimental variables were significant (see Appendix 5). Control measures were not therefore included in further analyses.

## **Experimental Measures**

Analysis was carried out on both the accuracy and the type of responses given by high and low schizotypes in the various conditions of the Stories and Triangles Tasks. Descriptive statistics for these scores are shown in Tables 4 and 5. Correlations between experimental variables are shown in Appendix 6.

### **1. Accuracy Scores**

Accuracy scores in the random conditions of the two tasks are not directly comparable to accuracy scores in the physical and ToM conditions. In the latter two conditions accuracy scores are measures of participants' ability to give correct meaningful interpretations of stimuli in response to a question. In the random conditions, by contrast, the stimuli are designed to provide no specific meaningful response to the question and accuracy scores reflect the extent to which participants infer meaning in the stimuli, with lower scores representing a greater tendency to see the items as non-random. Therefore, the physical condition in each task constitutes a control for the corresponding ToM condition but not for the random condition. For this reason, accuracy scores in the ToM and physical conditions of each task were compared in an analysis of variance while accuracy scores in the random conditions were analysed separately.

Table 4: Means (standard deviations) of accuracy and response type scores of high and low schizotypes on the Stories Task

	<b>Schizotypy group</b>		<b>Total sample</b>
	<b>Low</b>	<b>High</b>	
<b>Accuracy score:</b>			
ToM condition <sup>+</sup>	13.81 (1.68)	13.07 (1.55)	13.44 (1.65)
Physical condition <sup>+</sup>	11.94 (2.31)	11.43 (2.91)	11.69 (2.61)
Random condition	6.06 (3.45)	5.94 (2.87)	6.00 (3.15)
<b>Response type:</b>			
Reading meaning in randomness <sup>+</sup>	13.66 (7.45)	13.77 (6.77)	13.42 (7.05)
Mental state attributions in random condition	3.00 (1.79)	3.06 (1.57)	3.03 (1.67)
Mental state attributions in physical condition	1.58 (1.48)	1.77 (2.03)	1.68 (1.76)

<sup>+</sup> One outlier removed

Table 5: Means (standard deviations) of accuracy and response type scores of high and low schizotypes on the Triangles Task

	<b>Schizotypy group</b>		<b>Total sample</b>
	<b>Low</b>	<b>High</b>	
<b>Accuracy score:</b>			
ToM condition	5.55 (1.52)	5.42 (1.43)	5.48 (1.46)
Physical condition	6.90 (0.87)	6.58 (1.20)	6.74 (1.05)
Random condition	6.74 (2.16)	5.77 (1.93)	6.26 (2.09)
<b>Nature of response:</b>			
Reading meaning in randomness <sup>+</sup>	2.35 (3.79)	5.50 (4.80)	3.90 (4.57)
Agency attribution in random condition	1.03 (1.52)	1.55 (1.23)	1.29 (1.40)
Mental states attribution in physical condition	0.26 (0.77)	0.58 (0.99)	0.42 (0.90)

<sup>+</sup> One outlier removed

### ***Stories Task: ToM and physical conditions***

There was one outlying accuracy score (standard score more than three standard deviations from the mean) in the ToM condition of the Stories Task: a single high schizotypy with a particularly low ToM accuracy score. This outlier was removed from the analysis. Subsequent analysis of the skewness and kurtosis statistics of each of the variables found them to meet conditions for normality to be assumed in both high and low schizotypy groups.

As can be seen from Table 4, there was little difference between the performance of the two groups on either the ToM or the physical condition, although both high and low schizotypes performed less accurately on the physical than on the ToM task. A two-way mixed ANOVA with two levels on the between subject factor of subject group (low and high schizotypy) and two levels on the within subject factor of story type (ToM and physical) found the main effect of story type to be significant,  $F(1,59)=22.99$ ,  $p<0.001$ , indicating that the sample as a whole scored lower in the physical than in the ToM condition. Contrary to predictions, there was no evidence that high schizotypes were specifically impaired on the ToM condition as the interaction between story type and group was non-significant,  $F(1,59)=0.11$ ,  $p=0.75$ . The main effect of the between subjects factor (schizotypy group) was also non-significant,  $F(1,59)=2.17$ ,  $p=0.13$ .

### ***Stories Task: Random condition***

There were no outliers in this condition and, based on analysis of skewness and kurtosis statistics, both high and low schizotypy groups met conditions for normality to be



assumed. Again, contrary to hypotheses, there was no significant group difference in accuracy score in the random stories condition,  $t(60)=0.16$ ,  $p=0.87$ .

### ***Triangles Task: ToM and physical conditions***

There were no outlying accuracy scores in the ToM or the physical condition of the Triangles Task and analysis of the skewness and kurtosis of the distributions of these scores revealed that conditions were met for normality to be assumed. The descriptive data (Table 5) indicates little difference between the accuracy scores of high and low schizotypes on either condition.

A two-way mixed ANOVA with two levels on the between subject factor of subject group (low versus high schizotypy) and two levels on the within subject factor of story type (ToM and physical) revealed a significant main effect of condition,  $F(1,60)=40.52$ ,  $p<0.001$ , suggesting that the sample as a whole performed less accurately in the ToM condition than in the physical condition. Contrary to predictions, there was no significant interaction between condition and group,  $F(1,60)=0.24$ ,  $p=0.63$ , and hence no evidence that the high schizotypy group were specifically impaired, relative to the low schizotypy group, in the ToM condition. The main effect of the between subjects factor (schizotypy group) was not significant,  $F(1,60)=0.76$ ,  $p=0.39$ .

### ***Triangles Task: Random condition***

The low schizotypy group but not the high schizotypy group performed at ceiling in the random triangles condition. A non-parametric comparison revealed that, in line with predictions, there was a significant group difference between high and low schizotypy

groups in accuracy scores on this condition,  $U=298.00$  ( $z=-2.69$ ),  $p=0.007$ , with greater scores in the low schizotypy group than in the high schizotypy group. The accuracy scores of high and low schizotypes in the random condition of the Triangles Task are illustrated in Figure 1.

## **2. Response types**

### **i) Reading meaning in randomness**

A “reading meaning in randomness” variable was created by summing the number of connections and elaborations given in responses to random condition items for each task.

#### ***Stories Task***

There was one outlying reading meaning in randomness score in the Stories Task (a high schizotype with an unusually high score). After removing this outlier, analysis of skewness and kurtosis found the variable to meet conditions for normality to be assumed. A t-test was performed and no significant difference was found in reading meaning in randomness scores between high and low schizotypes,  $t(59)=-0.059$ ,  $p=0.95$ .

A regression was performed to investigate whether reading meaning in randomness score in the Stories Task was predicted by any of the four dimensions of schizotypy derived from the O-LIFE questionnaire. The dependent variables were standardized scores on each of the four sub-scales of the O-LIFE (the IA variable was square root

transformed to meet conditions for normality to be assumed) and the independent variable was reading meaning in randomness. One outlier was removed. All dependent variables were entered simultaneously. Overall this model did not significantly predict variance in reading meaning in randomness,  $F(4,56)=0.098$ ,  $p=0.983$ . Adjusted  $R^2=-0.064$ . As can be seen in Table 6 below, none of the dimensions of the O-LIFE independently predicted reading meaning in randomness on this task.

Table 6: Associations between O-LIFE sub-scale standard scores and reading meaning in randomness scores on the Stories Task

<b>O-LIFE sub-scale</b>	<b>Beta</b>	<b>t</b>	<b>P</b>
Unusual Experiences	0.090	-0.464	0.645
Cognitive Disorganisation	-0.047	-0.232	0.817
Introvertive Anhedonia	-0.026	-0.153	0.879
Impulsive Non-conformity	-0.079	-0.423	0.674

### ***Triangles Task***

After removing one outlier (a high schizotypy who showed an unusually high tendency to make connections and elaborate) and transforming the variable using a square root transformation, analysis of skewness and kurtosis statistics indicated that the reading meaning in randomness variable met conditions for normality in both high and low schizotypy groups. A t-test comparing the means on the transformed variable found high schizotypes to be significantly more likely to read meaning into random items than low schizotypes,  $t(59)=-3.28$ ,  $p=0.002$ . The reading meaning in randomness scores of high and low schizotypes in the Triangles Task are illustrated in Figure 2.

A regression was performed to investigate whether any of the four dimensions of schizotypy (measured by the standardized score on the O-LIFE) independently predicted reading meaning in randomness (again the variable was square root transformed and one outlier was removed, such that it met conditions for normality to be assumed). All four O-LIFE dimension scores were entered simultaneously (again with the IA variable square root transformed to meet conditions for normality). This model accounted for 16.8% of the variance in reading meaning into randomness,  $F(4,56)=4.027$ ,  $p=0.006$ . Adjusted  $R^2=0.168$ . As can be seen in Table 7 below, only UE was a significant independent predictor of reading meaning in randomness in the Triangles Task.

Table 7: Associations between O-LIFE sub-scale standard scores and reading meaning in randomness scores on the Triangles Task

<b>O-LIFE sub-scale</b>	<b>Beta</b>	<b>T</b>	<b>P</b>
Unusual Experiences	0.475	2.974	0.004**
Cognitive Disorganisation	-0.019	-0.108	0.915
Introvertive Anhedonia	0.019	0.126	0.901
Impulsive Non-conformity	0.004	0.023	0.981

\*\* Regression coefficient significant at the 0.01 level.

## **ii) Imputing 'social cognition'**

In the Triangles Task responses were classified as 'mentalizing', 'interaction/goal-directed', or 'random' while in the Stories Task they were classified as 'mentalizing', 'physical' or 'random'. In line with the hypothesis that high schizotypes tend to impute mental states more readily than low schizotypes in conditions where no mental state is obviously implied, the level of mentalizing in responses of both groups to random and physical items was analysed. Correlations were also performed to investigate the extent to which mentalizing was associated with UE score in random and physical conditions of each task.

### ***Stories Task: Random condition***

In the Stories Task, there was no significant group difference in tendency to impute mental states in the random condition,  $t(60) = -1.51, p = 0.88$ . A Pearson correlation revealed no significant association between UE standard score and tendency to impute mental states in the random stories condition,  $r = 0.152, N = 62, p = 0.237$ .

### ***Stories Task: Physical condition***

The number of mental state responses in the physical condition of the Stories Task was negatively skewed in both high and low schizotypy groups. A square root transformation was performed after which analysis of skewness and kurtosis statistics indicated that the variable met conditions for normality to be assumed. A t-test found no significant difference between groups in the tendency to give mental state responses in physical conditions,  $t(60) = -0.12, p = 0.90$ . There was no significant correlation between

UE score and the number of mental state responses given in the physical condition,  $r=-0.061$ ,  $N=62$ ,  $p=0.64$ .

### ***Triangles Task: Random condition***

Very few participants ( $n=10$ ) made mentalizing attributions in the random condition of the Triangles Task. However, interaction/goal-directed attributions entail an implicit consideration of social cognition and an attribution of agency to the object. For this reason 'mentalizing' and 'interaction/goal-directed' responses were combined into a single 'agency' variable.

'Agency' scores in the low schizotypy group but not the high schizotypy group were at floor. A non-parametric test was carried out. This revealed that high schizotypes were significantly more likely than the low schizotypes to impute agency to the randomly moving triangles,  $U=345.00$ ,  $z=-2.00$ ,  $p=0.046$ . Figure 3 illustrates the number of agency attributions made by high and low schizotypes in the random condition of the Triangles Task. Agency scores in the random condition were significantly correlated with UE scores,  $\rho=0.365$ ,  $N=62$ ,  $p=0.004$ .

### ***Triangles Task: Physical condition***

The number of mental state responses given in the physical condition was close to floor in both high and low schizotypy groups and the variable remained negatively skewed after a square root transformation was performed. A non-parametric test was therefore carried out. High schizotypes tended to give more mental state attribution responses when the animation depicted a purely physical interaction than did low schizotypes; this

difference reached trend levels of significance,  $U=384.50$ ,  $z=-1.77$ ,  $p=0.077$ . Figure 4 shows the number of mental state responses given by high and low schizotypes in the physical triangles condition. There was a significant correlation between UE scores and number of mental state responses given in the physical condition,  $\rho=0.261$ ,  $N=62$ ,  $p=0.04$ .

