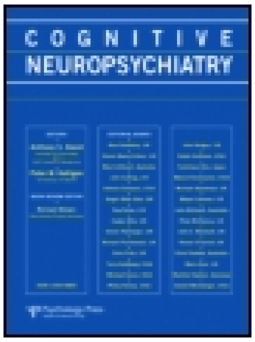

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Perceiving and attributing intentionality in schizophrenia

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ABSTRACT

Introduction: People with schizophrenia perform poorly on theory-of-mind (ToM) tasks. They also generate less mental-state language to describe test stimuli depicting intentionality. Some of these individuals also show excessive mentalising when objective cues of intentionality are absent. We tested perceiving and attributing intentionality to resolve this paradox.

Methods: 23 schizophrenia patients and 20 healthy controls completed the chasing detection task to assess perceptual sensitivity to cues of intentionality. Other tasks assessed spontaneous attributions of intentionality (irrespective of accuracy) and accurate ToM inferences.

Results: Perceptual sensitivity to cues of intentionality did not differ between groups. Patients were less likely to spontaneously attribute intentionality (irrespective of accuracy) or perform ToM tasks accurately. Chasing-detection response bias, but not perceptual sensitivity, correlated with attributions of intentionality. Referential (and to less extent) persecutory ideation associated with excessive mentalising when cues of intentionality were absent.

Conclusions: Intentionality can be directly perceived, independent of attributions or inferences, in people with schizophrenia. We conclude that the flow of information from intact perceptual detection to evoke spontaneous attributions of intentionality is disrupted in schizophrenia, with flow-on detrimental effects on accurate ToM reasoning. Referential/persecutory ideation motivates inappropriate mentalising when objective cues of intentionality are absent.

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Intentions; theory of mind; social cognition; schizophrenia; psychosis

Introduction

There is substantial evidence that mentalising, or theory-of-mind (ToM), abilities are impaired in schizophrenia (Green et al., 2012), and that these impairments contribute to the poor social functioning that characterises the illness (Fett et al., 2011). This evidence comes primarily from studies that use explicit tasks. Task instructions are typically direct to elicit deliberative processing and accurate prediction and/or explanation of mental-state causation indexes task performance. However, Klin (2000) argues that tasks of this type may underestimate capacities for implicit, or indirect, mentalising in individuals with poorer deliberative reasoning or declarative language skills, such as autistic individuals. Frith (2004) likewise suggests that some aspects of implicit mentalising may be intact in

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people with schizophrenia, despite that these individuals perform poorly on explicit TOM tasks. (Note that we use the terms "mentalising" and "ToM" in their traditional narrow sense to refer to processing cues of "intentionality": an agent's mental directedness towards the world, and mental-state causation,)

Clinical observations support Frith's proposal. Delusions of persecution and reference are common in schizophrenia and frequently co-occur. People with persecutory delusions believe that others harbour malevolent intent towards them. People with referential delusions may believe that others are surveilling them or neutral events or words signify an intentional communication directed at them. The implication is that mentalising capacities to represent others as agents, infer the contents of others' mental states (albeit inappropriately), and reflect on signifiers of intent and causal consequences of mental states are intact in many people with schizophrenia. Yet, people with schizophrenia show difficulty with using whatever mentalising capacities they might retain to perform ToM tasks. Researchers report poor ToM task performances in people with schizophrenia whether task stimuli are visual or verbal, required response is non-verbal or verbal, and when indirect instructions reduce demands for deliberative processing (see, e.g., Langdon et al., 2017). Most compelling is that people with schizophrenia show mentalising impairments even when task measures take no account of accuracy. For example, animations of dynamic geometric shapes, such as Heider and Simmel's (1944) classic video (see https://www.youtube.com/watch?v=VTNmLt7QX8E for an illustration) reliably elicit spontaneous mental-state attributions when healthy children and adults (across cultures) are simply asked to describe what they see (an indirect instruction), despite that the shapes look nothing like animate creatures. In contrast, people with schizophrenia spontaneously generate significantly fewer mental-state terms, irrespective of the accuracy or appropriateness of their mental-state language, to describe this video (Langdon et al., 2017). Horan et al. (2009) similarly reported significantly lower "Intentionality" scores, indexing complexity of intentional mental-state language, irrespective of appropriateness, when people with schizophrenia described similarly, shorter ToM animations from the "Triangles" task (Castelli et al., 2000: see https://www.spectrumnews.org/news/cognition-and-behavior-mind-blindness-in-autism-syndromes/ for an illustration).

