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Theory of mind, schizotypy, and persecutory ideation in young adults

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Introduction. Previous studies of the relation between theory of mind (ToM) and schizotypy have suggested that ToM deficits may be associated with positive signs (e.g., hallucination- and delusion-like experiences). Good theoretical reasons exist to suggest that this relation may be largely due to ToM deficits being predominantly associated with the occurrence of persecutory delusion-like beliefs. This study set out to test this hypothesis and address limitations of previous research.
Method. Online administration of measures to a large nonclinical sample of young adults ($N = 828$) was used to examine schizotypy, assessed by a new 30-item version of the Oxford-Liverpool Inventory of Feelings and Experiences (Mason, Claridge, & Jackson, 1995), persecutory delusion-like beliefs, assessed by the Persecutory Ideation Questionnaire (McKay, Langdon, & Coltheart, 2006), and ToM, indexed by the Hinting task (Corcoran, Mercer, & Frith, 1995) and a cartoon comprehension task (Corcoran, Cahill, & Frith, 1997).
Results. No relations with ToM were found for global, positive, or negative schizotypy, nor persecutory delusion-like beliefs. This was the case both for whole group correlations and in analyses comparing groups formed by fifth-centile (top–bottom) splits by schizotypy scores. Scores on the two ToM tasks were not strongly correlated.
Conclusion. Our findings point to no correlations with ToM for either schizotypy or persecutory ideation. These findings are discussed in relation to previous research.

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INTRODUCTION

The capacity to reason about the mental states and emotions of others, also known as "theory of mind" (ToM), has been proposed to play an important role in psychopathology (Brüne, 2005; Brüne & Brüne-Cohrs, 2006). Frith (1992) proposed that a lack of awareness of others' intentions might lead to persecutory delusions and delusions of reference in patients with schizophrenia. This proposal has been supported by evidence of mentalising deficits specific to patients with paranoid schizophrenia (Corcoran, Cahill, & Frith, 1997; Corcoran & Frith, 1996; Corcoran, Mercer, & Frith, 1995; Frith & Corcoran, 1996; Harrington, Langdon, Siegert, & McClure, 2005). In the first of these studies, Corcoran et al. (1995) assessed the ToM of patients with schizophrenia using the Hinting task, in which participants are required to interpret a series of vignettes ending with one character dropping a hint to another character. Patients with schizophrenia with paranoid features performed more poorly on this task than healthy controls, psychiatric controls with depression and/or anxiety, and patients with schizophrenia exhibiting nonparanoid features (e.g., passivity experiences). Patients with schizophrenia with paranoia in remission had ToM abilities comparable to controls. In a subsequent study (Corcoran et al., 1997), a series of visual cartoon jokes were presented to patients with schizophrenia with paranoid symptoms. Some of these cartoons were based around physical/behavioural humour, whereas others necessitated the understanding of the mental state of the protagonist. Patients found the mental state cartoons more difficult to understand than the non-ToM cartoons, whereas healthy controls and patients in remission understood both forms of cartoon equally well.

Several later studies have failed to replicate these findings of a specific association between persecutory delusions and ToM deficits (e.g., Drury, Robinson, & Birchwood, 1998; Greig, Bryson, & Bell, 2004; Sarfati, Hardy-Bayle, Brunet, & Widlocher, 1999). One reason may be that ToM deficits will be strongest in schizophrenia patients with so-called "behavioural" signs (Frith, 1992), whose cooccurrence with persecutory delusions may potentially confound relations between ToM and persecutory delusions (Pickup & Frith, 2001). Another explanation is that ToM deficits in paranoia are manifested specifically in individuals' tendency to make external-personal attributions for negative events (Bentall, Corcoran, Howard, Blackwood, & Kinderman, 2001), a prediction that has been borne out in findings both with patients (Randall, Corcoran, Day, & Bentall, 2003) and university students (Kinderman, Dunbar, & Bentall, 1998; Taylor & Kinderman, 2002).

These last findings point to the possibility that individual differences in ToM will relate to symptoms of psychopathology in healthy populations.