Figures 1-4: Graphs to illustrate significant group differences

Figure 1: Accuracy scores of high and low schizotypes in random condition of Triangles Task

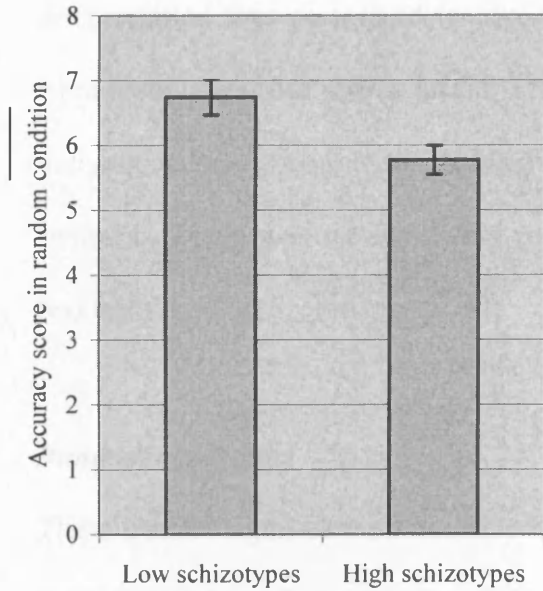
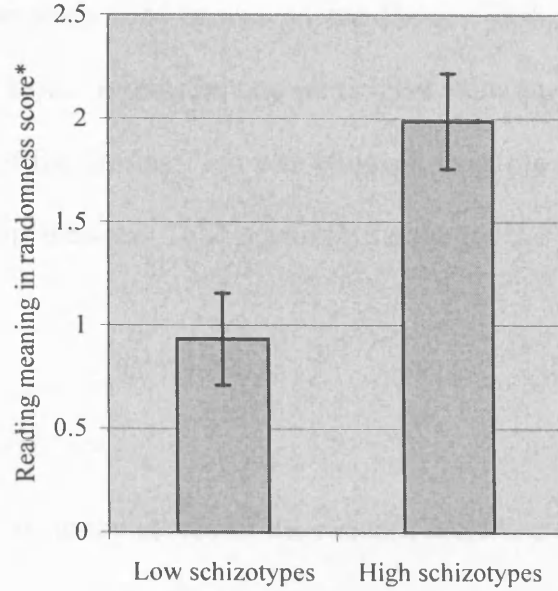


Figure 2: Reading meaning in randomness scores of high and low schizotypes in Triangles Task



\* Variable square root transformed

Figure 3: Agency responses of high and low schizotypes in random condition of Triangles Task

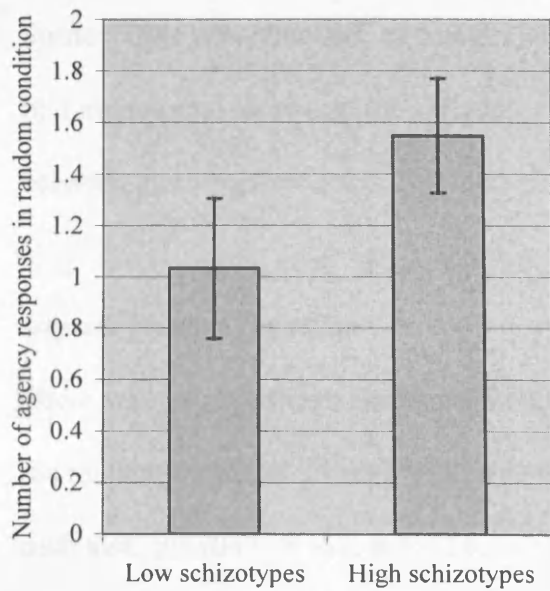
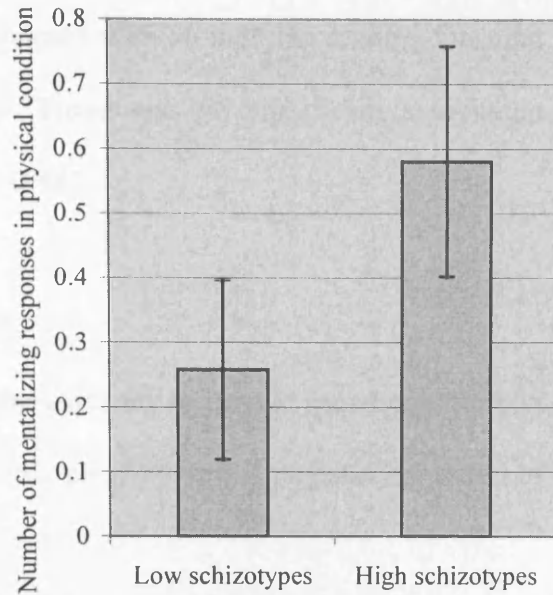


Figure 4: Mental state responses of high and low schizotypes in physical condition of Triangles Task





### **3. Comparison of tasks**

#### ***ToM conditions***

A correlation was performed to investigate whether ToM scores on the Stories Task were associated with scores on the Triangles Task. Again the one participant with an outlying accuracy score in the ToM condition of the Stories Task was removed from the analysis. There was no significant relationship between ToM accuracy scores on the two tasks,  $r=-0.035$ ,  $N=61$ ,  $p=0.791$ .

#### ***Random conditions***

There was no significant relationship between accuracy scores in the random condition in the two tasks,  $\rho=0.10$ ,  $N=62$ ,  $p=0.43$ .

#### ***Reading meaning in randomness***

The one participant with an outlying reading meaning in randomness score on the Stories Task was removed, as was the one participant with an outlying reading meaning in randomness score on the Triangles Task. There was no significant association between these two variables,  $r=0.091$ ,  $N=60$ ,  $p=0.487$ .

#### ***Imputing social cognition***

There was no significant association between the tendency to impute social cognition in the random condition of each task,  $\rho=0.067$ ,  $N=62$ ,  $p=0.604$ , or the physical condition of each task,  $\rho=0.047$ ,  $N=62$ ,  $p=0.716$ .

## DISCUSSION

In the light of inconclusive evidence regarding atypical mentalizing as a marker of risk for psychosis, the current study was designed to explore the relationship between ToM and schizotypy using both non-verbal and auditory-verbal paradigms. In line with Frith's (1992) theory, it was predicted that high schizotypes would perform less accurately than low schizotypes on the ToM conditions of both tasks. Given the findings of Lippett (2004) it was also hypothesised that high schizotypes would perform less accurately in the 'random' condition of each task. It was expected that, in line with Lippett's (2004) findings and the suggestions of Abu-Akel (1999) and Frith (2004), high schizotypes would impute social cognition more readily than low schizotypes where none was obviously indicated (i.e. in random and physical conditions of both tasks), and that this tendency would be associated with the UE dimension of schizotypy in particular. Finally, it was predicted that there would be an association between corresponding measures of mentalizing derived from each task.

Contrary to expectations, and to the predictions of Frith's (1992) model, there was no difference between the accuracy of high and low schizotypes in the ToM condition of either task. These findings are inconsistent with those of Langdon and Coltheart (1999, 2001, 2004) and Docherty et al. (1998). However, they are consistent with those of Young and Mason (2006) who found no difference in the mentalizing abilities of high and low schizotypes on three different measures of ToM. They replicate the findings of Lippett (2004) and Pickup (2006) who report no evidence for a difference between the

performance of those with high and low overall schizotypy scores on the ToM condition of the Triangles Task and the Stories Task respectively.

In the current study, the mode of presentation used by Pickup (2006) was altered in order to obtain a more ecologically valid and perhaps more sensitive measure of ToM. Participants were required to listen to, rather than read, the stories and make more 'on-line' judgements in response to questions. Pickup (2006) reasons that this mode of presentation should produce a larger effect size than that used in his study, which allowed participants as much time as they wanted to read each story before responding to a question; however, despite altering the mode of presentation, no effect was detected. As an extension of Lippett's (2004) study, executive function, verbal IQ and performance IQ were controlled for. Consistent with the findings of Raine et al. (1992), executive function was found to be associated with schizotypy, however no relationship was detected between any of the control variables and measures of performance on either ToM task.

In line with hypotheses, high schizotypes performed worse than low schizotypes on the random condition of the Triangles Task. They showed a greater tendency than low schizotypes to read meaning in the random movements of the triangles and to attribute agency to the shapes. There was also a tendency for high schizotypes to attribute more mental states in the physical condition of the Triangles Task where the movement of triangles could be described in purely mechanical terms, although this tendency did not reach significance. These findings replicate and extend those of Lippett (2004). In the triangles condition, reading meaning in randomness, attributing agency in the random

condition, and attributing mental states in the physical condition were all associated with the UE dimension of schizotypy in particular. These findings relate to that of Pickup (2006) in that those scoring highly on UE in particular show differences in mentalizing style. They are consistent with Lippett's (2004) finding of an association between scores on the Cognitive Perceptual factor of the SPQ and less accurate performance on the random condition of the Triangles Task. They also correspond to Abu-Akel's (1999) suggestion that the positive symptoms of schizophrenia are associated with a tendency to 'hyper-mentalize', with Frith's (2004) theory that paranoid delusions are underpinned by 'over-mentalizing', and with Blakemore et al.'s (2003) finding that patients with delusions of persecution perceived contingency between the movement of shapes in conditions where non-clinical controls and psychiatric patients without persecutory delusions did not.

The method of participant selection used in this study (which was also that used by Pickup (2006)) may have favoured the finding of a particular association between UE, over any of the other three dimensions, and unusual mentalizing. Of the O-LIFE sub-scales, the STA questionnaire is most heavily weighted towards UE. Using this questionnaire as a screen and ensuring that a range of STA scores was represented in the sample would be likely to lead to wider representation of UE scores than of scores on other dimensions, increasing the likelihood of a relationship being detected for UE as opposed to other sub-scales. However, although the range and standard deviation of scores on the UE scale was greatest, there was also a good range of scores on each of the other O-LIFE sub-scales within the sample making it likely that any association between abnormal mentalizing and other dimensions of schizotypy would have been detected.

The finding of increased propensity to read meaning in randomness in the Triangles Task amongst high as compared to low schizotypes may relate to the well-established association between schizotypy and 'creativity' (e.g. Burch, Pavelis, Hemsley & Corr, 2006; Eysenck & Furnham, 1993; Green & Williams, 1999). Several studies have demonstrated that high schizotypes provide a greater number of 'original' responses than do low schizotypes on measures of 'divergent thinking', which are argued to tap one aspect of creativity (e.g. Green & Williams, 1999). 'Divergent thinking' tasks require participants to, for example, think of as many possible different uses for a particular object, or name as many items in a particular category as they can. It is easy to see how the tendency to see possible meaningful explanations for random triangle movements might relate to an ability to generate more ideas.

It is possible that the finding of increased attribution of agency or 'mental states' to mechanical or random movements amongst high, as compared to low, schizotypes is purely an artefact of their greater tendency to read meaning in randomness. This would be the case if, for both high and low schizotypes, the most obvious ascription of meaning to a random scenario involved attribution of mental states. The skewed nature of the data in this study prevented further exploration of this possibility; it would be interesting to investigate whether high schizotypy is associated with greater tendency to impute agency in random or mechanical animations when 'divergent thinking' or reading meaning in randomness is controlled for.

The Stories Task, unlike the Triangles Task, produced no performance differences between high and low schizotypes in random conditions and there was no association

between any individual dimension of schizotypy and the tendency to read meaning in randomness or to impute mental states in the random or physical conditions of this task. The failure to find evidence of any such relationships in the Stories Task may reflect the fact that it is not possible to design items in auditory-verbal form that are unstructured in the way that visual items can be. They therefore provide more cues towards particular answers and leave less room for divergent thinking to be evidenced.

Perhaps related to these differences between the auditory-verbal and visual tasks, is the surprising lack of association between scores on the ToM conditions of the two tasks. The absence of a relationships between the tendency to impute 'mental states' in non-ToM conditions of each task, and between the tendency to read meaning in randomness in one task and the parallel tendency in the other was also unexpected. Much of ToM research is premised on the belief that scores on different measures of ToM reflect abilities in a single domain of functioning. However, a similar lack of association between ToM performance on verbal and non-verbal tasks has been found by other researchers (Harrington, Langdon, Siegert & McClure, 2005). These findings indicate a need for greater attention at least to the construct validity of paradigms designed to measure ToM, and possibly also to the validity of current conceptualisations of ToM as a unitary domain of functioning.

These issues of validity may to some extent account for variation in findings across research into ToM in schizophrenia and psychosis-proneness, where a wide range of measures have been employed. Evidently, different ToM paradigms tap different abilities in addition to any putative ToM construct. For example, the Stories Task

employed in this study, where stories were read aloud to participants once only before they were asked to respond to a question, draws more on auditory-verbal comprehension and memory than does the Triangles Task. The possible dependence of Stories Task scores on auditory-verbal memory may mask an association between scores on the ToM conditions of this and the Triangles Tasks. However, there may also be variability within the domain of mentalizing that is not generally taken into account in ToM research. ToM abilities may be more fractionated, at least in some individuals, than is commonly assumed; they may be tied more closely to specific contexts or domains of functioning (e.g. verbal or non-verbal) than is often thought to be the case and may be affected by the level of explicitness of mentalizing demanded by the task and by non-specific variables, such as anxiety, that are not normally taken into account in studies within this field.