The picture changes, however, when objective cues of intentionality are absent. In contrast to the relative lack of mentalising seen when task stimuli depict cues of intentionality, researchers report excess, inappropriate mental-state attributions when such cues are absent, at least in some people with schizophrenia. Russell et al. (2006) found that persecutory-deluded patients used more intentional mental-state language to describe randomly moving shapes in the control condition of the Triangles task. Blakemore et al. (2003) similarly found that persecutory-deluded patients judged the strength of relationships between animate shapes (depicted as self-initiating movement) as similar whether one shape's movement was a causal consequence of the other shape's movement or not. In other words, persecutory-deluded patients rated the relationships just as strong when cues depicting causal connection were absent; in contrast, healthy and clinical controls rated the relationships stronger in the animate contingent compared to non-contingent conditions.

Drawing together these lines of evidence: (1) many people with schizophrenia show evidence of excess inappropriate attributions of intentionality and mental-state reasoning (albeit unjustified by the evidence) when objective cues of intentionality are absent, suggesting that they retain some mentalising capacities. And (2) people with schizophrenia show difficulty with using whatever mentalising capacities they retain to process task stimuli depicting intentionality, irrespective of accuracy. One possible explanation for this paradox is that schizophrenia disrupts the perceptual processing of cues of intentionality: either the perceptual detection of such cues or the flow of information from intact perceptual detection to evoke spontaneous conscious attributions of intentionality. Other cognitive impairments then compound this disruption to further compromise accurate ToM reasoning, whereas top-down biases in some people with schizophrenia motivate inappropriate mentalising when objective cues of intentionality are absent.

The current study evaluates this proposal by testing, in the same groups of people with schizophrenia and healthy controls: (a) perceptual detection of cues of intentionality depicted in the chasing detection task (Gao et al., 2009); (b) spontaneous mental-state attributions in narratives generated to describe similar displays of dynamic geometric shapes (the ToM animations from the Triangles task); and (c) accurate ToM inferencing on more traditional false-belief/deception tasks. The chasing detection task presents arrays of moving discs. On half the trials, one disc pursues another disc, with visual detectability of the pursuit systematically varied. By systematically varying display characteristics, and controlling for lower-level properties such as proximity and common motion in the chasing-absent trials, this psychophysical task provides an objective index of perceptual detection of intentionality (specifically, intentional pursuit) due solely to the presence of a visual motion cue. Of note, a previous brief report using this task has provided preliminary evidence that the perceptual detection of cues of intentionality is intact in schizophrenia (Langdon et al., 2014).

The primary aim of this study is to replicate this finding, and to extend this line of research to demonstrate a dissociation between intact perceptual detection of cues of intentionality and impairments of spontaneous mental-state attributions (irrespective of accuracy) and accurate ToM inferencing in the same groups of people with schizophrenia, compared to healthy controls. Our secondary aim is to examine associations between inappropriate mental-state attributions (i.e., in the absence of objective cues of intentionality, specifically in the Random control condition of the Triangles task) and paranoid or referential ideation in the same clinical sample.

Materials and method

Participants

Twenty-four clinical patients were recruited for the study. Data for one patient, who failed to follow instructions for the chasing task, was subsequently removed from all analyses. (This patient responded "yes: chase present" on 100% of all trials, whether chasing-present or chasing-absent: see later.) The final sample thus comprised 23 patients with mean age of 46 years (range 25-58), and 20 non-clinical general community control participants (mean age of 47 years, range 24-63), matched on age, gender ratio, and NART-estimated IQ (see Table 1). The clinical participants were all stable community-based outpatients, medicated at the time of testing.

