

Do patients with schizophrenia attribute mental states in a referential communication task?

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Introduction. Many studies have reported that individuals with schizophrenia (SZ) may have impaired social cognition, resulting in communication disorders and theory of mind (ToM) impairments. However, the classical tasks used to assess impaired ToM ability are too complex. The aim of this study was to assess ToM ability using both a classical task and a referential communication task that reproduces a “natural” conversation situation.

Methods. Thirty-one participants with schizophrenia and 29 matched healthy participants were tested individually on a referential communication task and on a standard ToM task.

Results and Conclusion. The main results showed that SZ participants had difficulties using reference markers and attributing mental states in both ToM tasks. Contrary to healthy participants, they exhibited a tendency to ineffectively mark the information they used (indefinite articles for old information and/or definite articles for new information) and had problems using information they shared with the experimenter.

Keywords: Real-life conversation; Schizophrenia; Shared knowledge; Social cognition.

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INTRODUCTION

Social cognition includes Theory of Mind (ToM) ability, among other skills. ToM is the ability to form representations of other people's mental states (e.g., intentions, beliefs, shared knowledge) and to use these representations to understand, predict, and judge their statements and behaviours (Premack & Woodruff, 1978). A deficit in social cognition, including a ToM impairment, is a core feature of schizophrenia and is a significant factor in the social isolation experienced by many individuals with schizophrenia (SZ). Indeed, the ability to quickly process social stimuli is essential for social interactions, and problems in this area can impact family relationships and work and school behaviour.

Several studies have shown that SZ individuals have ToM impairments (Brune, 2005; Champagne-Lavau, Stip, & Joannette, 2006; Harrington, Siegert, & McClure, 2005; Lee, Farrow, Spence, & Woodruff, 2004). However, a review of the literature concerning ToM impairments in SZ (Harrington, Siegert, & McClure, 2005) emphasises the complexity of the processes studied and the inherent difficulty of studying them. Indeed, ToM is typically operationalised in research as participants' ability to understand false beliefs (first- and second-order beliefs such as *I believe Paul thinks it's raining*) in complex stories (Happé, Brownell, & Winner, 1999) or in cartoons (Sarfati, Hardy-Bayle, Besche, & Widlocher, 1997). Except for recent studies (Russell, Reynaud, Herba, Morris, & Corcoran, 2006; Stewart, Corcoran, & Drake, 2008), all studies of ToM in SZ have used the same tasks, such as the hinting task (Corcoran, Mercer, & Frith, 1995) or the Faux-Pas task (Baron-Cohen, O'Riordan, Stone, Jones, & Plaisted, 1999). The latter task, for example, requires a second-order false belief paradigm (belief about the belief of a protagonist in the story), with an empathetic appreciation of the protagonist's emotional state (knowledge of emotions). Because most of the tasks used to assess ToM are artificial and very complex, they create a cognitive overload that might impair ToM performance in SZ individuals (Shamay-Tsoory et al., 2007). Given that SZ individuals generally show various impairments in other cognitive domains (including memory and executive functions; Stip, 2006), it becomes difficult to tease out the role of ToM versus cognitive impairment, as evaluated by these tasks. Some studies showing ToM difficulties have tried to control for the influence of cognitive functioning in ToM (see Brune, 2005; Harrington, Siegert, & McClure, 2005, for a review). Indeed, some authors have controlled for general cognitive functioning by taking into account cognitive variables such as attention (Randall, Corcoran, Day, & Bentall, 2003), executive functioning (Brune, 2005; Brune, Abdel-Hamid, Lehmkamper, & Sonntag, 2007; Champagne-Lavau, Charest, Blouin, & Rodriguez, 2008; Janssen, Krabbendam, Jolles, & van Os, 2003; Langdon,

Coltheart, Ward, & Catts, 2001; Langdon, Coltheart, Ward, & Catts, 2002; Mitchley, Berber, Gray, Brooks, & Livingston, 1998), autobiographical memory (Corcoran & Frith, 2003), and general picture sequencing (Harrington, Langdon, Siegert, & McClure, 2005; Langdon, Coltheart, & Ward, 2006; Langdon et al., 1997, 2002).