A final point worth further investigation relates to the change in mentalizing abilities that accompanies transition to psychotic illness. It is clear that any abnormalities in ToM functioning associated with vulnerability to psychosis differ from those evident in patients diagnosed with schizophrenia. This difference may relate to changes in other abilities affected by psychotic illness, such as executive function. In addition, or alternatively, the change in mentalizing abilities accompanying transition to the psychotic state may be mediated by stress. Aspects of cognitive function have been demonstrated to vary with anxiety (Braunstein-Bercovitz, Rammsayer, Gibbons & Lubow, 2002) and it is possible that ToM too is affected when an individual becomes anxious. Psychotic symptoms and the treatment protocols commonly encountered by those experiencing them are associated with high levels of distress (Shaw, McFarlane,

Bookless & Air, 2002) and it may be that anxiety associated with this distress impacts on ToM. Future research into ToM functioning in those with prodromal signs of psychosis and those in the early stages of the illness will help to explore the pattern of change in ToM that accompanies the onset of psychosis.

The evidence for differences in social cognition in those at risk for psychosis has important clinical implications. Increasingly powerful and specific operational criteria are being developed for identifying those at 'ultra-high-risk' of developing a psychotic illness (e.g. Phillips, Yung & McGorry, 2000; Yung, Phillips, Yuen & McGorry, 2004). Insight into cognitive markers of vulnerability to psychosis can inform the further development of these criteria.

Psychological interventions are increasingly being offered to those in the earliest stages of psychotic illness, and in some cases to those with no history of psychosis who exhibit the sub-clinical signs and symptoms often sited as precursors to its development. Such interventions may be usefully informed by greater understanding of cognitive markers of vulnerability to psychosis. Roncone et al. (2004) report a pilot study in which patients with schizophrenia who were treated with a therapeutic approach aimed at developing meta-cognitive strategies showed significant improvements on a first-order and a second-order ToM task and on a measure of social functioning. It is possible that benefits could be derived from similar interventions with those at risk of developing a psychotic disorder, before illness manifests.



## REFERENCES

- Abell, F., Happé, F. & Frith, U. (2000). Do triangles play tricks? Attribution of mental states to animated shapes in normal and abnormal development. *Cognitive Development, 15*, 1-16.
- Abu-Akel, A. (1999). Impaired theory of mind in schizophrenia. *Pragmatics and Cognition, 7*, 247-282.
- Abu-Akel, A. & Bailey, A.L. (2000). Correspondence, *Psychological Medicine, 30*, 735-738.
- Baron, M., Asnis, L. & Gruen, R. (1981). The Schedule for Schizotypal Personalities (SSP): A diagnostic interview for schizotypal features. *Psychiatry Research, 4*, 213-228.
- Baron-Cohen, S., Wheelwright, S., Hill, J., Raste, Y. & Plumb, I. (2001). The 'Reading the mind in the eyes' test revised version: a study with normal adults, and adults with Asperger syndrome or high-functioning autism. *Journal of Child Psychology and Psychiatry, 42*, 241-251.
- Blakemore, S.-J., Sarfati, Y., Bazin, N. & Decety, J. (2003). The detection of intentional contingencies in simple animations in patients with delusions of persecution. *Psychological Medicine, 33*, 1433-1441.
- Braunstein-Bercovitz, H., Rammsayer, T., Gibbons, H. & Lubow, R.E. (2002). Latent inhibition deficits in high-schizotypal normals: symptom-specific or anxiety-related? *Schizophrenia Research, 53*, 109-121.

Brüne, M. (2005). "Theory of mind" in schizophrenia: A review of the literature. *Schizophrenia Bulletin*, 31, 21-42.

Burch, S.-J., Pavelis, C., Hemsley, D.R. & Corr, P.J. (2006). Schizotypy and creativity in visual artists. *British Journal of Psychology*, 97, 177-190.

Burch, G.S., Steel, C. & Hemsley, D.R. (1988). Oxford-Liverpool Inventory of Feelings and Experiences: reliability in an experimental population. *British Journal of Clinical Psychology*, 37, 107-108.

Burgess, P.W. & Shallice, T. (1997). *The Hayling and Brixton tests*. Bury St Edmunds: Thames Valley Test Company.

Castelli, F., Happé, F., Frith, U. & Frith, C. (2000). Movement and mind: A functional imaging study of perception and interpretation of complex intentional movement patterns. *NeuroImage*, 12, 314-325.

Chapman, L.J., Chapman, J.P., Kwapil, T.R., Eckblad, M. & Zinser, M.C. (1994). Putatively psychosis-prone subjects 10 years later. *Journal of Abnormal Psychology*, 103, 171-183.

Claridge, G. (1994). Single indicator of risk for schizophrenia: Probable fact or likely myth? *Schizophrenia Bulletin*, 20, 151-168.

Claridge, G. & Broks, P. (1984). Schizotypy and hemisphere function: I. Theoretical considerations and the measurement of schizotypy. *Personality and Individual Differences*, 5, 633-648.

Claridge, G. & Hewitt, J.K. (1987). A biometric study of schizotypy in a normal population. *Personality and Individual Differences*, 8, 303-312.

Claridge, G., McCreery, C., Mason, O., Bentall, R., Boyle, G., Slade, P. & Popplewell, D. (1996). The factor structure of 'schizotypal' traits: a large replication study. *British Journal of Clinical Psychology*, 35, 103-115.

Docherty, N.M., Rhinewine, J.P., Labhart, R.P. & Gordinier, S.W. (1998). Communication disturbances and family psychiatric history in parents of schizophrenic patients. *Journal of Nervous and Mental Disease*, 186, 761-768.

Done, D.J., Crow, T.J., Johnstone, E.C. & Sacker, A. (1994). Childhood antecedents of schizophrenia and affective illness: social adjustment at age 7 and 11. *British Medical Journal*, 309, 699-703.

Eysenck, H.J., & Eysenck, S.B.G. (1991). *Manual of the Eysenck Personality Scales (EPS adult)*. London: Hodder & Stoughton.

Eysenck, H.J., & Eysenck, S.B.G. (1996). *Manual of the Eysenck Personality Scales (EPS adult) (revised ed.)*. London: Hodder & Stoughton Educational.

Eysenck, H.J. & Furnham, A. (1993). Personality and the Barron-Welsh art scale. *Perceptual and motor skills*, 76, 837-838.

Fletcher, P.C., Happé, F., Frith, U., Baker, S.C., Dolan, R.J., Frackowiak, R.S.J. & Frith, C.D. (1995). Other minds in the brain: a functional imaging study of 'theory of mind' in story comprehension. *Cognition*, 57, 109-128.

Frith, C.D. (1992). *The cognitive neuropsychology of schizophrenia*. Hove, UK: Lawrence Erlbaum associates.

Frith, C.D. (2004). Schizophrenia and theory of mind. *Psychological Medicine*, 34, 385-389.

Frith, U. Morton, J. & Leslie A.M. (1991). The cognitive basis of a biological disorder: autism. *Trends in Neuroscience*, 14, 433-438.

Green, M.J. & Williams, L.M. (1999). Schizotypy and creativity as effects of reduced cognitive inhibition. *Personality and Individual Differences*, 27, 263-276.

Gregory, C., Lough, S., Stone, V., Erzinclioglu, S., Martin, L., Baron-Cohen, S. & Hodges, J.R. (2002). Theory of mind in patients with frontal variant fronto-temporal dementia and Alzheimer's disease: Theoretical and practical implications. *Brain*, 125, 752-764.

Happé, F.G.E. (1994). An advanced test of theory of mind: Understanding of story characters' thoughts and feelings by able autistic, mentally handicapped and normal children and adults. *Journal of Autism and Developmental Disorders*, 24, 129-154.

Happé, F.G.E., Brownell, H. & Winner, E. (1999). Acquired 'theory of mind' impairments following stroke. *Cognition*, 70, 211-240.

Happé, F.G.E., Winner, E. & Brownell, H. (1998). The getting of wisdom: theory of mind in old age. *Developmental Psychology*, 34, 358-362.

Harrington, L., Langdon, R., Siegert, R.J. & McClure, J. (2005). Schizophrenia, theory of mind and persecutory delusions. *Cognitive Neuropsychiatry*, *10*, 87-104.

Harrington, L., Siegert, R.J. & McClure, J. (2005). Theory of mind in schizophrenia: A critical review. *Cognitive Neuropsychiatry*, *10*, 249-286.

Janssen, I., Krabbendam, L., Jolles, J. & van Os, J. (2003). Alterations in theory of mind in patients with schizophrenia and non-psychotic relatives. *Acta Psychiatrica Scandinavica*, *108*, 110-117.

Johns, L.C., Cannon, M., Singleton, N., Murray, R.M., Farrell, M., Brugha, T., Bebbington, P., Jenkins, R. & Meltzer, H. (2004). Prevalence and correlates of self-reported psychotic symptoms in the British population. *The British Journal of Psychiatry*, *185*, 298-305.

Johns, L.C. & van Os, J. (2001). The continuity of psychotic experiences in the general population. *Clinical Psychology Review*, *21*, 1125-1141.

Kelemen, O., Kéri, S., Must, A., Benedek, G. & Janka, Z. (2004). No evidence for impaired 'theory of mind' in unaffected first-degree relatives of schizophrenia patients. *Acta Psychiatrica Scandinavica*, *110*, 146-149.

Kendler, K.S. & Hewitt, J.K. (1992). The structure of self-report schizotypy in twins. *Journal of Personality Disorders*, *6*, 1-17.

Kendler, K.S., Ochs, A.L., Gorman, A.M., Hewitt, J.K., Ross, D.E. & Mirsky, A.F. (1991). The structure of schizotypy: A pilot multitrait twin study. *Psychiatry Research*, *36*, 19-36.

Langdon, R. & Coltheart, M. (1999). Mentalizing, schizotypy, and schizophrenia. *Cognition*, 71, 43-71.

Langdon, R. & Coltheart, M. (2001). Visual perspective taking and schizotypy: Evidence for a simulation-based account of mentalizing in normal adults. *Cognition*, 82, 1-26.

Langdon, R. & Coltheart, M. (2004). Recognition of metaphor and irony in young adults: the impact of schizotypal personality traits. *Psychiatry Research*, 125, 9-20.

Lippett (2004). *An investigation of the interaction between schizotypy and cognitive monitoring processes*. Doctoral Thesis.

Mason, O. & Claridge, G. (2006). The Oxford-Liverpool Inventory of Feelings and Experiences (O-LIFE): Further description and extended norms. *Schizophrenia Research*, 82, 203-211.

Mason, O., Claridge, G., & Jackson, M. (1995). New scales for the assessment of schizotypy. *Personality and Individual Differences*, 18, 7-13.

Phillips, L.J., Yung, A.R. & McGorry, P.D. (2000). Identification of young people at risk of psychosis: validation of Personal Assessment and Crisis Evaluation Clinic intake criteria. *Australian and New Zealand Journal of Psychiatry*, 34 (suppl.), s164-s169.

Pickup, G. (2006). Theory of mind and its relation to schizotypy. *Cognitive Neuropsychiatry*, 11, 177-192.

- Pickup, G. & Frith, C.D. (2001). Theory of mind impairments in schizophrenia: symptomatology, severity and specificity. *Psychological Medicine*, 31, 207-220.
- Premack, D. & Woodruff, G. (1978). Does the chimpanzee have a 'theory of mind'? *Behavioural and Brain Sciences*, 4, 515-526.
- Raine, A. (1991). The SPQ: A scale for the assessment of schizotypal personality based on DSM-III-R criteria. *Schizophrenia Bulletin*, 17, 55-64.
- Raine, A., Sheard, C., Reynolds, G.P. & Lencz, T. (1992). Prefrontal structural and functional deficits associated with individual differences in schizotypal personality. *Schizophrenia Research*, 7, 237-247.
- Rawlings, D. & Freeman, J.L. (1997). Measuring paranoia/suspiciousness. In: Claridge, G. (Ed.), *Schizotypy: Implications for Illness and Health*. Oxford, England: Oxford University Press.
- Schiffman, J., Lam, C.W., Jiwatram, T., Ekstrom, M., Sorensen, H., & Mednick, S. (2004). Perspective-taking deficits in people with schizophrenia spectrum disorders: A prospective investigation. *Psychological Medicine*, 34, 1581-1586.
- Shaw, K., McFarlane, A.C., Bookless, C. & Air, T. (2002). The aetiology of post-psychotic posttraumatic stress disorder following a psychotic episode. *Journal of Traumatic Stress*, 15, 39-47.
- Wechsler, D. (2001). *Wechsler test of adult reading*. San Antonio, Texas: The Psychological Corporation.

Wykes, T., Hamid, S. & Wagstaff, K. (2001). Theory of mind and executive functions in the non-psychotic siblings of patients with schizophrenia. [Abstract]. *Schizophrenia Research*, 49 (suppl 1), 148.