Exclusion criteria for both groups included history of serious head injury, developmental disorder, neurological disease, and IQ less than 75. All patients were interviewed using the

Table 1. Means (SDs) of basic demographics, cognition scores and self-report measures of both groups, and clinical demographics of patients.

	Patients ($n = 23$)	Controls ($n = 20$)	*Statistics*	*p*
Basic demographics				
Age (yrs)	45.8 (8.7)	46.9 (12.7)	$t(32.93) = 0.32$	ns
Gender (M:F)	16:7	14:6	$\chi^2(1) = 0.001$	ns
Formal education (yrs)	12.7 (3.2)	15.5 (1.7)	$t(35.39) = 3.62$	0.001
NART-IQ	104.5 (9.3)	105.1 (22.7)	$t(24.48) = 0.11$	ns
Basic cognition scores				
Visual Working Memory	15.4 (2.6)	17.4 (2.6)	$t(41) = 2.51$	0.016
RBANS	92.0 (10.6)	102.1 (16.1)	$t(32.16) = 2.37$	0.024
Self-report measures				
Referential Thinking	65.1 (22.3)	41.5 (11.4)	$t(33.71)=-4.45$	<0.0005
Persecutory Ideation	23.6 (9.3)	11.7 (4.5)	$t(32.56)=-5.44$	<0.0005
Clinical demographics				
Age of illness onset (yrs)	23.2 (7.5)			
Duration of illness (yrs)	23.1 (11.0)			
Mean SANS global rating	1.7 (0.9)			
Mean SAPS global rating	1.4 (1.1)			

Diagnostic Interview for Psychosis (DIP; Castle et al., 2006) and met the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition (DSM-5: American Psychiatric Association, 2013) criteria for schizophrenia (n=18) or schizoaffective disorder (n=5) according to their interview responses and clinical history. Patients were recruited from the Belief Formation Register at Macquarie University and the Australian Schizophrenia Research Bank Volunteer Register (Loughland et al., 2010). Control participants were recruited from the Macquarie University Belief Formation Register, newspaper advertisements, and undergraduate psychology units, and screened for presence of affective and psychotic disorders, and substance abuse. The study was approved by the Macquarie University Human Ethics Review Committee. All participants gave written informed consent.

Materials and procedure

Clinical symptom ratings and self-report measures

To rate current symptom severity, patients were interviewed using the Scales for the Assessment of Positive and Negative Symptoms of Schizophrenia (SAPS/SANS; Andreasen, 1983, 1984). All participants completed the Persecutory Ideation Questionnaire (PIQ; McKay et al., 2006) and the Referential Thinking Scale (RTS; Lenzenweger et al., 1997) to index levels of persecutory and referential ideation respectively.

Basic cognitive measures

Participants completed: the Wechsler Memory Scale – Revised (Wechsler, 1987) to index visual working memory; and the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Randolph et al., 1998) to index general cognitive function.

Perceiving intentionality

Perceptual sensitivity to signals of intentionality was assessed using the chasing detection task (Gao et al., 2009). Participants viewed displays of moving discs, with one disc (the "wolf") pursuing another disc (the "sheep") on half the trials. The same algorithm generated all displays, with the sheep made invisible on chasing-absent trials. Chasing subtlety, the angle at which a wolf deviated from a perfect heading-angle, varied between 0° (i.e., directly angling towards the sheep), 30°, 60°, and 90° to progressively obscure a wolf's intended target. Participants were told that one of the discs (a wolf) would chase one of the other discs (a sheep) on half the trials. They were also told that wolves, when present, could behave differently and would not always aim directly at a sheep, but would always move closer to the targeted sheep over time. Each trial lasted for 11 seconds and participants were instructed to indicate whether a wolf was present after each trial. Participants received feedback: either a green (correct) or a red (incorrect) frame that appeared around the display. We recorded hits and false alarms and drew upon signal detection theory (Stanislaw & Todorov, 1999) to calculate perceptual sensitivity to motion cues of pursuit, and contrasted this with the response-bias measure of judgment or decision-making on this task.