The results obtained by McCabe, Leudar, and Antaki (2004) suggested that factors such as task demands might influence SZ patients' performance. The authors were interested in the evaluation of ToM in SZ individuals in a conversational situation. Contrary to what is reported in the literature, they showed that SZ participants exhibited no difficulties in attributing mental states (e.g., intent, belief) to the clinicians with whom they interacted. This study is relevant because it was the only one, to our knowledge, that assessed ToM in an interaction between clinicians and SZ participants. However, this study had some weaknesses. There was no healthy control group, and the conversational analysis the authors performed on the conversations they recorded was not explained. The authors' conclusions seemed to be based on the interpretation of particular conversational sequences described as reporting an intact ToM in some SZ participants. The criteria used for this interpretation were not described. Similarly, no information was provided concerning the sequence selection, and the choice of some patients rather than others. Accordingly, the analyses seemed to be intuitive and interpretive, whereas they should have been based on predetermined objective measures quantified in the corpus collected during the interactions. In addition, the SZ participants in this study were not tested with a classical ToM task and their performances were not compared to those of a healthy control group. Thus, no conclusion can be reached regarding whether this SZ group did or did not have ToM difficulty.

Others studies have used original methodology involving participants to verbally describe ToM scenarios (Langdon et al., 1997; Russell et al., 2006). For example, in Langdon et al. (1997), SZ participants were submitted to picture sequencing and storytelling tasks that required participants to infer causal mental states in story characters. In a second experiment, the authors also examined ratios of different types of mental state terms used by the participants to tell stories about completed sequences. Results showed that SZ participants were impaired in monitoring their own and others' mental states. Using a paradigm that takes into account the dynamic nature of complex social interactions, Russell et al. (2006) showed that patients were less likely than healthy controls to use mentalising terms to describe ToM scenes and generally showed lower levels of accuracy. Similarly, Stewart et al. (2008) recently used a request/response task which was a dialogue-based empirical task to assess alignment of politeness and ability to infer knowledge of characters. This task presented participants with a fictional conversation and required them to choose the appropriate

conversational reply from choices. Results indicated mentalising impairments in SZ participants while they had intact alignment skills. Although these studies did not involve communication per se, they led to a new step towards natural communication in the assessment of ToM ability in schizophrenia.

To sum up, according to this brief literature review, it is clear that SZ individuals may present ToM impairments when they are tested with classical ToM tasks (artificial tasks that involve cognitive overload) as well as with “more natural” tasks requiring them to verbalise ToM scenarios. However, no relevant study has determined whether such an impairment is present in natural communication. Indeed, the tasks used to date did not really reflect the reality of ToM ability in social interactions. They were also poorly adapted insofar as they increased the cognitive load.

This paper examines ToM in schizophrenia with an original psycholinguistic paradigm—the referential communication paradigm (Chantraine, Joanette, & Ska, 1998), involving interaction in a natural conversation situation. The concept of referential communication enables one to assess how interlocutors who are conversing about how to arrange a set of figures take into account, or fail to take into account, shared knowledge. In this referential communication task, participants must produce discriminating information that will enable the experimenter to identify certain target figures. If the task is repeated (several trials) with the same interlocutors and the same figures, an evolution of the referential negotiation process will generally be observed, meaning that there is a significant increase in communicative efficacy. Linguistic markers of referential cohesion, such as indefinite (a mountain) or definite (the mountain) descriptions, play a primary role in the construction of shared knowledge between interlocutors. During a conversation, the interlocutors use these cohesion markers as surface cues to guide each other in the coconstruction of a coherent mental representation of speech (Cornish, 1999; Fossard & Rigalleau, 2005). The use of these markers reveals the knowledge that the speaker assumes that the listener shares with him/her. These markers also help the listener to understand the speaker’s intentions during a conversation. A model such as Ariel’s accessibility marking scale (1990, 1996) claims indeed that the use of any particular marker of reference (indefinite, definite descriptions, pronouns, etc.), far from being a random choice, is closely connected to the level of accessibility that the referent is assumed to have in the listener’s mental model of the discourse under construction. This model provides a formal basis, making it possible to justify and predict the presence or use of a particular marker. Then, when the referent targeted is assumed to be accessible enough in the listener’s mental discourse representation, a definite description (the mountain), marking an old, already known information, should be used. On the other hand, an indefinite description (a mountain) is

more expected to introduce new information, not already shared with the listener. Therefore, these linguistic elements represent relevant and rigorous markers to determine SZ patients' ability to judge, understand, and attribute mental states such as belief or shared knowledge (ToM) in a natural conversation.