Such studies have the advantage of avoiding potential confounds such as institutionalisation and medication (Claridge, 1987). In the first study of this type, Langdon and Coltheart (1999) investigated the relation between ToM and schizotypy in healthy adults. Schizotypy has been conceptualised as a nonclinical manifestation of the same underlying biological factors which give rise to schizophrenia and schizophrenia spectrum disorders (Claridge, 1994; Claridge & Beech, 1995). In two studies using the Schizotypal Personality Questionnaire (SPQ; Raine, 1991), Langdon and Coltheart (1999); Exps 1 and 2) found that high- and low-schizotypy groups did not differ in their ability to sequence social script or mechanical stories (not necessitating the use of a ToM), but that high-schizotypy individuals performed worse at sequencing false-belief stories. When Langdon and Coltheart performed median splits on the basis of ToM scores, conflicting results were found. Their Experiment 1 found poorer ToM to be associated with schizotypal interpersonal deficits (e.g., no friends, high social anxiety), but not schizotypal cognitive-perceptual disturbances (e.g., hallucination- or delusion-like experiences) or schizotypal disorganisation, whilst their Experiment 2 found poorer ToM to be associated with schizotypal cognitive-perceptual disturbances and disorganisation, but not interpersonal deficits. These conflicting findings may have had a base in the small sample sizes, and/or the use of a median-split methodology.

Several recent studies have attempted to replicate these findings (see Table 1). No studies subsequent to Langdon and Coltheart (1999) have found a relation between global schizotypy and ToM, although Pickup (2006) found an association between ToM and the schizotypal analogues of the positive symptoms of schizophrenia. Pickup has suggested that the SPQ's strong weighting towards schizotypal analogues of the positive symptoms of schizophrenia may have been primarily responsible for Langdon and Coltheart's finding. There is accordingly a need for replication of these findings employing instruments designed to assess those particular psychosis-like experiences expected to be most strongly associated with ToM deficits. Given Frith's (1992) hypothesis about the role of ToM deficits in delusion formation, one would expect a particularly strong relation between ToM and persecutory delusion-like beliefs.

Another possible reason for the non-replication of Langdon and Coltheart's (1999) findings may relate to the instruments used to assess ToM abilities. Commenting on possibly unfounded assumptions about the reliability and validity of ToM tasks used in such studies, Harrington et al. (2005) note that the use of different ToM tasks, and a failure to report the psychometric properties of these measures, make the results of these studies difficult to interpret. In particular, few studies have employed more than one ToM measure in order to assess convergent validity. Harrington et al. distinguish between two broad categories of ToM tasks used in

TABLE 1
Previous research on schizotypy and theory of mind

	Langdon & Coltheart (1999)	*Pickup (2006)*	*Meyer & Shean (2006)*	*Jahshan & Sergi (2007)*
Schizotypy measure	SPQ	O-LIFE	Magical Ideation Scale (MIS)	SPQ-B
ToM task	Picture sequencing task	ToM and "physical" control stories	Character Intention Test Reading the Mind in the Eyes test	The Awareness of Social Inference Test
Controlled for Analysis	Gender	Age, gender, verbal IQ, executive functioning	None	Age, gender, education
	Median split of SPQ scores followed by ANOVA	(a) Multiple linear regression (b) ANOVA of median split on O-LIFE	Multiple linear regression	High and low fifth-centile splits on SPQ-B scores
Global schizotypy and ToM relations found	Expts. 1 & 2: Higher SPQ total score associated with poorer ToM	Total O-LIFE score and factors not related to ToM (median split analysis)	No global measure used	Total SPQ-B scores not related to ToM
Schizotypy factors and ToM relations found	Expt. 1: Poorer ToM associated with interpersonal factor but not cognitive-perceptual or disorganised	O-LIFE UE factor predicts ToM (regression analysis)	Nonrealism scale of the MIS predicted by both ToM measures	No subscale analysis
	Expt. 2: Poorer ToM associated with cognitive-perceptual and disorganised factors but not Interpersonal	Composite score of CD, IA, & IN O-LIFE factors not predictors of ToM (regression analysis)	New Age Ideas scale of the MIS predicted by Reading the Mind in the Eyes test	