Spontaneous attributions of intentionality

Participants were shown the four ToM animations of the Triangles task (Abell et al., 2000; Castelli et al., 2000). These display a large red triangle and a small blue triangle moving against a white background to depict seducing, mocking, surprising and coaxing social behaviours. The four ToM animations were intermixed with four animations of randomly moving shapes, presented in a fixed pseudo-random order. Each animation lasted 30–45 seconds. Participants were simply asked to describe what they saw after each animation (an indirect instruction). We recorded word count to ensure that any potential group difference was not a consequence of patients generating fewer words. The primary measure was the Intentionality score (Horan et al., 2009), reflecting the degree to which purposeful movements and intentional mental states are spontaneously described, irrespective of appropriateness or accuracy. Narratives are coded 0–5 as follows: 0=non-purposeful action; 1=purposeful action without mention of interaction with another; 2=purposeful social action with another; 3=intentionally-driven goal-directed social behaviour; 4=mental state attributions made during reciprocal interactions; 5=one agent intentionally manipulating or affecting the mental state of another. Scores were averaged separately for the ToM and Random animations.

ToM false-belief/deception tasks

Three ToM tasks assessing accurate judgments and explanations of causal mental states that misrepresent reality (false beliefs and deception) were selected from the pre-existing literature to vary the type of instruction (direct vs. indirect) and response mode (verbal vs. non-verbal).

(a) The False-belief Picture-Sequencing Task (Langdon & Coltheart, 1999) uses indirect instructions with non-verbal stimuli and requires non-verbal responses. Participants re-arrange sequences of picture-cards in the correct order to show a logical sequence of events. We used an abbreviated version of the original task, comprising four false-belief (or ToM) sequences and four control sequences (Atkinson et al., 2017). Scores were calculated as per Langdon and Coltheart (1999), and averaged across the ToM and control sequences separately (range 0–6).
(b) The Jokes Appreciation Task (Langdon & Ward, 2009) uses indirect instructions with non-verbal stimuli and requires verbal responses. Participants are shown a set of

cartoons and asked to “Explain the joke”. Five ToM cartoons (that require appreciation of the cartoon characters’ mental states to understand the joke) and five control cartoons (that depict behavioural or situational humour and can be understood without appreciating mental states) were presented in a fixed, pseudo-random order. Verbal responses were scored for accuracy and completeness of explicit explanations as per Langdon and Ward (2009), and scores averaged separately for the ToM and control cartoons (range 0–3).

(c) The False-belief/Deception Comprehension Task (Langdon et al., 2017) uses more direct instructions with verbal stimuli and requires written response. Participants read four short stories. After each, questions probed for accurate prediction of story characters’ actions, and explicit understanding that those actions were governed by a false belief or intent to deceive. Predictions scored “1” if correct, else “0”. Explanations scored “2” if explicitly correct, “1” if partially correct, else “0”. Scores were summed across the four stories (range 0–12). Participants were also asked a factual question after each story, and responses scored “1” if correct. Comprehension scores were similarly summed across the four stories (range 0–4).

Statistical analyses

Independent samples t-tests compared schizophrenia and control groups on demographics and basic cognitive measures. To address the primary aim of demonstrating a dissociation between intact perceptual detection of intentionality and impairments of spontaneous mental-state attributions and accurate ToM inferencing in schizophrenia, t-tests and ANOVAs compared groups on the primary task measures. Follow-up analyses of covariance (ANCOVAs) took account of basic cognitive measures, as appropriate. We then examined whether the pattern of correlations was consistent with the between-group results in suggesting that perceiving intentionality (indexed by perceptual sensitivity to chasing cues, in contrast to response bias, on the chasing task) is independent of attributing or inferring mental states. Towards this end, we examined correlations between the chasing task measures and other task measures, partialling out shared contributions of general cognitive abilities. Additional regression analyses explored associations between spontaneous mental-state attributions (irrespective of accuracy) and accurate ToM inferencing. To address our secondary aim, ANOVAs compared subgroups of patients with current persecutory or referential delusions (relevant SAPS ratings ≥ 2) to those without such delusions and controls on the Random Intentionality score of the Triangles task, indexing inappropriate mental-state attributions. We also examined correlations between the Random Intentionality score and current symptom ratings, as well as trait levels of persecutory and referential ideation within patients. Correlations between task measures and other symptom measures were also examined. Given the number of analyses, α was set at 0.01.