In the referential communication task, the shared knowledge (or common ground) is provided by the physical context (in this case, the identical sets of figures) and, more importantly, by the history of previous exchanges between the two interlocutors. According to the collaborative model of reference (Clark & Wilkes-Gibbs, 1986), the speaker assumes that the knowledge he/she uses (the common ground) is shared by the listener and will allow the most appropriate formulation of the message. The first trial entails a fairly complex exchange with several descriptions, whereas this is not necessary in the following trials. The initial speaker's referential utterance may not be perfectly clear. From one trial to the next, the two interlocutors (experimenter and participant) come to mutually agree on common references (Clark & Wilkes-Gibbs, 1986; Garrod & Anderson, 1987). Within the context of the interactive alignment model proposed by Pickering and Garrod (2004), this agreement results from an automatic alignment process of the different levels of linguistic representation that the interlocutors develop as the dialogue proceeds. As linguistic elements accumulate, mental discourse representations (also called "situational models") of both interlocutors are refined and become aligned, permitting a mutual understanding. Consequently, the number of words used by the participants and the number of speaking turns usually decrease. Indefinite descriptions (as in "*a* fish") are progressively replaced by definite descriptions on which an agreement was reached between the interlocutors (as in "*the* fish"). Expressions of uncertainty ("a kind of", "it looks like") tend to be omitted and routines (particular use of an expression during a particular interaction) develop (Pickering & Garrod, 2004). Ambiguity dissipates, the interlocutors agree on the proposed interpretation and they mark this agreement linguistically by the use of the definite reference (definite description). When a participant makes such a definite reference, he/she tries to establish with the interlocutor the mutual belief that the interlocutor has understood the reference before continuing the conversation. Whereas indefinite articles are linguistic forms used to point out new information, definite articles are markers used to retrieve old references that have already been introduced in speech. They are used by participants to indicate that they expect the coming reference to be known by the interlocutor. This phenomenon shows the construction of shared knowledge by the interlocutors.

It appears, then, that the referential communication task is an original option for studying ToM ability in natural conversation situations in schizophrenia.¹ In addition to the objective linguistic measures and the limited demands on cognitive resources, this referential communication task offers a considerable advantage over free conversation by lessening interference from autobiographical or episodic memory problems as the speaker is requested to describe static, visually presented items (e.g., tangrams). Furthermore, the task involves social interaction (which is collaborative since the participant has to help the experimenter) and the correction of possible misunderstandings signalled by the experimenter.

The aim of this study was to determine whether SZ individuals always present an impairment of ToM reasoning in a natural communication situation, in contrast to classical tasks, which are known to be very complex and resource demanding. To this end, a referential communication task (Clark & Wilkes-Gibbs, 1986) was used to address attribution and comprehension of mental states, such as shared knowledge, in a natural communication situation. A classical nonverbal ToM task (Sarfaty et al., 1997) was also used to measure the task effect.

If the ToM impairments previously evidenced in SZ individuals were task dependent, SZ participants would be expected to perform worse than healthy control (HC) participants on a classical ToM task (Sarfaty et al., 1997) but as well as HC participants on the referential communication task. By contrast, if SZ individuals' ToM impairments were not task dependent, they would be expected to perform worse than HC participants on both tasks.

METHOD

Participants

Inclusion criteria were a DSM-IV diagnosis of schizophrenia with no medical or neurological diseases and no concomitant Axis I or Axis II disorders. Thirty-one schizophrenia outpatients and 29 healthy volunteers matched for age and educational level participated in the study after signing a detailed informed consent. All participants were native French-speakers and signed the consent form approved by the local ethic committee. The mean duration of illness in the patients was 16.2 years ($SD \pm 9.5$). The patients' mean age at the time of assessment was 42.0 years ($SD \pm 9.3$) and the mean years of education amounted to 12.8 ($SD \pm 2.2$). The SZ and

¹ Authors such as Docherty, Cohen, Nienow, Dinzeo, and Dangelmaier (2003), Docherty, Hall, Gordinier, and Cutting (2000), and Rochester and Martin (1979) have shown an inadequate use of reference markers in the discourse of patients with schizophrenia.