Young, E. & Mason, O. (2006). *Is there really a theory of mind deficit in psychosis-proneness?* Manuscript submitted for publication.

Yung, A.R., Phillips, L.J., Yuen, H.P., McGorry, P.D. (2004). Risk factors for psychosis in an ultra high-risk group: psychopathology and clinical features. *Schizophrenia Research*, 67, 131-142.



# **Critical Appraisal**

# **CRITICAL APPRAISAL**

## **INTRODUCTION**

The process of conducting this experimental study into the relationship between theory of mind (ToM) and schizotypy has raised a number of interesting issues. The following discussion will reflect on these issues, beginning with those arising at the planning and recruitment stage of the project. Observations made during the process of testing participants and of analysing and interpreting results will then be presented. The discussion will finish by considering the findings of the study in the context of wider clinical and theoretical perspectives and outlining possible directions for future research.

## **PLANNING THE STUDY**

At the stage of planning this study, a number of issues immediately presented themselves. Few experimental investigations of ToM in schizotypy have been conducted and their findings have been inconsistent. The implications of this constrained the design of the current study in that the need to replicate evidence for a general association between ToM and psychosis-proneness superseded the need for investigation of more specific questions. This was frustrating as it seemed more interesting to design the study focusing on the specifics (e.g. selecting participants so as

to ensure greatest variability on a particular symptom-related dimension) than to aim to replicate existing findings. Although more specific questions could be addressed in a study devised to replicate general findings, the design of the study had to favour the latter.

From the outset, it was apparent that studies of the relationship between ToM and both schizophrenia and psychosis-proneness have employed diverse methodology. As in much of the research into psychosis and associated characteristics/vulnerability factors, various approaches have been taken to measuring both schizophrenia and psychosis-proneness. Vulnerability to psychosis has been assessed using a range of questionnaires, and definitions of schizophrenia have drawn on various criteria e.g. clinical diagnosis of schizophrenia and/or schizoaffective disorder or clinical ratings/self-reports of particular symptomatology. At the symptom/symptom cluster level, different methods of grouping participants have been used e.g. those based on a positive-negative symptom dichotomy and those focused on individual symptoms argued to be relevant on the basis of a particular theory. Furthermore, a range of ToM paradigms has been employed in this field of research, with variation in the nature of the task, the mode of presentation (e.g. verbal/visual/both), the non-mentalizing capacities also tapped by the task, the ecological validity of the measure and the level of explicitness of mentalizing demanded. The extent of variability between studies addressing similar questions made it difficult to identify consistencies, draw overall conclusions, and select measures and design a study to fill the gaps in the literature.

A number of further considerations regarding the concepts under investigation presented themselves at the planning stage of the study. Firstly, both ToM and schizotypy seemed somewhat abstract as concepts (the multitude of measures employed in both ToM and schizotypy research is perhaps a reflection this.) Secondly, mentalizing in particular has been discussed extensively in a wide range of fields and approaches to the concept vary considerably. Thirdly, as an aspect of social cognition, ToM is to a large extent interpersonal and likely to be influenced by the emotional context of an interaction (Fonagy, Gergely, Jurist & Target, 2002). ToM differences may therefore manifest differently in real-life situations and under experimental conditions. All of these factors present challenges to the experimental study of ToM abilities in schizotypy.

Furthermore, the majority of the research into ToM has been concerned with identifying deficits associated with particular clinical conditions. Relatively little is known about individual differences in normal functioning ToM. In investigating mentalizing differences in the non-clinical population, where ToM functioning is unlikely to be seriously impaired, it was difficult to know what differences might exist other than a pure deficit.

The aspect of difference in the ToM ability focused on in this study was the tendency to 'over-mentalize' (i.e. to impute mental states in situations where most people would not.) To investigate this tendency a new 'random stories' condition was designed to accompany Fletcher et al.'s (1995) Stories Task. The process of designing these stories raised a number of issues. Effort was made to match the stories in difficulty and length to those in the 'physical' and 'ToM' conditions of the task. This raised questions such

as how to measure length (e.g. by number of clauses, number of words, or duration when read aloud). Secondly, the stories had to be as ‘random’ as possible, but at the same time had to be structured enough to be comprehensible such that participants would give a range of responses. There seemed to be a great deal of subjectivity in, for example, what constitutes a connection between events. It did not seem possible to design stories that were random in the same sense as the unstructured movements of the triangles in the random condition of Abell, Happé and Frith’s (2000) task and, in fact, it was impossible to envisage a task in the auditory-verbal domain to parallel this random Triangles Task. This relates to the issue of measuring a single ability in multiple domains of functioning and raises the question of whether consistency across domains can be assumed given the differences associated with, for example, verbal and non-verbal modes of presentation.

## **SELECTING AND RECRUITING PARTICIPANTS**

The method of recruiting participants employed in this study aimed to ensure that a wide range of schizotypy was represented in the sample. There was a high level of response to advertisements placed around the university campus and participants scoring across the range on the questionnaire used as a screen could be identified and recruited. There were however noticeably fewer responses from ‘low schizotypes’ (i.e. those scoring more than one standard deviation below the population mean on the STA questionnaire) than from ‘high schizotypes’ (scoring more than one standard deviation above the population mean) and low schizotypes were hardest to recruit. Furthermore, amongst

our sample, scores on the 'Introvertive Anhedonia' scale of the O-LIFE questionnaire were negatively skewed with the majority of participants scoring highly on this scale. This experience draws attention to a consideration relating to participant selection particularly in research into aspects of personality. Clearly aspects of personality are associated to some extent with willingness to take part in experimental trials and the distribution of these variables in the sample is likely to be skewed unless attention is paid to ensuring that this is not the case.

## **COLLECTING THE DATA**

The process of collecting the data brought to light a number of considerations. It was clear that different participants had very different approaches to being tested. It seemed that a number of personality variables were likely to affect responses. For example those who were more extrovert might give more elaborated answers, and those more confident in their responses, or more experienced in participating in psychological studies, might feel less pressure to expand on their answers.

When the manner in which various participants responded to the test questions was attended to, it seemed that the same answers were often given for different reasons. For example, in ToM items of either task, one participant might respond quickly and briefly to a question, sound confident in their response and give little elaboration. Although they would make no reference to mental states, an appreciation of these would be implicit in their answer. The impression given would be that they understood the

story/animation and considered the importance of mental states to be obvious and not in need of explicit mention. Another individual might however give the same response but sound less certain and appear confused by the story/animation, giving the impression that they had not considered the mental states of the characters/triangles. The scoring system for each task failed to account for this and it was possible that the scores of some good mentalizers were for this reason misleadingly low.

Another example of participants apparently giving the same answer for different reasons was in the random conditions of the Stories Task. Here participants were asked a question for which no direct answer was provided in the passage and there was variation in the extent to which individuals read into the information provided in order to respond. Some participants appeared to be thinking hard and searching for a logical response, whilst others would give similar answers, speaking with conviction and apparently giving the matter little thought. In line with the study hypotheses, the former respondents may have been low schizotypes who thought that, given that a question had been asked, they should be able to think of a logical answer with reference to the passage, whilst the latter category of participants may have been high schizotypes who instinctively read meaning into the random assortment of pieces of information. The tendency of participants to respond similarly to random story items for different reasons might account for the failure of the study to find a connection between schizotypy and tendency to 'read meaning in randomness' in the Stories Task.

In designing the study, it was assumed that, if differences in ToM constituted a marker of vulnerability for psychosis, mentalizing scores would be normally distributed along a

continuum throughout the non-clinical population, and that this distribution would be associated with that of schizotypy scores, with high schizotypes scoring most poorly on mentalizing accuracy and low schizotypes performing best. However, observations of participant performance during the data collection phase brought to mind the possibility that mentalizing scores might have a U-shaped relationship to schizotypy, with both very low schizotypes and very high schizotypes performing less accurately than those in the middle range. It seemed that some of the 'low schizotypy' group might have a more autistic-like cognitive style, which would be expected to be associated with poorer performance on ToM tasks (Frith, Morton & Leslie, 1991), whilst high schizotypes would be predicted to perform less accurately on measures of ToM on the basis of Frith's (1992) theory.

At the data collection and recruitment stages of project, it was of great benefit to be working jointly with another researcher. The data collection and scoring of questionnaires was divided evenly between us, such that we each administered tasks additional to those we would eventually report. Overall, however, working jointly lessened the time spent by each of us on recruitment, data collection and scoring. Both researchers were present at the time of testing of almost all participants. Although this decreased the extent to which we could be flexible about the times of testing participants, it enabled us to discuss our reflections on participants' performance soon after testing. Such discussions helped to develop each of our ideas about the processes that might be contributing to performance patterns. Earlier, discussions around the design of the study had been similarly beneficial in expanding our thoughts about how the project could best be carried out.



## **ANALYSING THE RESULTS**

At the data analysis stage, it was striking how many apparently subjective decisions had to be made. Different statistical manuals recommend different approaches to determining whether the distributions of variables are adequate for normality to be assumed and for parametric tests to be applied. Decisions had to be made about whether it was preferable to leave variables untransformed, include outliers and perform non-parametric tests or to transform variables, exclude outliers and carry out parametric analyses. Whether one condition of a task (in this case the random stories and triangles conditions) was sufficiently analogous to other condition(s) (i.e. physical and ToM stories and triangles conditions) for performance on each to be compared also had to be considered, as did the way in which participants were grouped and scores computed. Here data could be analysed using either regressions or group comparisons. Preceding studies were used to give some guidance as to which approaches might be appropriate; it was preferable to employ techniques similar to those used in these studies in order to enable more direct comparisons to be made with their findings. However, variability across previous studies in how analyses were conducted made it difficult to make decisions through reference to these.

## **INTERPRETING FINDINGS**

At the stage of interpreting the findings, particular limitations became apparent. Attention was focused on possible alternative explanations for findings and it was clear

that caution was required in drawing conclusions. Most notably, it became apparent that 'over-mentalizing' might be purely a bi-product of 'reading meaning in randomness'. The non-parametric nature of the data, precluded further exploration of this possibility. It would be interesting to investigate whether an increased tendency to 'read meaning in randomness' amongst high as compared to low schizotypes remains after controlling for divergent thinking.

## **THE WIDER CONTEXT AND FUTURE DIRECTIONS**

When considering the findings of this study within a wider context, it is immediately apparent how many different fields of research can be drawn on. This allows light to be shed on the findings but also throws up a huge number of possibilities for future research.

As an explanatory model of psychotic illness, the cognitive-behavioural approach is becoming increasingly dominant and Cognitive Behavioural Therapy (CBT) has been shown to be effective in treating symptoms of psychosis (Haddock et al., 1998; Birchwood & Spencer, 1999). Cognitive models of psychosis (e.g. Garety, Kuipers, Fowler, Freeman & Bebbington, 2001) posit a central role for poor social understanding in symptom formation and maintenance, and CBT focuses on meta-cognitive skills and the viewing of thoughts and beliefs as hypotheses rather than truths. Findings of abnormal mentalizing style in those prone to psychosis are therefore of relevance to cognitive-behavioural models, particularly when considering cognitive behavioural

interventions in prodromal and first episode psychosis. With this in mind, there is a need for investigation of mentalizing abilities amongst those showing prodromal signs of psychosis and those who have recently experienced a first psychotic episode.

The 'mentalization' literature bridges a gap between cognitive and psychodynamic approaches. Fonagy has argued for differences in mentalizing arising from early experiences in the attachment relationship and for mentalizing deficits developing in some individuals in particular contexts as a means of protection from psychic pain (Fonagy et al., 2002). In Fonagy et al.'s (2002) model, differences in mentalizing style arising in this way are implicated in patterns of relating seen in borderline personality disorder. However, given the association between psychosis and negative child-parent relationships (Schiffman et al., 2002) and early abuse/neglect (e.g. Read, van Os, Morrison & Ross, 2005), it would be interesting to investigate further the relationship between insecure attachment patterns and the later development of psychotic disorders.

The variability across contexts of mentalizing abilities, which Fonagy et al. (2002) discuss, raises the possibility that ToM varies with levels of anxiety. Effects of anxiety on other aspects of cognition, such as latent inhibition, have been documented in the literature (Braunstein-Bercovitz, Rammsayer, Gibbons & Lubow, 2002) and there is a possibility that mentalizing too is affected when an individual is anxious. Psychotic symptoms and their treatment are associated with high levels of distress (Shaw, McFarlane, Bookless & Air, 2002) and it may be that anxiety related to this distress mediates the decline in ToM functioning that appears to accompany the onset of psychosis. There is little discussion of the possible impact of anxiety on ToM in the

ToM and psychosis literature, anxiety is not generally controlled for in studies of mentalising and psychosis, and I did not consider controlling for anxiety when planning this study. However over the course of conducting the project, I became increasingly aware of the potential for anxiety to impact on ToM performance. It would have been useful to have controlled for anxiety in this study and there is a need for future research into the impact of stress and anxiety on mentalizing.