CD = cognitive disorganisation, IA = introvertive anhedonia, IN = impulsive nonconformity, UE = unusual experiences. SPQ-B = Schizotypal Personality Questionnaire–Brief (Raine & Benishay, 1995). O-LIFE = Oxford-Liverpool Inventory of Feelings and Experiences (Mason, Claridge, & Jackson, 1995).

psychopathology-related research: tasks assessing false belief and deception, and tasks assessing pragmatic speech comprehension. Several studies of schizotypy and ToM have used ToM tasks assessing the understanding of false belief and deception (Langdon & Coltheart, 1999; Pickup, 2006), whilst only one study has examined pragmatic speech comprehension (Langdon & Coltheart, 2004). The latter found individuals high in schizotypy to have similar metaphor recognition abilities to those low in schizotypy, but to be impaired in irony appreciation. No studies with healthy individuals have yet investigated relations between these two forms of ToM assessment, although correlations have been found in schizophrenia patients (Corcoran & Frith, 2003). Arguably, evaluating the clinical implications of findings on the relation between schizotypy and ToM will require the use of the same ToM tasks that have been used in schizophrenia studies (Jahshan & Sergi, 2007).

As Table 1 shows, Pickup's (2006) finding of no relation between global schizotypy and ToM was recently replicated by Jahshan and Sergi (2007). These authors assessed ToM using The Awareness and Social Inferencing Task (TASIT; McDonald, Flanagan, Rollins, & Kinch, 2003), a task developed for the assessment of cognitive impairments in brain-injured patients, which may be considered to raise questions about the validity of its use in a healthy sample. In addition, Jahshan and Sergi used a measure of global schizotypy (the Schizotypal Personality Questionnaire–Brief Version; Raine & Benishay, 1995), which has been shown to have psychometric limitations, with the internal reliability for the cognitive-perceptual and disorganised subscales being less than adequate (Compton, Chien, & Bollini, 2007).

Another possible criticism of some previous studies concerns their methods of statistical analysis. Firstly, Langdon and Coltheart's (1999) study used median splits to create groups of high and low schizotypy. Contrary to the notion of schizotypy as a trait forming a continuum between healthy and psychopathological groups, the use of such a procedure emphasises qualitative differences between groups. Indeed, there is some consensus among statisticians that performance of a median split followed by an ANOVA analysis is undesirable because it fails to make maximum use of the variance in the data (e.g., Field, 2005; Maxwell & Delaney, 1993).

A more satisfactory procedure would be to investigate relations between ToM and schizotypy scores using multiple linear regression (MLR), as Pickup (2006) has done. However, the MLR of Pickup also had a number of limitations. Green (1991) has recommended that, in the case where individual predictors within an MLR are being tested, the minimum sample size should be $104 + k$ (where k is the number of predictors). By this criterion, Pickup's minimum sample should have been 108, compared to an actual sample of 62. The design of any such study should also take account of the sample size required to detect the anticipated effect size. Based on the

calculations of Miles and Shevlin (2000), Pickup's design ($N = 62$, $k = 4$) would only have been sufficient to detect a large to medium effect. Furthermore, their MLR used an unusual method of controlling for the age and gender of participants, which have been shown to be associated with schizotypy levels (Claridge & Hewitt, 1987). Rather than entering these as covariates in the MLR, participants' scores were normalised using standardised age and gender data from Mason et al. (1995). However, the dataset used by Mason et al. to generate the norms was relatively small in the first place (e.g., 76 males were used to generate the 16- to 25-year-old male mean schizotypy score) and it is unclear whether the composition of Pickup's and Mason et al.'s samples were equivalent. For example, in addition to students and associates of the researcher, Pickup recruited individuals from a psychic studies organisation, whereas Mason et al.'s was predominantly a student sample.

The present study set out to address these limitations of previous studies of schizotypy and ToM in healthy samples. First, in addition to a new, brief measure of schizotypy, we employed a measure of persecutory ideation suitable for the general population. Second, we administered two different ToM tasks exemplifying both categories of ToM identified by Harrington et al. (2005). Further, as recommended by Jahshan and Sergi (2007), we used tasks commonly used with patients with schizophrenia, namely the Hinting task (Corcoran et al., 1995) and the cartoon comprehension task of Corcoran et al. (1997). Finally, we recruited a much larger sample than used in previous studies, and conducted analyses using a method suitable for dealing with continuous data.