control groups did not differ significantly with regard to age, $t(58) = -0.23$, $p > .05$, educational level, $t(58) = -1.39$, $p > .05$, or IQ, measured by the NART (Nelson, 1982), $t(58) = 1.10$, $p > .05$. Patients were stabilised on one or more antipsychotic medications. Patients received antipsychotics in the following doses, expressed as mean \pm SD: olanzapine ($n = 8$) 23.5 mg \pm 15.8; risperidone ($n = 4$) 6.0 mg \pm 1.8; quetiapine ($n = 3$) 800.0 mg \pm 458.3; clozapine ($n = 10$) 363.9 mg \pm 201.2, six patients received polypharmacy with risperidone (three clozapine and three quetiapine). Refractory patients who received clozapine were stable with the prescribed medication. The demographic and clinical data are summarised in Table 1. Psychiatric symptoms were measured with the Positive and Negative Syndrome Scale (PANSS; Kay, Fiszbein, & Opler, 1987).

Measures

All participants were tested individually over one session 1 hour long in a quiet room. Tasks were administered to all participants in random order.

Theory of Mind measures

Comic-strip task: Attribution of intentions to others (Sarfati et al., 1997). The task designed by Sarfati et al. was used to assess ToM without language. This task is composed of a series of 28 short comic strips, each of which represents a sequence of three pictures. Each comic strip shows a character performing an action, motivated by an easily recognisable volitional mental state (desire and intention). After viewing the comic strips, participants are asked to select, as quickly as possible, the answer card most likely to be the last drawing in the comic strip from among the three

TABLE 1
Demographic and clinical data on individuals with schizophrenia and healthy control participants

	<i>Schizophrenia</i>		<i>Healthy control</i>		<i>p-value</i>
	<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>	
Age	42.0	9.4	42.6	10.6	.819
Educational level	12.8	2.2	13.7	2.9	.171
Gender (male/female)	20/11		16/13		
NART	45.4	9.6	42.5	8.1	.275
Duration of illness	16.2	9.5			
PANSS (positive)	18.0	4.2			
PANSS (negative)	20.1	4.6			
PANSS (general)	38.6	6.4			

presented. The different answer cards are presented in random order. Participants must understand the characters' volitional mental state to correctly complete each comic strip. One card is the correct answer, which provides an appropriate ending in light of the character's mental state; another card depicts a very frequent everyday action; and a third card is pictorially very similar to the last picture in the story. These two last cards have no plausible link with the story in view of its contextual information and the character's mental state.

The dependent variable is the number of correct answer cards chosen.

Referential communication task. Stimuli were composed of five geometric figures from the tangram set (an ancient Chinese game; Chantraine et al., 1998). They have no a priori names and participants have to find a way to refer to them. The task was developed with two levels of complexity, depending on the type of tangram used, in order to determine whether more or less complex figures influence SZ participants' performance (see Figure 1). Indeed, Isaac and Clark (1987) and Hupet, Seron, and Chantraine (1991) have shown that the relative complexity of referents affects the referring procedure. In other words, when figures are difficult to name, more words and more speaking turns are required.

In our study, participant and experimenter were separated by an opaque screen in order to avoid nonverbal communication (gestures). The participant received the five figures in a given order on a sheet of paper. This order was unknown to the experimenter. The experimenter had the same set of figures but on individual cards that were scattered randomly. The participant was asked to describe the five figures from left to right in such a way as to help the experimenter arrange them in the same order. Each participant was told that both players had identical figures and that they would play the game four times, each time with a new order of the figures. Thus, the

First level



Second level



Figure 1. Tangrams used at the first and second levels of complexity.

participant had to provide discriminating information in order to enable the experimenter to identify each figure. The experimenter never suggested definite references concerning figures until the participant did. The task was repeated four times (the four trials) with the same partner and the same material. The order of the five figures given to the participant was changed in each trial. At the end of each trial, the participant and the experimenter checked to find out whether the experimenter's arrangement was similar to that of the participant. Two experimenters interacted with participants and the testing order of SZ and HC participants was randomised. Speech productions were recorded and later transcribed verbatim.