Ideas from other areas of schizotypy research are also of relevance. The evidence for greater divergent thinking in high as compared to low schizotypes is well established (e.g. Eysenck & Furnham, 1993; Green & Williams, 1999) and it has been suggested that this characteristic may be accounted for in terms of reduced cognitive inhibition (Eysenck, 1993). Cognitive inhibition refers to the process involved in selective attention, of inhibiting irrelevant stimuli and there is considerable evidence for a reduction in this capacity amongst those vulnerable to schizophrenia (e.g. Williams, 1995). Reduced cognitive inhibition leaves an individual 'inundated with an increased array of percepts or 'loose' associative links' (Green & Williams, 1999). It is possible that the current findings of an increased tendency amongst high schizotypes to see meaning in random animations might be explicable in terms of reduced cognitive inhibition. It would be useful to carry out further studies investigating the relationship between cognitive inhibition and divergent thinking and the tendency to 'read meaning in randomness' and 'over-mentalize'.

Finally, it is interesting to consider this field of research in relation to clinical work. I currently work in an early intervention team for young people who have recently

experienced a first episode of psychosis. In my clinical practice in this service, I have often observed clients making unusual attributions of mental states, or struggling to consider the thoughts and beliefs of other people. For example, while working within a cognitive-behavioural framework, a client may be asked what a friend might think in a given situation, as a means of eliciting alternatives to their own negative thoughts. I have often been struck by the difficulty some of my clients have in entertaining the possibility that others might have thoughts that differ from their own when given this task.

One attempt to apply ToM and psychosis research to clinical practice is reported in a pilot study described by Roncone et al. (2004). These researchers found that patients with schizophrenia who were treated with a therapeutic approach aimed at developing meta-cognitive strategies showed significant improvements on a first-order and a second-order ToM task and on a measure of social functioning. There is clearly a need for further investigation of the potential therapeutic applications of research into the relationship between ToM and schizophrenia and psychosis-proneness.

## REFERENCES

- Abell, F., Happé, F. & Frith, U. (2000). Do triangles play tricks? Attribution of mental states to animated shapes in normal and abnormal development. *Cognitive Development*, 15, 1-16.
- Birchwood, M. & Spencer, E. (1999). Psychotherapies for schizophrenia a review. In *Schizophrenia (WPA Series: Evidence and Experience in Psychiatry, Vol. 2)* M. Maj and N. Sartorius (eds.), pp. 147-214. Chichester: Wiley.
- Braunstein-Bercovitz, H., Rammsayer, T., Gibbons, H. & Lubow, R.E. (2002). Latent inhibition deficits in high-schizotypal normals: symptom-specific or anxiety-related? *Schizophrenia Research*, 53, 109-121.
- Eysenck, H.J. (1993). Creativity and personality: suggestions for a theory. *Psychological Inquiry*, 4, 147-178.
- Eysenck, H.J. & Furnham, A. (1993). Personality and the Barron-Welsh art scale. *Perceptual and Motor skills*, 76, 837-838.
- Green, M.J. & Williams, L.M. (1999). Schizotypy and creativity as effects of reduced cognitive inhibition. *Personality and Individual Differences*, 27, 263-276.
- Fletcher, P.C., Happé, F., Frith, U., Baker, S.C., Dolan, R.J., Frackowiak, R.S.J. & Frith, C.D. (1995). Other minds in the brain: a functional imaging study of 'theory of mind' in story comprehension. *Cognition*, 57, 109-128.

- Fonagy, P., Gergely, G., Jurist, E. & Target, M. (2002). *Affect regulation, mentalization, and the development of the self*. New York: Other Press.
- Frith, C.D. (1992). *The cognitive neuropsychology of schizophrenia*. Hove, UK: Lawrence Erlbaum associates.
- Frith, U. Morton, J. & Leslie A.M. (1991). The cognitive basis of biological disorder: autism. *Trends in Neuroscience*, 14, 433-438.
- Garety, P.A., Kuipers, E., Fowler, D., Freeman, D. & Bebbington, P.E. (2001). A cognitive model of the positive symptoms of psychosis. *Psychological Medicine*, 31, 189-195.
- Haddock, G., Tarrrier, N., Spaulding, W., Yusupoff, L., Kinney, C & McCarthy, E. (1998). Individual cognitive behaviour therapy in the treatment of hallucinations and delusions: a review. *Clinical Psychology Review*, 18, 821-828.
- Read, J., van Os, J., Morrison, A.P. & Ross, C.A. (2005). Childhood trauma, psychosis and schizophrenia: a literature review with theoretical and clinical implications. *Acta Psychiatrica Scandinavica*, 112, 330-350.
- Roncione, R., Mazza, M., Frangou, I., de Risio, A., Ussorio, D., Tozzini, C. & Casacchia, M. (2004). Rehabilitation of theory of mind deficit in schizophrenia: A pilot study of metacognitive strategies in group treatment. *Neuropsychological Rehabilitation*, 14, 421-435.

Schiffman, J., LaBrie, J., Carter, J., Tyrone, C., Schulsinger, F., Parnas J. & Mednick S. (2002). Perception of parent-child relationships in high-risk families, and adult schizophrenia outcome of offspring. *Journal of Psychiatric Research*, 36, 41-47.

Shaw, K., McFarlane, A.C., Bookless, C. & Air, T. (2002). The aetiology of post-psychotic posttraumatic stress disorder following a psychotic episode. *Journal of Traumatic Stress*, 15, 39-47.

Williams, L. M. (1995). Further evidence for a multidimensional personality disposition to schizophrenia in terms of cognitive inhibition. *British Journal of Clinical Psychology*, 34, 193-213.



# Appendices

**APPENDIX 1: Participant Information Sheet and Consent Form**

**APPENDIX 2: Letter of Ethical Approval**

**APPENDIX 3: Questionnaires, Measures and Scoring Criteria**

**APPENDIX 4: Correlations Between O-LIFE Scores and Control Variables**

**APPENDIX 5: Correlations Between Experimental and Control Variables**

**APPENDIX 6: Correlations Between Experimental Variables**

**APPENDIX 1: Participant Information Sheet and Consent Form**

**Information sheet for volunteers**

**Consent form for volunteers**

## INFORMATION SHEET FOR VOLUNTEERS

**Study Title:** Theory of Mind and Schizotypy

**Investigators:** **Claire Williams, Department of Clinical Health Psychology,  
UCL, Gower Street, London WC1E 6BT**

**Sophie Fyfe, Department of Clinical Health Psychology,  
UCL, Gower Street, London WC1E 6BT**

**Dr O. Mason, Department of Clinical Health Psychology,  
UCL, Gower Street, London WC1E 6BT**

**Dr G. Pickup, Department of Clinical Health Psychology,  
UCL, Gower Street, London WC1E 6BT**

You are invited to participate in a research project which investigates the relationship between certain personality traits and the ability to work out what other people think in particular situations. As a healthy volunteer, the data you provide will give us information about the normal variation in people's understanding of social situations.

You will be asked to complete a brief screening questionnaire. On the basis of this you may then be asked to participate in the study. This would entail completing two more questionnaires, answering questions on some stories, completing two short tests of intelligence and reasoning ability, and answering questions about some objects you will watch moving around a screen. This interview takes approximately one hour in total. Your answers to all these questions will be completely confidential and identified only by a number rather than by your name. You will receive £10 for taking part, which is a 'thank you' gesture from us.

There are no potential risks involved in the research.

**You do not have to take part in this study if you do not want to. If you decide to take part you may withdraw at any time without having to give a reason.**

**All proposals for research using human subjects are reviewed by an ethics committee before they can proceed. This proposal was reviewed by the UCL Committee on the Ethics of Human Research.**

Please feel free to ask any questions about the research, and we will do our best to answer them.

**CONFIDENTIAL**

**CONSENT FORM FOR VOLUNTEERS**

**Study Title:** Theory of Mind and Schizotypy

**Investigators:** Claire Williams, Department of Clinical Health Psychology,  
UCL, Gower Street, London WC1E 6BT

Sophie Fyfe, Department of Clinical Health Psychology,  
UCL, Gower Street, London WC1E 6BT

Dr O Mason, Department of Clinical Health Psychology, UCL, Gower  
Street, London WC1E 6BT

Dr G. Pickup, Department of Clinical Health Psychology, UCL, Gower  
Street, London WC1E 6BT

	Yes	No
Have you read the Participant Information sheet?		
Has the project been explained to you orally?		
Have you had the opportunity to ask questions and discuss the study?		
Have you received satisfactory answers to all your questions?		
Have you received enough information about the study? Who have you spoken to?.....		
Do you understand that you are free to withdraw from the study without penalty at any stage?		
Do you agree with the publication of the results of this study in an appropriate outlet/s?		

**Comment or Concerns During the Study**

If you have any comments or concerns you should discuss these with the Principal Researcher. If you wish to go further and complain about any aspect of the way you have been approached or treated during the course of the study, you should email the Chair of the UCL Committee for the Ethics of Non-NHS Human Research ( ) or send a letter to: The Graduate School, North Cloisters, Wilkins Building, UCL, Gower Street, London WC1E 6BT who will take the complaint forward as necessary.

Signed:..... Date.....

Full Name in Capitals:.....

Signature of Witness:..... Date.....

Full Name in Capitals:.....

**APPENDIX 2: Letter of Ethical Approval**



**The Graduate School**  
University College London  
Gower Street London WC1E 6BT

Head of the Graduate School

---

14 March 2005

Dr Oliver Mason  
Sub-Department of Clinical Health Psychology  
UCL

Dear Dr Mason

**Re: Notification of Ethical Approval**

**Project ID: 0416/001: Study to test the predictions of Frith's cognitive neuropsychological model of schizophrenia**

The above research has been given ethical approval following review by the Chair of the UCL Committee for the Ethics of non-NHS Human Research for the duration of the project subject to the following conditions:

1. You must seek Chair's approval for proposed amendments to the research for which this approval has been given. Ethical approval is specific to this project and must not be treated as applicable to research of a similar nature. Each research project is reviewed separately and if there are significant changes to the research protocol you should seek confirmation of continued ethical approval by completing the 'Amendment Approval Request Form'.

The form identified above can be accessed by logging on to the ethics website homepage: <http://www.grad.ucl.ac.uk/ethics/> and clicking on the button marked 'Key Responsibilities of the Researcher Following Approval'.

2. It is your responsibility to report to the Committee any unanticipated problems or adverse events involving risks to participants or others. Both non-serious and serious adverse events must be reported.

**Reporting Non-Serious Adverse Events.**

For non-serious adverse events you will need to inform Ms [redacted], Ethics Committee Administrator ([redacted]), within ten days of an adverse incident occurring and provide a full written report that should include any amendments to the participant information sheet and study protocol. The Chair or Vice-Chair of the Ethics Committee will confirm that the incident is non-serious and report to the Committee at the next meeting. The final view of the Committee will be communicated to you.

**Reporting Serious Adverse Events**

The Ethics Committee should be notified of all serious adverse events via the Ethics Committee Administrator immediately the incident occurs. Where the adverse incident is

unexpected and serious, the Chair or Vice-Chair will decide whether the study should be terminated pending the opinion of an independent expert. The adverse event will be considered at the next Committee meeting and a decision will be made on the need to change the information leaflet and/or study protocol.

3. On completion of the research you must submit a brief report (a maximum of two sides of A4) of your findings/concluding comments to the Committee, which includes in particular issues relating to the ethical implications of the research.

Yours sincerely

**Chair of the UCL Ethics Committee**

Cc: Sophie Fyfe and Claire Williams, Trainee Clinical Psychologists, Sub-Department of Clinical Health Psychology, UCL

### **APPENDIX 3: Questionnaires, Measures and Scoring Criteria**

**STA** - Questionnaire

**O-LIFE** - Questionnaire  
- Key to sub-scale items

**Stories Task** - ToM, physical and random stories  
- Example scoring criteria

**Triangles Task** - Example scoring criteria



## STA QUESTIONNAIRE

Age.....

Sex *M F* (please delete either *M* or *F* leaving only your response)

Please answer each question by deleting either *Y* or *N* leaving only your response.