Our first hypothesis, following Pickup (2006), was that ToM would not be associated with either global schizotypy or the negative signs of schizotypy, when age and gender were controlled for. Second, also following Pickup, we predicted that higher levels of the positive signs of schizotypy would be associated with weaker ToM when age and gender were controlled for. Third, we made a similar prediction for persecutory delusion-like beliefs. We further predicted that these relations would hold for both categories of ToM under study: false-belief/deception and pragmatic comprehension of speech. Finally, we predicted a positive association between the two ToM measures.

METHOD

Participants

Eight hundred and twenty-eight undergraduates (320 male, 508 female) at a UK university were recruited through e-mail invitation, with a mean age of 20.3 years ($SD = 1.43$, range = 18–25 years). Of the total 881 respondents, 12 were excluded for providing inappropriate answers, and 2 for not entering

their gender. Participants aged over 25, of whom there were 39, were also removed on the basis of previous findings of a decrease in schizotypy levels with age (Mata, Mataix-Cols, & Peralta, 2005). Participants visited a website which outlined the study and invited consent to participate. Participants were asked to self-exclude if they had a history of psychiatric illness or head injury. There was no financial incentive to participate, meaning that the likelihood of repeated participation was negligible. Information on age, gender, and academic department was also collected. Measures were administered electronically in the order given later. When all measures had been completed, participants were taken to a web page where they were debriefed.

Measures

Hinting task. The Hinting task was adapted for computer administration from Corcoran et al. (1995). Five of the original ten vignettes were used. Each vignette described an interaction between two characters along with an extract of their dialogue, and ended with one character dropping a hint to the other. Participants were required to state (by typing into a textbox) what the character really meant by their utterance, and then click a button marked "Continue". Following Corcoran et al., an appropriate inference scored 2 points. A second, more obvious hint was then displayed. A correct response at this stage was given a score of 1 and an incorrect response a score of 0. Total scores (designated ToM_H) could hence range from 0 to 10. Corcoran and Frith (2003) note that this task has good face validity and has been found to be sensitive to ToM deficits in a number of studies (Corcoran et al., 1995).

Cartoons task. The Cartoons task was adapted for computer administration from Corcoran et al. (1997). Eight cartoons were used, four requiring mentalistic explanations (ToM cartoons) and four requiring nonmentalistic explanation (non-ToM cartoons). Cartoons were presented on the screen, and participants told to click "Continue" when they understood the joke. This time interval was recorded. Participants were then asked to type an explanation for the joke into an empty text box. Following Corcoran et al., responses for both forms of cartoon were scored as 1 for an appropriate answer and 0 for an incorrect one. In the case of the ToM cartoons, an appropriate response required the use of a mentalistic explanation. Scores could therefore range from 0 to 4 for both the ToM cartoons (designated ToM_C) and non-ToM cartoons. Participants were also asked to rate on a scale of 1–5 how funny they thought the cartoon to be.

Brief O-LIFE (OLIFE-B). This is a 30-item shortened version of the original 104-item Oxford-Liverpool Inventory of Feelings and Experiences (OLIFE; Mason, et al., 1995). It comprises two subscales, each with 15 items. Odd-numbered items contribute to the introverted anhedonia/negative features subscale, labelled OLIFE-B(−); even-numbered items contribute to the unusual experiences/positive features subscale, labelled OLIFE-B(+). These scales have been showed to have Cronbach's alphas of .70 and .79, respectively (Bentall, unpublished data) representing satisfactory internal reliability.

Proneness to persecutory delusion-like beliefs. The Persecutory Ideation Questionnaire (PIQ; McKay, Langdon, & Coltheart, 2006) is a 10-item questionnaire designed to measure persecutory ideation in both clinical and nonclinical samples. Items are rated on a 5-point Likert scale ranging from "very true" (4) to "very untrue" (0). This measure has been shown to have good reliability and validity (McKay et al., 2006).