Scoring. For each trial (first, second, third, fourth), a linguist (GM) who was blind to group membership, measured: (1) the total number of words produced; (2) the number of speaking turns (defined as series of speech with no intervention by the partner); (3) the number of indefinite references (indefinite articles like “an angel”); and (4) the number of definite references (use of the definite article irrespective of the length of the noun phrase). Given that the total number of words varied across the participants, a ratio of indefinite references/total words and a ratio of definite references/total words were calculated. Misunderstandings were measured with the number of requests for clarification (e.g., request for more information, suggestion of a different way of describing the figure) and answers to these requests. The analysis of misunderstanding incidents due to confounding or irrelevant information also evidences specific impairment in the ability to adopt the experimenter's perspective.

Statistical analyses were performed on these dependent variables.

RESULTS

Unpaired *t*-tests were performed on the comic-strip data while analyses of variance (ANOVAs) were performed on the referential communication data.

Theory of Mind assessment

Comic-strip task

Unpaired *t*-tests performed on the comic-strip score revealed that SZ participants performed significantly worse than HC participants on this task, $t(58) = -4.09$, $p < .0001$.

Referential communication task

First level of complexity. A 2×4 repeated measure ANOVA for Group (SZ, HC) \times Trial (first trial, second trial, third trial, fourth trial) was

performed on each dependent variable: total number of words, number of speaking turns, ratio number of indefinite references/total words, and ratio number of definite references/total words.

For the total number of words, the results showed a main effect of trial, $F(3, 174) = 52.48, p < .0001$. Tukey's HSD revealed that the differences between the first trial and the other trials were significant ($p < .0001$). The differences between the second trial and the third trial ($p < .004$) and between the third trial and the fourth trial ($p < .01$) were also significant, meaning that the total number of words produced by participants decreased continuously from the first trial to the fourth trial. There was no main effect of group, $F(1, 58) = 0.37, p > .05$. The Group \times Trial interaction was not significant, $F(3, 174) = 1.35, p > .05$.

For the total number of speaking turns, the results showed a main effect of group, $F(1, 58) = 4.57, p < .05$; interactions involving SZ participants contained more speaking turns than interactions with HC participants. There was a main effect of trial, $F(3, 174) = 42.71, p < .0001$. Tukey's HSD revealed that the differences were significant ($p < .0001$) between the first trial and the other three trials. The Group \times Trial interaction was not significant, $F(3, 174) = 0.88, p > .05$ (cf. Table 2).

For the ratio indefinite references/total words, the results showed a main effect of group, $F(1, 58) = 17.67, p < .0001$. The ratio was higher for SZ participants than for HC participants. There was also a main effect of trial, $F(3, 174) = 18.09, p < .0001$. Tukey's HSD revealed that the ratio was higher in the first trial than in the second, third, or fourth trials ($p < .0001$). Differences were found between the second and third trials ($p < .05$), and the second and fourth trials ($p < .05$). No difference was found between the third and fourth trials ($p > .05$). The Group \times Trial interaction was also significant, $F(3, 174) = 7.89, p < .0001$. This interaction was decomposed by trial. There was no significant difference between the two groups on the first trial, $F(1, 58) = 0.85, p > .05$, but differences were found between the two groups on the second trial, $F(1, 58) = 15.44, p < .0001$, the third trial, $F(1, 58) = 15.44, p < .0001$, and the fourth trial, $F(1, 58) = 18.86, p < .0001$ (cf. Figure 2).

For the ratio definite references/total words, the results showed a main effect of group, $F(1, 58) = 17.43, p < .0001$. This ratio was higher for HC participants than for SZ participants. There was also a main effect of trial, $F(3, 174) = 51.86, p < .0001$. Tukey's HSD revealed that the ratio was lower in the first trial than in the second, third, and fourth trials ($p < .0001$). The ratio was also lower in the second trial than in the third and fourth trials ($p < .0001$). No difference was found between the third and fourth trials ($p > .05$). The Group \times Trial interaction was also significant, $F(3, 174) = 4.41, p < .005$. This interaction was decomposed by trial. There was a significant difference between the two groups on all trials: first trial,

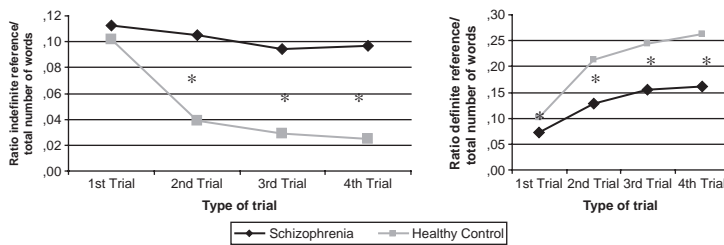


Figure 2. Ratios of indefinite and definite references per total words for SZ and HC participants at the first level of complexity. *Indicates significant differences.