1. Do you believe in telepathy?  
Y N
2. Do you often feel that other people have it in for you?  
Y N
3. When in the dark do you often see shapes and forms, even though there's nothing there?  
Y N
4. If you say you will do something, do you always keep your promise no matter how inconvenient it might be?  
Y N
5. Does your own voice ever seem distant, faraway?  
Y N
6. Does it often happen that almost every thought immediately and automatically suggests an enormous number of ideas?  
Y N
7. Do you ever become over sensitive to light or noise?  
Y N
8. Were you ever greedy by helping yourself to more than your share of anything?  
Y N
9. Do you often have vivid dreams that disturb your sleep?  
Y N
10. When you are worried or anxious do you have trouble with your bowels?  
Y N
11. Have you ever felt when you looked in a mirror that your face seemed different?  
Y N

12. Have you ever blamed someone for doing something you knew was really your fault?  
Y N
13. Do you think it is safer to trust nobody?  
Y N
14. Do things sometimes feel as if they were not real?  
Y N
15. Do you feel lonely most of the time even when you're with people?  
Y N
16. Are *all* your habits good and desirable ones?  
Y N
17. Do everyday things sometimes seem unusually large or small?  
Y N
18. Are you often bothered by the feeling that people are watching you?  
Y N
19. Do you feel that you cannot get 'close' to other people?  
Y N
20. Have you ever taken anything (even a pin or a button) that belonged to someone else?  
Y N
21. Do you dread going into a room by yourself where other people have already gathered and are talking?  
Y N
22. Does your sense of smell sometimes become unusually strong?  
Y N
23. Are you sometimes sure that other people can tell what you are thinking?  
Y N
24. Have you ever broken or lost something belonging to someone else?  
Y N
25. Have you ever had the sensation of your body or part of it changing shape?  
Y N

26. Do you ever feel sure that something is about to happen even though there doesn't seem to be any reason for your thinking that?  
Y N
27. Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?  
Y N
28. Have you ever said anything bad or nasty about anyone?  
Y N
29. Do you ever have a sense of vague danger or sudden dread for reasons that you do not understand?  
Y N
30. Have you ever thought you heard people talking only to discover that it was in fact some nondescript noise?  
Y N
31. Do your thoughts ever stop suddenly causing you to interrupt what you're saying?  
Y N
32. As a child were you ever cheeky to your parents?  
Y N
33. Do you feel that you have to be on guard even with your friends?  
Y N
34. Do you feel that your thoughts don't belong to you?  
Y N
35. When in a crowded room do you often have difficulty in following a conversation?  
Y N
36. Have you ever cheated at a game?  
Y N
37. Do you sometimes feel that your accidents are caused by mysterious forces?  
Y N
38. Do you feel at times that people are talking about you?  
Y N

39. Do you believe that dreams can come true?  
Y N
40. Have you ever taken advantage of someone?  
Y N
41. Do you ever feel that your speech is difficult to understand because the words are all mixed up and don't make sense?  
Y N
42. Are your thoughts sometimes so strong that you can almost hear them?  
Y N
43. When coming into a new situation, have you ever felt strongly that it was a repeat of something that has happened before?  
Y N
44. Do you always practice what you preach?  
Y N
45. Have you ever felt that you were communicating with another person telepathically?  
Y N
46. Are you easily distracted from work by daydreams?  
Y N
47. Are you very hurt by criticism?  
Y N
48. Do you sometimes put off until tomorrow what you ought to do today?  
Y N
49. Do you ever get nervous when someone is walking behind you?  
Y N

Thank you for your time.

## O-LIFE QUESTIONNAIRE

**Please read these instructions before completing the questionnaire:**

These questions relate to your thoughts, feelings, experiences and preferences. There are no right or wrong answers or trick questions so please be as honest as possible.

For each question please choose either YES or NO and circle this on the form. Please do not spend too much time thinking about it – choose the answer closest to your own.

1. Do you often hesitate when you are going to say something in a group of people whom you more or less know?
2. Do you often overindulge in alcohol or food?
3. Are the sounds you hear in your daydreams really clear and distinct?
4. Do you enjoy many different kinds of play and recreation?
5. Do your thoughts sometimes seem as real as actual events in your life?
6. Does it often happen that nearly every thought immediately and automatically suggests an enormous number of ideas?
7. When in a group of people do you usually prefer to let someone else be the centre of attention?
8. Do you frequently have difficulty in starting to do things?
9. Has dancing or the idea of it always seemed dull to you?
10. When you catch a train do you often arrive at the last minute?
11. Is trying new foods something you have always enjoyed?
12. Do you often change between intense liking and disliking of the same person?
13. Have you ever cheated at a game?
14. Are there very few things that you have ever really enjoyed doing?
15. Do you at times have an urge to do something harmful or shocking?
16. Do you often worry about things you should not have done or said?
17. Are your thoughts sometimes so strong that you can almost hear them?
18. Are you usually in an average sort of mood, not too high and not too low?
19. Would you take drugs which may have strange or dangerous effects?
20. Do you think you could learn to read other's minds if you wanted to?
21. When in a crowded room, do you often have difficulty in following a conversation?
22. No matter how hard you try to concentrate do unrelated thoughts creep into your mind?
23. Are you easily hurt when people find fault with you or the work you do?

24. Do you stop to think things over before doing anything?
25. Have you ever felt that you have special, almost magical powers?
26. Are you much too independent to really get involved with other people?
27. Do ideas and insights sometimes come to you so fast that you cannot express them all?
28. Do you easily lose your courage when criticised or failing in something?
29. Can some people make you aware of them just by thinking about you?
30. Does a passing thought ever seem so real it frightens you?
31. Have you ever blamed someone for doing something you know was really your fault?
32. Are you a person whose mood goes up and down easily?
33. Does your voice ever seem distant or faraway?
34. Do you think having close friends is not as important as some people say?
35. Are you rather lively?
36. Are you sometimes so nervous that you are 'blocked'?
37. Do you find it difficult to keep interested in the same thing for a long time?
38. Do you dread going into a room by yourself where other people have already gathered and are talking?
39. Does it often feel good to massage your muscles when they are tired or sore?
40. Do you sometimes feel that your accidents are caused by mysterious forces?
41. Do you like mixing with people?
42. On seeing a soft thick carpet have you sometimes had the impulse to take off your shoes and walk barefoot on it?
43. Do you often have difficulties in controlling your thoughts?
44. Do the people in your daydreams seem so true to life that you sometimes think they are real?
45. Are people usually better off if they stay aloof from emotional involvements with people?
46. Can just being with friends make you feel really good?
47. Is your hearing sometimes so sensitive that ordinary sounds become uncomfortable?
48. Have you often felt uncomfortable when your friends touch you?
49. When things are bothering you do you like to talk to other people about it?
50. Do you have many friends?
51. Would being in debt worry you?

52. Do you think people spend too much time safeguarding their future with savings and insurance?
53. Do you ever have the urge to break or smash things?
54. Do you often feel that there is no purpose to life?
55. Do you worry about awful things that might happen?
56. Have you ever felt the urge to injure yourself?
57. Would it make you nervous to play the clown in front of other people?
58. Have you felt that you might cause something to happen just by thinking too much about it?
59. Have you had very little fun from physical activities like walking, swimming, or sports?
60. Do you feel so good at controlling others that it sometimes scares you?
61. Are you easily distracted from work by daydreams?
62. Are you easily confused if too much happens at the same time?
63. Do you ever have a sense of vague danger or sudden dread for reasons that you do not understand?
64. Is it true that your relationships with other people never get very intense?
65. Have you sometimes had the feeling of gaining or losing energy when certain people look at you or touch you?
66. Do you worry too long after an embarrassing experience?
67. Do you love having your back massaged?
68. Do you consider yourself to be pretty much an average kind of person?
69. Have you ever taken advantage of someone?
70. Would you like other people to be afraid of you?
71. Have you ever thought you heard people talking only to discover that it was in fact some nondescript noise?
72. Have you occasionally felt as though your body did not exist?
73. Do you often feel lonely?
74. Do you often have an urge to hit someone?
75. Do you often experience an overwhelming sense of emptiness?
76. On occasions, have you seen a person's face in front of you when no one was in fact there?
77. Is it fun to sing with other people?
78. Do you often have days when indoor lights seem so bright that they bother your eyes?

79. Have you wondered whether the spirits of the dead can influence the living?
80. Do people who try to get to know you better usually give up after a while?
81. Do you often feel 'fed up'?
82. Have you felt as though your head or limbs were somehow not your own?
83. When you look in the mirror does your face sometimes seem quite different from usual?
84. Do people who drive carefully annoy you?
85. Would you call yourself a nervous person?
86. Can you usually let yourself go and enjoy yourself at a lively party?
87. Do you ever suddenly feel distracted by distant sounds that you are not normally aware of?
88. Do you sometimes talk about things you know nothing about?
89. When in the dark do you often see shapes and forms even though there's nothing there?
90. Have you sometimes sensed an evil presence around you, even though you could not see it?
91. Is it hard for you to make decisions?
92. Do you find the bright lights of a city exciting to look at?
93. Does your sense of smell sometimes become unusually strong?
94. Do you usually have very little desire to buy new kinds of food?
95. Do you ever feel that your speech is difficult to understand because the words are all mixed up and don't make sense?
96. Do you often feel like doing the opposite of what other people suggest, even though you know they are right?
97. Do you like going out a lot?
98. Do you feel very close to your friends?
99. Do you ever feel sure that something is about to happen, even though there does not seem to be any reason for you thinking that?
100. Do you often feel the impulse to spend money which you know you can't afford?
101. Are you easily distracted when you read or talk to someone?
102. Do you feel that making new friends isn't worth the energy it takes?
103. Do you believe in telepathy?
104. Do you prefer watching television to going out with other people?

---

Thank you very much for taking the time and effort to fill this in.



**Key to O-LIFE sub-scale items:**

Unusual Experiences:	3, 5, 6, 17, 20, 25, 27, 29, 30, 33, 40, 44, 47, 58, 60, 63, 65, 71, 72, 76, 78, 79, 82, 83, 87, 89, 90, 93, 99, 103
Cognitive Disorganisation:	1, 8, 16, 21, 23, 28, 32, 36, 37, 38, 43, 54, 55, 61, 62, 66, 73, 75, 81, 85, 91, 95, 101
Intravertive Anhedonia:	4, 9, 11, 14, 26, 34, 35, 39, 41, 42, 45, 46, 48, 49, 50, 59, 64, 67, 77, 80, 86, 92, 94, 97, 98, 102, 104
Impulsive Non-Conformity:	2, 7, 10, 12, 13, 15, 18, 19, 22, 24, 31, 51, 52, 53, 56, 57, 68, 69, 70, 74, 84, 88, 96, 100

## STORIES TASK

### Instructions

At the start of the task, the tester says: 'I am going to play you some stories and after each one there will be a question. I want you to listen to the story and then answer the question. First of all there will be a practice story so you can get the hang of it. Are you ready?'

### Practice

On Christmas Eve, Alice's mother takes her to the big department store in town. They go to look in the toy department. In the toy department Mr. Brown, Alice's next-door neighbour is dressed up as Santa Claus, giving out sweets to all the children. Alice thinks she recognises Mr. Brown, so she runs up to him and asks, "Who are you?" Mr. Brown answers, "I'm Santa Claus!"

Q: Why does he say this?

### ToM Stories

Simon is a big liar. Simon's brother Jim knows this; he knows that Simon never tells the truth! Now yesterday Simon stole Jim's ping-pong paddle, and Jim knows Simon has hidden it somewhere, though he can't find it. He's very cross. So he finds Simon and he says, "Where is my ping-pong paddle? You must have hidden it either in the cupboard or under your bed, because I've looked everywhere else. Where is it, in the cupboard or under your bed?" Simon tells him the paddle is under his bed.

Q: Why will Jim look in the cupboard for the paddle?

During the war, the Red army captures a member of the Blue army. They want him to tell them where his army's tanks are; they know they are either by the sea or in the mountains. They know that the prisoner will not want to tell them, he will want to save his army, and so he will certainly lie to them. The prisoner is very brave and very clever; he will not let them find his tanks. The tanks are really in the mountains. Now when the other side ask him where his tanks are, he says, "They are in the mountains".

Q: Why did the prisoner say that?

Brian is always hungry. Today at school it is his favourite meal - sausages and beans. He is a very greedy boy, and he would like to have more sausages than anybody else, even though his mother will have made him a lovely meal when he gets home! But everyone is allowed two sausages and no more. When it is Brian's turn to be served, he says, "Oh, please can I have four sausages, because I won't be having any dinner when I get home!"

Q: Why does Brian say this?

Jill wanted to buy a kitten, so she went to see Mrs. Smith, who had lots of kittens she didn't want. Now Mrs. Smith loved the kittens, and she wouldn't do anything to harm them, though she couldn't keep them all herself. When Jill visited she wasn't sure she wanted one of Mrs. Smith's kittens, since they were all males and she had wanted a female. But Mrs. Smith said, "If no one buys the kittens I'll just have to drown them!"

Q: Why did Mrs. Smith say that?

One day Aunt Jane came to visit Peter. Now Peter loves his aunt very much, but today she is wearing a new hat; a new hat, which Peter thinks is very ugly indeed. Peter thinks his aunt looks silly in it, and much nicer in her old hat. But when Aunt Jane asks Peter, "How do you like my new hat?" Peter says, "Oh, its very nice".