RESULTS

Descriptive statistics are presented in Table 2. Cronbach's alphas were acceptable for all questionnaire measures. Relations among schizotypy, persecutory delusion-like beliefs, age, and gender were examined first. Kolmogorov-Smirnov analysis indicated that the distribution of OLIFE-B, OLIFE-B(+), OLIFE-B(−), and PIQ scores all deviated significantly from normality. Transformations were unable to resolve this. Accordingly, correlations among these variables were analysed using Kendall's Rank and Partial Rank correlation coefficients, τ, which are suitable for nonparametric data analysis. Due to the large sample and the number of correlations performed (15), a Bonferroni correction was used and alpha set at $p = .003$ ($p = .05/15$). Age did not correlate significantly with either OLIFE-B, OLIFE-B(+), OLIFE-B(−), or PIQ when gender was controlled for ($\tau =$ .08, .08, .03, .09, respectively, all nonsignificant). Gender did not correlate, using point biserial correlations, with OLIFE-B, OLIFE-B(+), OLIFE-B(−), or PIQ when age was controlled for ($\tau = .06, .05, .02, .01$, respectively, all nonsignificant). Pairwise correlations are given in Table 3. Nonparametric analysis was again performed, as the distribution of both ToM_H and ToM_C deviated significantly from normality, $D = .24$, $p < .001$, and $D = .23$, $p < .001$ respectively. All correlations between schizotypy scores and ToM measures were nonsignificant. Similarly, PIQ scores did not correlate with any measures of ToM.

TABLE 2
Means (SD: range) of measures employed

Scale/task	*Overall*	*Male*	*Female*	*Cronbach's alpha*
OLIFE-B	9.74 (4.34: 0–25)	10.08 (4.30: 1–23)	9.53 (4.36: 0–25)	.72
OLIFE-B(+)	6.54 (3.27: 0–15)	6.33 (3.21: 0–15)	6.68 (3.30: 0–15)	.74
OLIFE-B(−)	3.20 (2.57: 0–13)	3.75** (2.64: 0–13)	2.86** (2.46: 0–12)	.68
PIQ	10.07 (6.97: 0–40)	10.06 (6.79: 0–37)	10.08 (7.09: 0–40)	.90
ToM_H	7.58 (1.38: 0–10)	7.43* (1.48: 0–10)	7.69* (1.30: 2–10)	n/a
ToM_C	2.65 (1.13: 0–4)	2.65 (1.16: 0–4)	2.66 (1.10: 0–4)	n/a

Males and females differ at $^*p < .01$, $^{**}p < .001$.

OLIFE-B = Oxford-Liverpool Inventory of Feelings and Experiences–Brief, OLIFE-B(+) = OLIFE-B unusual experiences/positive features subscale, OLIFE-B(−) = OLIFE-B introverted anhedonia/negative features subscale, PIQ = Persecutory Ideation Questionnaire, ToM_H = Theory of Mind Hinting task, ToM_C = Theory of Mind Cartoons task.

Multiple linear regression analysis

Multiple linear regressions (MLRs) were performed with age, gender, ToM_H, and ToM_C scores as independent variables. Age and gender were entered in a first step. ToM_H and ToM_C were entered together in a second step (deemed appropriate due to the lack of correlation between these two variables; see Table 3). Separate MLRs were then performed with OLIFE-B, OLIFE-B(+), OLIFE-B(−), or PIQ as the dependent variables. Results are shown in Table 4. Analysis of residuals gave no indication that the assumption of homogeneity of variance was violated, or that there was any significant influence of outliers, for any of the MLRs. Durbin-Watson scores were satisfactory and there was no evidence of multicollinearity in the data. However, as indicated in Table 4, Kolmogorov-Smirnov tests showed that

TABLE 3
Bivariate correlations (Kendall's τ) among variables under investigation

	OLIFE-B	*OLIFE-B(+)*	*OLIFE-B(−)*	*PIQ*	ToM_H	ToM_C	ToM^a_{Cp}
OLIFE-B	1	.67*	.47*	.31*	−.03	−.02	−.02
OLIFE-B(+)		1	.05	.28*	.01	.01	−.01
OLIFE-B(−)			1	.17*	−.06	−.01	−.01
PIQ				1	.01	.05	−.05
ToM_H					1	.05	.05
ToM_C						1	n/a
ToM^a_{Cp}							1

[a]Partialling for non-ToM cartoon scores.

$^*p < .003$.