$F(1, 58) = 6.59, p = .01$; second, $F(1, 58) = 12.81, p < .001$; third, $F(1, 58) = 12.24, p < .001$; fourth, $F(1, 58) = 14.21; p < .0001$ (cf. Figure 2).

To sum up, there was no difference between the HC and SZ groups based on the total number of words. SZ participants needed marginally more speaking turns than HC participants. However, the number of speaking turns decreases in the same way for both groups from the first to the fourth trial. There was an effect of type of trial for all dependent variables, meaning that participants' performance was different in the first trial from in the other trials. Taking into account the total number of words used, SZ participants used the same number of indefinite references as HC participants in the first trial while they differed in the other trials. They also differed from HC participants in all trials for the number of definite references they used.

Second level of complexity. A 2×4 repeated measure ANOVA for Group (SZ, HC) \times Trial (first trial, second trial, third trial, fourth trial) was performed on each dependent variable: total number of words, number of speaking turns, ratio indefinite references/total words, and ratio definite references/total words.

For the total number of words, the results showed a main effect of trial, $F(3, 174) = 50.32, p < .0001$. Tukey's HSD revealed that the differences between each pair of trials were significant ($p < .0001$) except between the third and the fourth trial ($p > .05$). This means that the total number of words produced by participants decreases continuously from the first trial to the third trial. There was no main effect of group, $F(1, 58) = 0.61, p > .05$. The Group \times Trial interaction was significant, $F(3, 174) = 4.64, p < .004$. This interaction was decomposed according to trial. There was no significant difference between the two groups on the first trial, $F(1, 58) = 1.72, p > .05$, but differences were found between the two groups on the second trial, $F(1, 58) = 9.16, p < .004$, the third trial, $F(1, 58) = 8.85, p < .004$, and the fourth trial, $F(1, 58) = 11.39, p < .001$.

TABLE 2
Group mean performance in the referential communication task at the first and second levels of complexity

		<i>Schizophrenia</i>		<i>Healthy control</i>	
		<i>Mean</i>	<i>SD</i>	<i>Mean</i>	<i>SD</i>
<i>First level of complexity</i>					
Total number of words	1st trial	147.4	113.2	164.0	136.7
	2nd trial	68.5	59.8	50.0	24.7
	3rd trial	58.8	48.7	37.2	17.0
	4th trial	44.2	30.6	35.2	17.8
Number of speaking turns	1st trial	11.4	6.4	9.1	5.4
	2nd trial	6.3	3.7	5.0	0.8
	3rd trial	6.1	2.2	4.8	0.8
	4th trial	5.5	1.3	4.8	0.8
Misunderstanding (Number of answers/requests for clarification)	1st trial	75/82		38/39	
	2nd trial	10/10		2/2	
	3rd trial	12/15		0	
	4th trial	5/5		0	
<i>Second level of complexity</i>					
Total number of words	1st trial	162.3	106.4	212.6	179.9
	2nd trial	86.2	56.4	50.3	26.3
	3rd trial	66.4	50.1	36.1	17.8
	4th trial	58.5	36.2	33.0	15.7
Number of speaking turns	1st trial	11.0	1.5	10.7	1.6
	2nd trial	6.8	0.4	5.1	0.4
	3rd trial	6.2	0.4	4.8	0.4
	4th trial	6.1	0.4	4.8	0.4
Misunderstanding (Number of answers/requests for clarification)	1st trial	69/77		35/36	
	2nd trial	8/9		1/1	
	3rd trial	8/9		0	
	4th trial	6/6		0	

For the total number of speaking turns, the results showed a main effect of trial, $F(1, 58) = 22.54, p < .0001$. Tukey's HSD revealed that the differences were significant between the first trial and the three others ($p < .0001$). There was no main effect of group, $F(3, 174) = 2.59, p > .05$. The Group \times Trial interaction was not significant, $F(3, 174) = 0.31, p > .05$ (cf. Table 2).