Q: Why does he say that?

Helen waited all year for Christmas, because she knew at Christmas she could ask her parents for a rabbit. Helen wanted a rabbit more than anything in the world. At last Christmas Day arrived, and Helen ran to unwrap the big box her parents had given her. She felt sure it would contain a little rabbit in a cage. But when she opened it, with all the family standing round, she found her present was just a boring old set of encyclopaedias, which Helen did not want at all! Still, when Helen's parents asked her how she liked her Christmas present, she said, "It's lovely, thank you. It's just what I wanted".

Q: Why did she say this?

Late one night old Mrs. Peabody is walking home. She doesn't like walking home alone in the dark because she is always afraid that someone will attack her and rob her. She really is a very nervous person! Suddenly, out of the shadows comes a man. He wants to ask Mrs. Peabody what time it is, so he walks towards her. When Mrs. Peabody sees the man coming towards her, she starts to tremble and says, "Take my purse, just don't hurt me please!"

Q: Why did she say that?

A burglar who has just robbed a shop is making his getaway. As he is running home, a policeman on his beat sees him drop his glove. He doesn't know the man is a burglar; he just wants to tell him he dropped his glove. But when the policeman shouts out to the burglar, "Hey, you! Stop!" the burglar turns round, sees the policeman, and gives himself up. He puts his hands up and admits that he did the break-in at the local shop.

Q: Why did the burglar do that?

### **Physical Stories**

Two enemy powers have been at war for a very long time. Each army has won several battles, but now the outcome could go either way. The forces are equally matched. However, the Blue army is stronger than the Yellow army in foot soldiers and artillery. But the Yellow army is stronger than the Blue Army in air power. On the day of the final battle, which will decide the outcome of the war, there is heavy fog over the mountains where the fighting is about to occur. Low-lying clouds hang above the soldiers. By the end of the day the Blue army has won.

Q: Why did the Blue army win?

A burglar is about to break into a jewellers' shop. He skilfully picks the lock on the shop door. Carefully he crawls under the electronic detector beam. If he breaks this beam it will set off the alarm. Quietly he opens the door of the storeroom and sees the gems glittering. As he reaches out, however, he steps on something soft. He hears a screech and something small and furry runs out past him, towards the shop door. Immediately the alarm sounds.

Q: Why did the alarm go off?

Mrs. Simpson, the librarian, receives a special book, which she has to catalogue and find an appropriate place for. She has to decide which section to file it under. The library is very big, and has different sections on many different subjects. The new book is about plants and their medical uses, and is heavily illustrated. However, Mrs. Simpson does not put it on the shelf with the rest of the books on botany. Neither does she put it with the books on medicine. Instead, she carefully takes it into a separate room. In this room all the books are kept in special cases, and the temperature is kept constant.

Q: Why did she do this?

Henry is preparing for a big dinner party. He is famous for his excellent mayonnaise. He has bought lots of fresh eggs. The recipe says, "Carefully separate the yolks of six eggs and add oil very gradually". He has already bought easily enough dessert to feed everyone. However, he now looks up the recipe for meringues. Henry will not waste anything.

Q: Why does Henry make meringues?

Paul is very rich, and today he is going to buy an expensive new car. He is considering whether to make a single payment, or whether to spread the cost over the year. If he pays in monthly instalments, the dealer will charge five percent interest on the loan. His bank currently gives him eight percent interest on the money in his account. Even though he has easily enough money to pay the full amount, he decides to pay by monthly instalments.

Q: Why does he do that?

Old Mrs. Robinson is very frail. One day she slips on her icy doorstep and falls on her side. She gets up right away, although she feels quite bruised and shaken. The next day her leg feels very stiff and she can scarcely walk. She makes her way to the doctors. As soon as the doctor hears about the fall, and sees her swollen side, he says, "Go immediately to the hospital". At the hospital they take an X-ray.

Q: Why did they take an X-ray?

Sarah is very long-sighted. She has only one pair of glasses, which she keeps losing. Today she has lost her glasses again and she needs to find them. She had them yesterday evening when she looked up the television programs. She must have left them somewhere that she has been today. She asks Ted to find her glasses. She tells him that today she went to her regular early morning exercise class, then to the post office, and last to the flower shop. Ted goes straight to the post office.

Q: Why is the post office the most likely place to look?

John is going shopping. He buys a nice new desk lamp, for his study. He needs a light bulb for his new lamp. He goes from the furniture department to the electrical department. In the electrical department he finds that there are two brands of light bulb of the right kind. Everbrite light bulbs cost less in single packs than Literite bulbs. However, only Literite bulbs come in multi-packs of six. John buys the multi-pack, even though he only needs one bulb.

Q: Why does John buy the Literite bulbs?

## **Random Stories**

Two football teams are playing against each other for the second time in the season. One is playing in yellow and the other is playing in red. The yellow team are playing at home but they are all very nervous. They run twice around the pitch before the match. They are playing in a new stadium, which is much bigger than the old stadium. It has been raining hard all morning but the sun comes out as soon as the match begins. The yellow team substitute a player after twenty minutes.

Q. Why do the yellow team substitute a player?

Pete has a brother called David. Pete is six foot two and taller than his brother. On Friday Pete had a cup of tea in the café five doors down from his house and read an article about global warming in the newspaper. He was in an irritable mood. He booked a holiday to a seaside resort in the south of Spain. He had a conversation with his brother on the telephone and said at the end of the conversation, "I had better go now but please come and visit soon." Pete hoovered the floor before going to bed.

Q. Why did Pete Hoover the floor?

Amy likes her school very much. Her favourite subject is Art. Today she got to school early and sat at the back of the class. She played in the playground at break time. In the afternoon she did some difficult sums and managed to finish them all by herself and faster than everyone else. After school she went round to her piano teacher's house next to the post-office for a piano lesson. She took her favourite piece of music and wore her red shoes.

Q. Why did Amy wear her red shoes?



Mrs Williams has long blond hair. She went to the park with her dog for a morning walk. She is teaching Jenny who lives down the road how to knit. When they last met, Jenny said, "I keep dropping stitches when I try to knit quickly." Mrs Williams planted some purple flowers in her garden. She had a bath with some bubble bath that she liked the smell of. She watched Coronation Street on television. She changed the light bulb in the hall.

Q. Why did Mrs Williams change the light bulb?

Aunt Anne said to Tom, "I have given up smoking." It was Saturday. She made some biscuits and chocolate cake to have for tea. In the supermarket she bought lots of vegetables to make a big pot of soup. She walked three blocks down the road to post a letter. She surfed the Internet for an hour and a half before dinner.

Q. Why did Aunt Anne surf the Internet?

Mrs Evans is very old. She was sick three times in the morning and called Dr Jackson who came round quickly. She was wearing her favourite yellow dress. Mrs Evans used to be a dancer and likes to watch ballet on television. She had a ham sandwich for lunch. She lost her green brooch when she was cleaning the house the day before. In the afternoon she paid her electricity bill at the local bank.

Q. Why did she pay her electricity bill?

Steven got up at 7.30 in the morning. It was his birthday and his parents gave him some computer games. He had breakfast with his family and ate toast and honey. He looked on the Internet for some books about turtles that he wanted to read but hadn't been able

to find in the bookshop. He rode his bicycle round the block very fast, passing a shop that had just opened in the village square. He stopped to read a big blue poster stuck to the bus shelter. He had a glass of orange squash and watched a science fiction programme on television.

Q. Why did Steven watch a science fiction programme?

A joyrider stole a white Vauxhall Astra and drove it into the centre of town. He passed a traffic warden who was putting a ticket on a car that was parked on a double yellow line. It was a very windy day although it had been sunny in the morning. The joyrider went home and washed his windows with a new cleaning product he had seen advertised on television and went for a drink in the local pub.

Q. Why did the joyrider go for a drink in the pub?

### **Scoring Criteria**

#### ***Accuracy - ToM and physical stories***

- 2 points: Full and complete answer
- 1 point: Incomplete or partially correct answer
- 0 points: Incorrect answer

#### ***Accuracy - Random stories***

- 2 points: Response referring to lack of available information relevant to the question
- 1 point: Simple response involving an obvious inference
- 0 points: Obscure or elaborate response

### ***Response type***

Responses were categorised as ‘mentalizing’, ‘physical’ or ‘random’ according to the criteria below.

**Mentalizing:** Any response involving mental state attribution e.g. thinking, wanting, tricking, lying.

**Physical:** Any response referring to physical causation without reference to mental states.

**Random:** Any response referring to the random nature of the passage, and/or the inability to deduce a response from available information, without reference to physical causation or mental states.

### ***‘Reading meaning in randomness’ score***

A ‘reading meaning in randomness’ score was computed by summing the number of connections made between distinct bits of information in the each story, and the number of elaborations given (pieces of information added to the most simple response).

### **Examples of Accuracy Scores**

#### ***ToM condition***

- Jim and the ping pong bat

2 points: Reference to Jim knowing Simon lies.

E.g. Because Simon has not told the truth.

He knows Simon is a liar and will try to make him look in a different place.

1 point: ref to facts (e.g. that's where it really is), or Simon hiding it without ref to implications of lying.

E.g. He thinks that Simon has hidden it in the cupboard.

0 points: Reference to general non-specific information.

E.g. Because he looked everywhere else.

Because Simon told him it was there.

He knows it's either in the cupboard or under the bed.

Because he normally kept the paddle there.

- Mrs Smith and the kitten

2 points: Reference to persuasion, manipulating feelings, trying to induce guilt/pity etc.

E.g. She would make Jill feel sorry for the kittens and make her take one.

To make Jill feel guilty and take one.

To scare Jill into buying one.

She wanted to emotionally blackmail Jill and force her to buy one.

1 point: Reference to outcome (to sell them or get rid of them in a way which implies not drowning), or simple motivation (to make Jill sad)

E.g. So Jill buys a kitten anyway.

There are too many of them and she can't keep them so she wants Jill to take one.

She wants the girl to take one.

0 points: Reference to general knowledge or dilemma without realisation that the statement was not true

E.g. She's a horrible woman / she hates cats/there are too many and she can't keep them / Her house isn't big enough.

She wants a female cat.

### ***Physical condition***

- Leg and X-ray

2 points: Reference to possibility that she has fractured/broken her hip/leg (e.g. they want to see if she's broken anything). Reference to wanting to know or trying to find out (i.e. 'it was broken' is not enough). Must ref to fact that they know that x-rays are about broken things or bones.

E.g. To see if there's any damage to the bone.

To see how bad the fracture could be.

1 point: Reference to general aim (e.g. to see what's wrong. Because of her fall she might have damaged something).

E.g. It's bruised and stiff.

To see why it's stiff.

0 points: Reference to irrelevant or incorrect factors (e.g. that's what doctors do).

Reference to X-rays being cures themselves (e.g. to mend her leg).

E.g. Because she fell.

To make it better.

- Armies and fog

2 points: Reference to both weather conditions and relative ground superiority or inability of other army's planes to be useful in fog (names of armies unimportant).

E.g. It was foggy and so the planes couldn't see the ground and so it was difficult for them to shoot the soldiers. So the foot soldiers had the advantage.

1 point: Reference either to weather or to relative superiority on ground versus air (e.g. because it was foggy). Nothing about why weather makes it especially difficult for planes or nothing about planes being affected more than tanks. Reference to fog to justify incorrect response (e.g. the aeroplanes won because the fog meant they could hide from the tanks).

E.g. It was foggy.

The army on the ground was stronger than the army in the air.

0 points: Reference to irrelevant or incorrect information (e.g. they won because they had better planes). Justifications for why tanks are better than planes.

E.g. Because that's where they were after the war with the yellow army.

They had aeroplanes, which can shoot tanks from the air.

The other soldiers lost.

Foot soldiers and tanks can't see when it's really foggy but planes can fly through the air.

***Random condition***

- Amy and her red shoes

2 points: Reference to the lack of available information in the story

E.g. I don't know

It doesn't tell you in the story

1 point: Reference to an obvious reason for wearing red shoes

E.g. Because she wanted to

Because they were the shoes she was wearing that day

0 point: Elaborate or obscure response

E.g. Because they matched the post box

Because they were her lucky shoes and she was having a very  
lucky day

- Football team substituting a player

2 points: Reference to the lack of available information in the story

E.g. I don't know

It doesn't tell you in the story

1 point: Reference to an obvious reason for substituting a player

E.g. Because the other player was injured

Because a player was tired and needed to come off

0 point: Elaborate or obscure response

E.g. Because one of the players was so nervous that he slipped in the rainy pitch because he was nervous

Because they were in a new stadium so they wanted to change players often



## TRIANGLES TASK

### **Instructions**

At the start of the task, the tester says: ‘In a moment I’m going to play you some animations. I want you to watch each animation and then tell me what you think was happening in it. First of all there will be two practices so you can get the hang of it. Are you ready?’