Results

Basic cognition and demographics

See Table 1 for a summary. Patients self-reported significantly fewer years of education, but did not differ from controls in NART-estimated IQ. They did however show (non-significant) tendencies to poorer visual working memory and general cognitive functioning. We also note that the patients were a chronic, mildly symptomatic sample.

Self-report measures

As reported in Table 1, PIQ and RTS scores of persecutory and referential ideation were significantly higher in patients.

Perceiving and attributing intentionality

GLM was used to analyse results for perceptual sensitivity to signals of intentionality (d-prime) on the chasing task. Greenhouse-Geisser corrections are reported whenever the assumption of sphericity is violated. A 2 × 4 mixed design, with 2 levels on the between-factor group (patients/controls) and 4 levels on the within-factor heading-angle (0°/30°/60°/90°), revealed that neither the main effect of group $F(1,41) = .05$; p=83, nor the interaction of group by heading-angle, $F(3,123) = 1.19$; p=.32, were significant: see Figure 1(a). The only significant result was a main effect of heading-angle, $F(3,123) = 81.65$; p<.0005; perceptual sensitivity decreased as heading angle increased across groups. Results for C-bias were similarly non-significant: neither the main effect of group, $F(1,41) = 1.77$; p=.19, nor the interaction of group by heading-angle, $F(1.37,55.97) = 1.17$; p=.30, were significant. Only the main effect of heading-angle reached significance, $F(1.37,55.97) = 13.20$; p<.0005; across groups, the participants displayed an increased bias to judge "no: chase absent" as heading-angle increased (see Figure 1(b)).

With regards the Triangles task, patients and controls did not differ in number of words generated to describe the animations (see Table 2). In contrast, Intentionality scores (indexing spontaneous attributions of intentionality irrespective of appropriateness) for ToM animations were significantly lower in patients. The group difference remained significant when the RBANS score was included as a covariate ($F(1,40) = 15.77$; p<.0005). We also note that the patients' mean of 2.89 suggests that viewing the cues of intentionality in the ToM animations triggered spontaneous attributions of purposive social behaviour

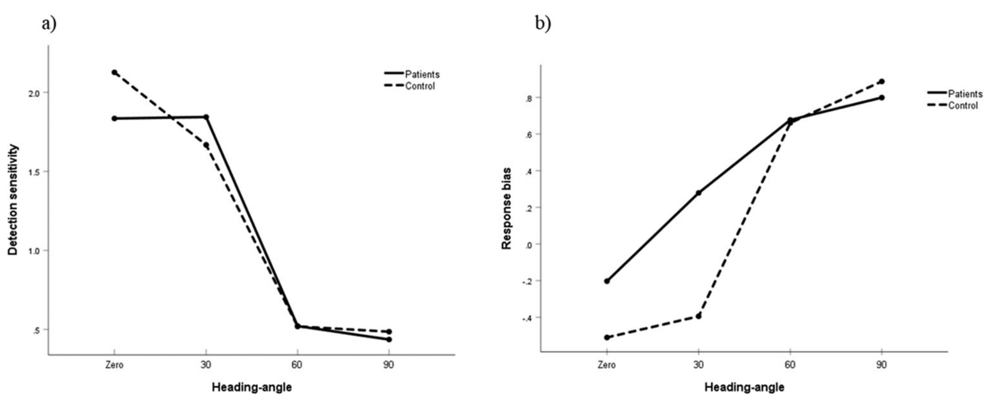

Figure 1. Perceptual sensitivity (d-prime) and response bias (C-bias) by heading-angle and group.