For the ratio indefinite references/total words, the results showed a main effect of group, $F(1, 58) = 20.36, p < .0001$. The ratio was higher for SZ than for HC participants. There was also a main effect of trial, $F(3, 174) = 27.51, p < .0001$. Tukey's HSD revealed that the ratio was higher in the first trial than in the second, third, or fourth trial ($p < .0001$). The ratio was also higher in the second trial than in the third trial ($p < .05$) or the fourth trial ($p < .001$). No difference was found between the third and fourth trials ($p > .05$). The Group \times Trial interaction was also significant, $F(3, 174) = 13.22, p < .0001$. This interaction was decomposed by trial. There was no significant difference between the two groups on the first trial, $F(1, 58) = 2.57, p > .05$, but differences were found between the two groups on the second, $F(1, 58) = 18.19, p < .0001$, third, $F(1, 58) = 22.06, p < .0001$, and fourth trials, $F(1, 58) = 23.25, p < .0001$ (cf. Figure 3).

For the ratio definite references/total words, the results showed a main effect of group, $F(1, 58) = 26.19, p < .0001$. The ratio was higher for HC participants than for SZ participants. There was also a main effect of trial, $F(3, 174) = 71.54, p < .0001$. Tukey's HSD revealed that the ratio was lower in the first trial than in the second, third, or fourth trial ($p < .0001$). The ratio was also lower in the second trial than in the third or fourth trial ($p < .0001$). No difference was found between the third and fourth trials ($p > .05$). The Group \times Trial interaction was also significant, $F(3, 174) = 10.73, p < .0001$. This interaction was decomposed by trial. There was significant difference between the two groups on the second trial, $F(1, 58) = 20.70, p < .0001$, the third trial, $F(1, 58) = 19.96, p < .0001$, and the fourth trial, $F(1, 58) = 23.87, p < .0001$. The difference between the two groups on the first trial was significant, $F(1, 58) = 4.23, p < .05$ (cf. Figure 3).

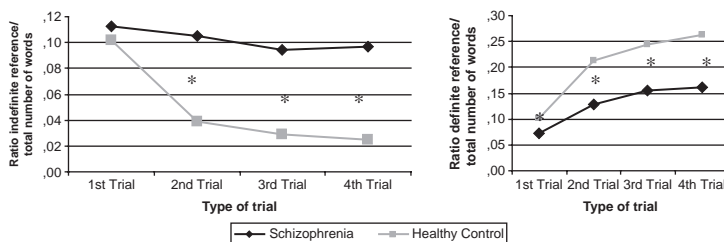


Figure 3. Ratios of indefinite and definite references per total words for SZ and HC participants at the second level of complexity. *Indicates significant differences.

In summary, results were similar to those found at the first level of complexity for the dependent variables: speaking turns, number of indefinite references, and number of definite references. However, at this level of complexity, SZ participants used more words than HC participants in the second, third, and fourth trials by contrast to the first trial.

Analyses were also performed by separating patients treated with clozapine from others. No difference was found between refractory patients treated and stable with clozapine and the others.

Misunderstanding. Statistical analyses were only performed on the first trial for the first and second levels of complexity since no demands for clarification were needed in the HC group in the other trials, unlike the situation with SZ participants (cf. Table 2). The results showed a difference between groups for requests for information at the first level of complexity, $t(56) = 2.29, p < .05$, and the second level of complexity, $t(54) = 2.65, p < .01$. Differences were found for answers to these requests at the first level of complexity, $t(43) = -2.7, p < .01$, but not at the second level of complexity, $t(44) = 0.66, p > .05$. These results mean that more requests for clarification were made with SZ participants than with HC participants and that SZ participants provided fewer answers than HC participants to requests for clarification at the first level of complexity.

Relationship between comic-strip and referential communication task

To determine if the same participants performed more poorly on the referential communication task and the comic-strip task, a median split of the SZ data into relatively unimpaired (SZ-U) versus relatively impaired (SZ-I) on the Comic-Strip task was used. A 2×4 repeated measure ANOVA for Group (SZ-U, SZ-I) \times Trial (first trial, second trial, third trial, fourth trial) was performed on the ratio indefinite references/total words, and on the ratio definite references/total words in the first and second level of complexity since these dependant variables best reflect ToM ability. SZ-I group ($n = 14$) contained participants' performances under the median (23) while SZ-U group ($n = 13$) contained participants' performances over the median. Participants' performances equal to the median ($n = 4$) were excluded from the analyses.