After each item, participants are asked: ‘What do you think was happening in that one?’

### **Scoring Criteria**

#### *Accuracy*

- 2 points: Spot-on description of the story or the actions represented; can be concise just capturing gist, or can be discursive
- 1 point: Partial description of the sequence; description is related to the sequence, but imprecise or incomplete
- 0 point: Bizarre descriptions, plainly wrong descriptions, and responses that focus solely on a minor unimportant aspect of the sequence

#### *Response type*

Responses were categorized as ‘mentalizing’, ‘interaction/goal directed’ or ‘random’ according to the following criteria. In each case the highest level of descriptive language is scored (i.e. mentalizing trumps interaction trumps action).

Mentalizing: Any response which uses mental states verbs e.g. wanting; hiding; tricking; pretending; being naughty. NOT: complex interaction, e.g. chasing each other round the house; x pushing y out of the way. NOT: solely direct speech.

Interaction/goal-directed: Specific reference to purposeful movement, without reference to mental states e.g. following; fighting; copying; racing. More than one action may be described, e.g. leading and following. NOT: purposeless action. NOT: implied mental state attribution.

Random: Simple action, no mention of a goal and no reference to interaction of the characters or to mental states, e.g. floating.

### ***'Reading meaning in randomness' score***

A 'reading meaning in randomness' score was computed by summing the number of references made to connections between the movements of the two triangles in each animation, and the number of elaborations given (pieces of information added to the most simple response).

### **Examples of Accuracy Scores**

#### ***Random Condition***

Floating/Bouncing: Character roles: just triangles (both sequences without enclosure)

2 points: Anything implying random or purposeless movement including moving, bouncing, just dancing

1 point: Purposeful movement without interaction, including turning round and getting dizzy, dancing in a circle

0 points: Purposeful movement implying interaction between the triangles including copying each other; avoiding each other

***Physical condition***

- Fighting: Character roles: two deer. No enclosure.

2 points: Action implying physical fight, e.g. bashing each other

1 point: Action that conveys the idea of a conflict but is either too specific or too vague, e.g. biting; pushing

0 points: Action that does not relate to conflict, e.g. following each other

- Following: Character roles: mother duck and duckling. Enclosure.

2 points: Description that conveys following each other

1 point: Description that is related to but somewhat remote from following, e.g. copying; chasing

0 points: Action that does not relate to following each other, e.g. jumping

***ToM condition***

- Surprising: Character roles: grandma and grandson. Enclosure.

2 points: Any mention of boy tricking, surprising his grandma; hiding, hide and seek

1 point: Description that gives part of the story but misses the critical point (see above)

- 0 points: Description which gives only minor part of action e.g. knocking on the door, or does not relate to any of the events in the sequence.
- Coaxing: Character roles: mother and child. Enclosure.
- 2 points: Description that conveys child's reluctance to go out and mother's attempts to get child out, e.g. persuading
- 1 point: Partially correct description focusing on one aspect of the story or one character only, e.g. child does not want to go out; or, mother is pushing child to go out
- 0 points: Actions that do not relate to the events or relate to a minor aspect of the sequence only, e.g. dancing together, or unrelated description.

**APPENDIX 4: Correlations Between O-LIFE Scores and Control Variables**

**Correlations between O-LIFE scores and control variables (two-tailed)**

		<b>O-LIFE standard score total</b>	<b>O-LIFE UE standard score</b>	<b>O-LIFE CD standard score</b>	<b>O-LIFE IA standard score (transformed)</b>	<b>O-LIFE IN standard score</b>
<b>Hayling</b>	Pearson r	-0.26*	-0.22	-0.27*	-0.089	-0.23
	Sig.	0.043	0.084	0.034	0.49	0.076
	N	62	62	62	62	62
<b>Performance IQ</b>	Pearson r	-0.17	-0.17	-0.091	-0.082	-0.16
	Sig.	0.20	0.19	0.48	0.53	0.21
	N	62	62	62	62	62
<b>Verbal IQ</b>	Pearson r	-0.16	-0.16	-0.087	-0.084	-0.16
	Sig.	0.21	0.21	0.50	0.52	0.23
	N	62	62	62	62	62

**APPENDIX 5: Correlations Between Experimental and Control Variables**

**Table 1: Stories Task - Parametric correlations between experimental and control variables**

**Table 2: Triangles Task - Parametric correlations between experimental and control variables**

**Table 3: Stories and Triangles Tasks - Non-parametric correlations between experimental and control variables**

**Table 1: Stories Task - Parametric correlations between experimental and control variables (two-tailed)**

		Accuracy in ToM condition	Accuracy in physical condition	Accuracy in random condition	Reading meaning in randomness	Mental state attributions in random condition	Mental state attributions in physical condition
<b>Hayling</b>	Pearson r	0.05	0.15	-0.033	-0.033	0.001	0.001
	Sig.	0.70	0.26	0.80	0.80	0.99	0.996
	N	61	62	62	61	62	62
<b>Performance IQ</b>	Pearson r	0.19	0.15	0.12	0.005	-0.046	0.032
	Sig.	0.13	0.25	0.36	0.97	0.72	0.80
	N	61	62	62	61	62	62
<b>Verbal IQ</b>	Pearson r	0.19	0.15	0.11	0.016	-0.042	0.005
	Sig.	0.14	0.25	0.41	0.90	0.74	0.97
	N	61	62	62	61	62	62

\* Variable square root transformed



**Table 2: Triangles Task - Parametric correlations between experimental and control variables (two-tailed)**

		<b>Accuracy in ToM condition</b>	<b>Accuracy in physical condition</b>	<b>Reading meaning in randomness*</b>
<b>Hayling</b>	Pearson r	0.234	0.16	-0.23
	Sig.	0.068	0.23	0.071
	N	62	62	61
<b>Performance IQ</b>	Pearson r	-0.18	-0.15	0.12
	Sig.	0.17	0.26	0.37
	N	62	62	61
<b>Verbal IQ</b>	Pearson r	-0.17	-0.13	0.12
	Sig.	0.18	0.31	0.35
	N	62	62	61

\* Variable square root transformed

**Table 3: Stories and Triangles Tasks - Non-Parametric correlations between experimental and control variables (two-tailed)**

		Triangles				Stories	
		Accuracy in random condition	Reading meaning into randomness	Agency attributions in random condition	Mental state attributions in physical condition	Reading meaning into randomness	Mental state attributions in physical condition
<b>Hayling</b>	$\rho$	0.18	-0.21	-0.16	-0.15	-0.079	-0.029
	Sig.	0.17	0.097	0.22	0.23	0.54	0.83
	N	62	62	62	62	62	62
<b>Performance IQ</b>	$\rho$	-0.14	0.10	0.15	-0.055	0.010	0.028
	Sig.	0.27	0.43	0.23	0.67	0.94	0.83
	N	62	62	62	62	62	62
<b>Verbal IQ</b>	$\rho$	-0.15	0.10	0.16	-0.053	0.027	0.011
	Sig.	0.25	0.43	0.22	0.68	0.83	0.93
	N	62	62	62	62	62	62

**APPENDIX 6: Correlations Between Experimental Variables**

**Correlations between experimental variables**

		Stories						Triangles						
		Accuracy ToM condition	Accuracy Physical condition	Accuracy Random condition	Reading meaning in randomness	Mental state responses Physical condition	Mental state responses Random condition	Accuracy ToM condition	Accuracy Physical condition	Accuracy Random condition	Reading meaning in randomness	Agency attributions Random condition	Mental state responses Physical condition	
<b>Stories</b>	<b>Accuracy ToM condition</b>	$\rho$	1.000	0.218	-0.060	0.217	0.032	0.139	-0.017	0.047	0.125	-0.127	-0.050	-0.224
		Sig.	.	0.088	0.645	0.090	0.806	0.281	0.895	0.715	0.333	0.326	0.700	0.081
		N	62	62	62	62	62	62	62	62	62	62	62	62
	<b>Accuracy Physical condition</b>	$\rho$	0.218	1.000	-0.267*	0.372**	0.065	0.259*	-0.062	0.136	-0.193	0.139	0.217	0.078
		Sig.	0.088	.	0.036	0.003	0.616	0.042	0.634	0.292	0.133	0.282	0.090	0.545
		N	62	62	62	62	62	62	62	62	62	62	62	62
	<b>Accuracy Random condition</b>	$\rho$	-0.060	-0.267*	1.000	-0.740**	0.061	-0.477**	0.147	0.016	0.102	-0.204	-0.139	-0.225
		Sig.	0.645	0.036	.	0.000	0.640	0.000	0.255	0.902	0.432	0.112	0.281	0.078
		N	62	62	62	62	62	62	62	62	62	62	62	62
	<b>Reading meaning in randomness</b>	$\rho$	0.217	0.372**	-0.740**	1.000	0.003	0.411**	-0.161	-0.035	-0.007	0.143	0.040	0.041
		Sig.	0.090	0.003	0.000	.	0.983	0.001	0.210	0.789	0.956	0.266	0.758	0.750
		N	62	62	62	62	62	62	62	62	62	62	62	62
	<b>Mental state responses Physical condition</b>	$\rho$	0.032	0.065	0.061	0.003	1.000	0.195	-0.245	-0.027	0.159	-0.183	-0.214	0.047
		Sig.	0.806	0.616	0.640	0.983	.	0.129	0.055	0.834	0.217	0.154	0.095	0.716
	N	62	62	62	62	62	62	62	62	62	62	62	62	
<b>Mental state responses Random condition</b>	$\rho$	0.139	0.259*	-0.477**	0.411**	0.195	1.000	-0.343**	0.052	-0.064	0.079	0.067	0.195	
	Sig.	0.281	0.042	0.000	0.001	0.129	.	0.006	0.688	0.623	0.544	0.604	0.129	
	N	62	62	62	62	62	62	62	62	62	62	62	62	

		Stories						Triangles						
		Accuracy ToM condition	Accuracy Physical condition	Accuracy Random condition	Reading meaning in randomness	Mental state responses Physical condition	Mental state responses Random condition	Accuracy ToM condition	Accuracy Physical condition	Accuracy Random condition	Reading meaning in randomness	Agency attributions Random condition	Mental state responses Physical condition	
<b>Triangles</b>	<b>Accuracy ToM condition</b>	$\rho$	-0.017	-0.062	0.147	-0.161	-0.245	-0.343**	1.000	0.256*	-0.149	0.106	0.132	-0.031
		Sig.	0.895	0.634	0.255	0.210	0.055	0.006	.	0.045	0.247	0.410	0.307	0.810
		N	62	62	62	62	62	62	62	62	62	62	62	62
	<b>Accuracy Physical condition</b>	$\rho$	0.047	0.136	0.016	-0.035	-0.027	0.052	0.256*	1.000	0.020	-0.094	-0.029	-0.113
		Sig.	0.715	0.292	0.902	0.789	0.834	0.688	0.045	.	0.877	0.470	0.826	0.383
		N	62	62	62	62	62	62	62	62	62	62	62	62
	<b>Accuracy Random condition</b>	$\rho$	0.125	-0.193	0.102	-0.007	0.159	-0.064	-0.149	0.020	1.000	-0.894**	-0.945**	-0.384**
		Sig.	0.333	0.133	0.432	0.956	0.217	0.623	0.247	0.877	.	0.000	0.000	0.002
		N	62	62	62	62	62	62	62	62	62	62	62	62
	<b>Reading meaning in randomness</b>	$\rho$	-0.127	0.139	-0.204	0.143	-0.183	0.079	0.106	-0.094	-0.894**	1.000	0.841**	0.395**
		Sig.	0.326	0.282	0.112	0.266	0.154	0.544	0.410	0.470	0.000	.	0.000	0.001
		N	62	62	62	62	62	62	62	62	62	62	62	62
<b>Agency attributions Random condition</b>	$\rho$	-0.050	0.217	-0.139	0.040	-0.214	0.067	0.132	-0.029	-0.945**	0.841**	1.000	0.322*	
	Sig.	0.700	0.090	0.281	0.758	0.095	0.604	0.307	0.826	0.000	0.000	.	0.011	
	N	62	62	62	62	62	62	62	62	62	62	62	62	
<b>Mental state responses Physical condition</b>	$\rho$	-0.224	0.078	-0.225	.041	0.047	0.195	-0.031	-0.113	-0.384**	0.395**	0.322*	1.000	
	Sig.	0.081	0.545	0.078	0.750	0.716	0.129	0.810	0.383	0.002	0.001	0.011	.	
	N	62	62	62	62	62	62	62	62	62	62	62	62	

\* Correlation is significant at the 0.05 level (two-tailed)

\*\* Correlation is significant at the 0.01 level (two-tailed)