TABLE 4
Summary of multiple linear regressions

Regression model	*OLIFE-B*	*OLIFE-B(+)*	*OLIFE-B(−)*	*PIQ*
R^2 (age, gender)	.02	.01	.03	.01
$F(2, 825)_{model}$	**6.18; $p = .002$**	**4.96; $p = .007$**	**13.46; $p < 0.001$**	**5.51; $p = .004$**
β(age)	**−.11; $p = .002$**	**−.10; $p = .006$**	−.06; $p = .11$	**−.12; $p = .001$**
β(gender)	**.07; $p = .048$**	−.04; $p = .198$	**.17; $p < .001$**	.01; $p = .862$
R^2 (age, gender, ToM_H, ToM_C)	.02	.01	.04	.02
$F(4, 823)_{model}$	**3.47; $p = .008$**	**2.58; $p = .036$**	**7.68; $p < .001$**	**4.19; $p = .002$**
$\Delta F(2, 823)_{step}$	0.77; $p = .464$	0.21; $p = .808$	1.87; $p = .154$	2.85; $p = .058$
β(age)	**−.10; $p = .003$**	**−.10; $p = .006$**	−.05; $p = .120$	**−.11; $p = .001$**
β(gender)	.07; $p = .060$	−.04; $p = .207$	**.17; $p < .001$**	.01; $p = .868$
$\beta(ToM_H)$	−.03; $p = .394$	.01; $p = .802$	−.06; $p = .075$	.01; $p = .987$
$\beta(ToM_C)$	−.03; $p = .415$	−.02; $p = .533$	−.02; $p = .555$	**−.08; $p = .018$**
Kolmogorov-Smirnov (D)	.03; $p = .063$	**.04; $p = .005$**	**.09; $p < .001$**	**.10; $p < .001$**

Bold type indicates statistically significant results.

the standardised residuals for all MLRs deviated significantly from normality, except for the analysis with OLIFE-B as the dependent variable. Such deviations from normality could not be resolved through the use of transformations. Cohen, Cohen, West, and Aiken (2003) note that, in large samples such as the present study, the effect of violation of the normality assumption does not lead to serious problems with the interpretation of significance tests.

The results of the MLRs confirmed previous findings of a negative correlation between schizotypy and age (Mata et al., 2005), and higher schizotypy scores among females (see also Table 2). Neither ToM score emerged as a strong predictor of schizotypy or persecutory ideation variables as a result of these analyses. Entering ToM scores did not produce a significant ΔR^2 for any model. Only ToM_C emerged as a significant predictor of any of the variables (PIQ), although the effect was weak, $\beta = -.08$, $p < .05$.

One possible objection is that the ToM_C measure may be confounded with participants' general ability to understand visual jokes. This interpretation is supported by our finding of a significant correlation ($\tau = .31$, $p < .001$) between scores on the ToM and non-ToM cartoons. In testing this possibility, we observed that the pattern of results for the MLRs did not change when they were reperformed with non-ToM cartoon scores entered along with age and gender in the first step, and ToM_C scores entered in the second step. Similarly, when the MLRs were repeated for each of the ToM tasks separately (i.e., an MLR performed with only ToM_H scores in the

second step, then another MLR performed with only ToM_C scores in the second step) the pattern of results reported above was not altered.

High/low schizotypy splits

In order to allow direct comparison with the findings of Jahshan and Sergi (2007), a high/low schizotypy split was performed with the top and bottom 5% of scores being classified as high- and low-schizotypy groups respectively, forming two groups of 40 participants. The creation of high-/low-fifth-centile groups was performed separately for OLIFE-B ($M_{high} = 19.85$, $M_{low} = 1.95$), OLIFE-B(+) ($M_{high} = 13.13$, $M_{low} = 0.68$), OLIFE-B(−) ($M_{high} = 9.99$, $M_{low} = 0.00$), and PIQ ($M_{high} = 29.13$, $M_{low} = 0.43$) scores. Due to the non-normal distribution of the ToM scores, group differences were analysed using Mann-Whitney *U* tests. Comparisons on psychopathology scores are shown in Table 5. There were no significant group differences on either ToM measure. This finding could be due to the lower power resulting from the use of a nonparametric, as compared to parametric, tests. As it has been argued that ANOVAs are relatively robust to violations of the assumption of normality (Field, 2005), the data in Table 5 were reanalysed using ANCOVA, controlling for age and gender. The pattern of results remained the same, with no significant group differences being found.