Table 2. Attributing intentionality on the Triangles task and false-belief/deception ToM task performances by group. Data expressed as mean (SD).

	Patients ($n = 23$)	Controls ($n = 20$)	*t-values*	*p*
Triangles task				
Word count: ToM condition	70.91 (36.61)	76.11 (31.06)	0.25	0.621
Word count: Random condition	49.43 (33.96)	37.47 (19.06)	1.95	0.171
Intentionality: ToM condition	2.93 (0.78)	3.89 (0.55)	20.72	<.0005
Intentionality: Random condition	0.72 (0.62)	0.66 (0.57)	0.10	.750
ToM tasks				
ToM composite	−0.36 (0.76)	0.41 (0.50)	3.84	<.0005
FB-PST[a]				
ToM	4.33 (1.43)	5.25 (0.69)	6.96	.012
Control	5.63 (0.75)	5.45 (0.79)	0.59	.445
Jokes				
ToM	1.36 (0.57)	1.94 (0.69)	9.19	.004
Control	1.99 (0.52)	2.27 (0.54)	3.00	.091
FB-D[b] **Comprehension**				
ToM	7.91 (2.33)	9.50 (1.82)	6.04	.018
Control	3.87 (0.46)	3.90 (0.31)	0.06	.802

[a]FB-PST = False-belief Picture Sequencing Test; [b]FB-D = False-belief/Deception.

(coded "2"). Consistent with this observation, 22/23 patients scored ≥2 for at least 3/4 ToM animations. In other words, patients spontaneously generated less intentional mental-state language than controls to describe the ToM animations, despite intact capacity to generate descriptors of purposive social interactions.

With regards accurate ToM inferencing, we first reduced the number of variables by computing a ToM composite score (the average of the three ToM scores standardised across all participants). The ToM composite was significantly lower in patients than controls (see Table 2, which also summarises results for the individual ToM tasks). Of note, the groups did not differ on any ToM control measure. Moreover, the group difference on the ToM composite remained significant when the RBANS score was taken into account ($F(1,40) = 8{,}33; p{=}.006$).

In sum thus far, the between-groups analyses reveal a dissociation between intact perception and impaired attributions and inferences of intentionality in people with schizophrenia compared to controls.

The correlation results were consistent with the between-groups findings: no correlations between d-prime (averaged across all heading-angles to index perceptual sensitivity to cues of intentionality on the chasing task) and the other task measures of attributing and inferring mental states were significant, after partialling out general cognitive abilities (visual working memory and RBANS scores) (all p's>.06). We acknowledge a non-significant tendency for d-prime to correlate with the ToM composite ($\rho{=}.30$; $p{=}.06$); however, there was no hint of such an association once a bivariate outlier (a patient with very low scores on both measures was removed) ($\rho{=}.19$, $p{=}.24$). In contrast, the C-bias measure of response bias on the chasing task (averaged across all heading-angles) correlated significantly with the ToM Intentionality score, partialling out general cognitive abilities ($\rho{=}-.47$; $p{=}.002$); the greater the tendency to spontaneously generate attributions of intentionality (irrespective of appropriateness), the lower the decision threshold to judge presence of intentionality on the chasing task.

Additional analyses revealed a significant association between the ToM Intentionality score (indexing spontaneous mental-state attributions, irrespective of appropriateness) and the ToM composite score (indexing accurate false-belief/deception reasoning) (r=.44, p=.003). The best predictive model of accurate ToM reasoning combined the ToM Intentionality and RBANS scores (R^2=.35, F=10.65, p<.0005).