Further analyses of ToM task performance

Table 3 indicates that the two ToM measures did not correlate with each other. Of the total 6624 cartoons (8 jokes × 828 participants), participants gave appropriate explanations for 70.9% (66.3% of ToM cartoons, 75.5% of non-ToM cartoons). For those cartoons explained appropriately, the time taken to appreciate the joke (i.e., time elapsed between presentation and clicking "Continue") for ToM cartoons ($M = 15.9$ s, $SD = 82.4$) was significantly longer than for non-ToM cartoons ($M = 10.5$ s, $SD = 75.6$), $t = 2.36$, $p < .05$. ToM cartoons were rated as significantly more funny ($M = 2.39$, $SD = 1.08$) than non-ToM cartoons ($M = 2.25$, $SD = 1.11$), $t = -4.31$, $p < .001$. Further analysis of responses to all cartoons showed that 36 participants spent more than 2 minutes looking at at least one cartoon. Such a long inspection time could not simply be attributed to participants' failure to appreciate the cartoon in question, as approximately 50% of such cartoons received appropriate explanations. When these 36 participants were removed from the dataset, the pattern of results in Table 3 was not altered. Finally, no significant correlations were observed between response times on the Cartoons task and schizotypy or PIQ scores.

TABLE 5
Mean (*SD*) psychopathology scores split by high/low fifth-centile schizotypy scores

	OLIFE-B		*OLIFE-B(+)*		*OLIFE-B(−)*		*PIQ*	
	Top 5% (n =40)	*Bottom 5% (n =40)*	*Top 5% (n =40)*	*Bottom 5% (n =40)*	*Top 5% (n =40)*	*Bottom 5% (n =40)*	*Top 5% (n =40)*	*Bottom 5% (n =40)*
ToM_H	7.35 (1.50)	7.33 (1.29)	7.48 (1.26)	7.57 (1.24)	7.68 (1.37)	7.32 (1.19)	7.70 (1.27)	7.80 (1.14)
ToM_C	2.58 (1.34)	2.80 (0.99)	2.50 (1.50)	2.70 (1.14)	2.58 (1.01)	2.38 (1.28)	2.25 (1.21)	2.65 (0.98)

All high/low comparisons were nonsignificant.

DISCUSSION

We set out to examine how performance on two widely used ToM tasks related to measures of schizotypy and persecutory delusion-like beliefs. Consistent with our first hypothesis, ToM scores on both tasks were unrelated to global schizotypy and negative signs of schizotypy when controlling for age and gender. Contrary to our second and third hypotheses, ToM scores on both tasks were unrelated to positive signs of schizotypy and levels of persecutory delusion-like beliefs when controlling for age and gender. Multiple linear regression analysis supported these null correlational findings, as did analysis through ANCOVA following fifth-centile splits based on schizotypy and persecutory delusion-like beliefs. Finally, contrary to our last hypothesis, there was no significant correlation between ToM scores obtained from the false-belief/deception and pragmatic comprehension of speech tasks.

Our finding of a lack of correlation between global schizotypy and ToM is in line with the recent studies of Jahshan and Sergi (2007) and Pickup (2006). With regard to positive signs of schizotypy and persecutory delusion-like beliefs, our results did not support previous findings by Pickup. One possible explanation for this replication failure is that the ToM skills tapped by the Cartoon and Hinting tasks employed here differ to those measured by the story task used by Pickup. That said, Harrington et al. (2005) predicted that false-belief/deception performance (represented here by scores on the Cartoons task) would correlate with performance on false-belief story tasks such as that employed by Pickup. Furthermore, scores on our second task, the Hinting task, have been found to correlate, in patients with schizophrenia, with ToM scores on similar story tasks (Corcoran & Frith, 2003; $r = .63$, $p < .001$).

Perhaps a more important difference between our tasks and those of Pickup (2006) relates to ecological factors. Pickup assessed ToM by asking participants to give immediate verbal responses to written stories in the presence of an experimenter, which may have approximated better to the kind of online processing required in real social situations. In contrast, our participants were given no time limit for responding (although they were instructed to click "Continue" when they were ready to give their responses, which may have introduced some implicit pressure to respond), meaning that they may have been able to respond using offline processing. As a possible explanation for our nonreplication of Pickup's findings, this idea could be tested by limiting exposure times to stimuli and available response periods. Alternatively, introducing an element of a social interactional context to the task, such as a virtual "experimenter" asking for responses, might conceivably result in a greater load on online processing.

It could be argued that our failure to find a correlation between ToM_C and ToM_H scores signifies unreliability in one or both of our measures of ToM. With regard to the Cartoons task, this suggestion may be valid given that scores on this task could only range from 0 to 4, and thus may not have provided sufficient variability to detect subtle differences in ToM according to schizotypy levels. In contrast, our version of the Hinting task was able to vary over a greater range (0–10). Our failure to replicate the findings of Pickup (2006) could also be due to our sample producing relatively homogeneous schizotypy scores with insufficient variability to allow detection of correlations. The same argument could be applied to our failure to find a relation with persecutory delusion-like beliefs. Pickup ensured a broad range of schizotypy scores by screening his sample with the Schizotypal Personality Scale (STA; Claridge & Broks, 1984) and then including participants with scores 1 *SD* above and below its population mean. Although we did not screen participants in this way, we note that our descriptive statistics indicate a wide range of scores for all of these variables. Furthermore, our use of fifth-centile splits allowed us to examine the extreme ends of the schizotypy spectrum with sufficient power to detect any non-negligible effects that might have been present. We also note that Raine (1991) found that 55% of the top 10% of scorers on the SPQ met the criteria for Schizotypal Personality Disorder as assessed by the Structured Clinical Interview for DSM-III-R (SCID; American Psychiatric Association, 1987).

A number of other potential limitations need to be considered. First, our computer-based administration and large sample size meant that neither IQ nor executive function (EF) could be measured and controlled for (cf. Pickup, 2006). That said, Pickup (2006) found that neither IQ nor EF predicted schizotypy, while Jahshan and Sergi (2007) found no IQ differences between high and low schizotypy groups. A second limitation was that participants were ask to self-exclude from the study if they had a history of psychiatric illness, but there was no independent check of this. Third, it is possible that our computer-based administration of the two ToM tasks may have introduced task demands not present in the standard experimental versions. Although this form of administration necessitated a highly verbal response modality, it is unlikely that this would have significantly confounded our results. Our university student participants presumably constituted a highly verbal sample, and the responses needed for success on both ToM tasks did not involve particularly elaborate verbal explanations. Our controlling for performance on non-ToM cartoons in the Cartoons task further suggests that our findings were not confounded by general differences in the appreciation of visual jokes. Perhaps more significantly, our version of the Hinting task necessitated the posing of the hint even when participants had already entered an appropriate answer in the first text box. Although this might have been distracting for participants,

it is unlikely to have affected those initial evaluations of the vignette. In sum, we suggest that our computer-based version of the Hinting task is a reliable and valid measure which can be used in future internet-based studies, and we recommend further testing of online versions of our Cartoons task. More generally, our results provide further support for a growing consensus that internet administration of psychopathology measures produces data which do not differ significantly from traditional pen-and-paper methods (e.g., Jones, Fernyhough, de-Wit, & Meins, 2008).

Our findings therefore point to no relation between schizotypy and ToM in a sample of healthy young adults. We propose that our overall failure to find any relation with ToM for positive schizotypy signs and persecutory delusion-like beliefs cannot be attributed solely to unreliable ToM measures, or a lack of range in schizotypy and persecutory ideation scores, although it is possible that ToM tasks incorporating a greater online processing load might have led to different findings. One possible conclusion, necessarily speculative at this time, is that Pickup's (2006) finding of a relation between positive schizotypy and ToM may have been due to strong associations between nonpersecutory positive schizotypal signs (e.g., auditory verbal hallucinations, delusions of reference) and ToM. It remains for future studies to investigate further which specific positive schizotypal signs are related to deficits in which particular forms of ToM reasoning.

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