Inappropriate mental-state attributions and paranoid or referential ideation in patients

First, there was no evidence of inappropriate mental-state attributions (indexed by the Random Intentionality score on the Triangles task) in patients, as a whole, compared to controls (see Table 2). Results were likewise non-significant when patients with current persecutory or referential delusions (with relevant SAPS ratings ≥ 2; n=11) were compared to patients without such delusions (n=12) and healthy controls; or when focusing solely on presence or absence of persecutory delusions, as per Russell et al. (2006) (all p's>.53). All correlations between current severity of persecutory or referential delusions and the Random Intentionality score were likewise non-significant (all p's>.67). There was, however, a significant positive correlation between the Random Intentionality score and trait levels of referential ideation (r=.60; p=.003), and a similar, albeit non-significant, association with trait levels of persecutory ideation (r=.40, p=.06). Higher levels of referential (and to less extent persecutory) ideation associated with more excessive inappropriate mental-state attributions (in the absence of cues of intentionality) in patients. No correlations between other task measures and clinical measures reached statistical significance.

Discussion

The current study examined, in the same groups of people with schizophrenia and healthy controls: (a) perceptual sensitivity to cues of intentionality depicted in animations of moving discs on the chasing detection task; (b) spontaneous mental-state attributions (irrespective of appropriateness) in narratives generated to describe similar displays of dynamic geometric shapes (the ToM condition of the Triangles task); and (c) accurate ToM inferencing on more traditional false-belief/deception tasks. Results with regards to each of the primary task measures were consistent with previous studies that have separately examined each of these measures. The current study is significant, however, in demonstrating, for the first time, a dissociation between intact perceptual sensitivity to cues of intentionality and impairments of spontaneous attributions of intentionality, irrespective of appropriateness (generated to describe similar animations), and accurate ToM reasoning, in the same group of people with schizophrenia, compared to controls.

Whereas patients spontaneously generated less intentional mental-state language to describe ToM animations on the Triangles task, they were perfectly capable of spontaneously describing purposive social interactions, suggesting that they perceived the relevant cues (just as they did on the chasing task), but were less likely to consciously attribute intentionality.

Correlations between the chasing task and other task measures were consistent with the between-group results in suggesting that perceiving intentionality is independent of attributing or inferring intentionality. In contrast, the response bias measure of decision-making on the chasing task correlated with spontaneous mental-state attributions; the greater the tendency to spontaneously generate attributions of intentionality (irrespective of appropriateness), the lower the decision threshold to judge the presence of intentionality on the chasing task. With regards to relations between the other task measures, the best predictive model of accurate ToM reasoning combined the measures of spontaneous mental-state attributions and general cognitive ability.

Counter to the findings of Russell at al. (2006), we found no evidence of an association between current persecutory or referential delusions and inappropriate mental-state attributions in the absence of objective cues of intentionality (indexed by the Random Intentionality score on the Triangles task). However, limitations of the current study include that our patient group was a relatively small chronic sample, comprised of community-based outpatients with mild symptoms. Russell et al.'s clinical sample was larger, younger and comprised a mix of acute inpatients and outpatients. Thus, a similar design to the current study with younger, larger clinical samples is warranted, as is research with other clinical samples (e.g., acute and first-episode patients). Nevertheless, trait measures of referential (and to less extent persecutory) ideation in our patients did associate with inappropriate mentalising, generally consistent with Russell et al.'s findings.

In conclusion, the theoretical significance of our findings in demonstrating a dissociation between intact perception and impaired attributions and inferences of intentionality in schizophrenia is to provide empirical support for current theorising that intentionality can be directly perceived, rather than attributed or judged (see, e.g., Froese & Leavens, 2014; Gallagher, 2008; Scholl & Gao, 2013). The clinical significance of our findings is to rule out that excess inappropriate mental-state attributions can be seen alongside poor mentalising task performances in some people with schizophrenia because schizophrenia disrupts the perceptual detection of cues of intentionality. Instead, we conclude that the flow of information from intact perceptual detection to evoke spontaneous conscious attributions of intentionality (irrespective of accuracy) is disrupted. Other cognitive impairments (perhaps including other higher-order mentalising impairments) then compound this disruption to further compromise accurate ToM reasoning, whereas top-down biases in people with referential/persecutory ideation motivate inappropriate mentalising when objective cues of intentionality are absent.

Disclosure statement

No potential conflict of interest was reported by the author(s).

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