First level of complexity. For the ratio indefinite references/total words, the results showed a main effect of group, $F(1, 25) = 9.79, p < .005$. The ratio was higher for SZ-I than for SZ-U participants. There was no main effect of trial, $F(3, 75) = 1.39, p > .05$. The Group \times Trial interaction was significant, $F(3, 75) = 4.93, p < .004$. This interaction was decomposed by trial. There

was no significant difference between the two groups on the first trial, $F(1, 25) = 0.47, p > .05$, but differences were found between the two groups on the second, $F(1, 25) = 7.40, p < .01$, third, $F(1, 25) = 10.75, p < .003$, and fourth trials $F(1, 25) = 8.93, p < .006$ (cf. Figure 4).

For the ratio definite references/total words, the results showed a main effect of group, $F(1, 25) = 8.12, p < .009$. The ratio was higher for SZ-U participants than for SZ-I participants. There was a main effect of trial, $F(3, 75) = 17.65, p < .0001$. Tukey's HSD revealed that the ratio was lower in the first trial than in the second ($p < .001$), third, or fourth trial ($p < .0001$). The ratio was also lower in the second trial than in the third ($p < .008$) or fourth trial ($p < .02$). No difference was found between the third and fourth trials ($p > .05$). The Group \times Trial interaction was marginally significant, $F(3, 75) = 2.63, p = .05$. This interaction was decomposed by trial. There was no significant difference between the two groups on the second trial, $F(1, 25) = 3.86, p < .06$, but differences were found between the two groups on the first, $F(1, 25) = 6.12, p < .02$, third, $F(1, 25) = 5.70, p < .025$, and fourth trials, $F(1, 25) = 9.05, p < .006$ (cf. Figure 4).

Second level of complexity. For the ratio indefinite references/total words, the results showed no main effect of group, $F(1, 25) = 0.84, p > .05$, and no main effect of trial, $F(3, 75) = 1.62, p > .05$. The Group \times Trial interaction was not significant, $F(3, 75) = 1.22, p > .05$.

For the ratio definite references/total words, the results showed no main effect of group, $F(1, 25) = 1.30, p > .05$. There was a main effect of trial, $F(3, 75) = 12.07, p < .0001$. Tukey's HSD revealed that the ratio was lower in the first trial than in the second ($p < .01$), third ($p < .002$), or fourth trials ($p < .0001$). The ratio was also lower in the second trial than in the third ($p < .006$) or fourth trials ($p < .002$). No difference was found between the

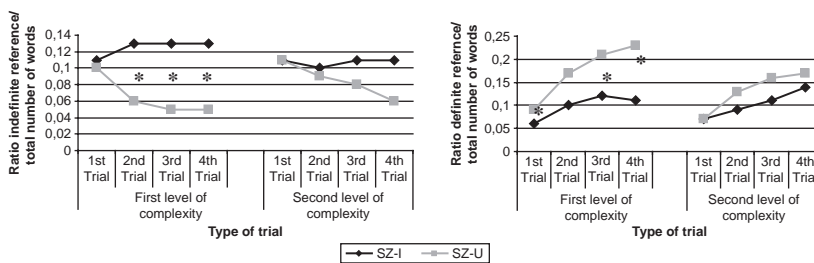


Figure 4. Ratios of indefinite and definite references per total words for SZ-I and SZ-U participants at the first and second level of complexity. SZ-I: SZ participants relatively impaired on the comic-strip task; SZ-U: SZ participants relatively unimpaired on the comic-strip task. *Indicates significant differences.

third and fourth trials ($p > .05$). The Group \times Trial interaction was not significant, $F(3, 75) = 0.81, p > .05$.

In summary, in the first level of complexity, taking into account the total number of words used, SZ participants relatively unimpaired, and SZ participants relatively impaired on the comic-strip task used the same number of indefinite references in the first trial while they differed in the other trials. They also differed in the first, third, and fourth trials for the number of definite references they used. No difference was found between the two SZ subgroups in the second level of complexity.

Correlation between Theory of Mind and symptoms

There was no significant correlation (Spearman correlation) between the performances of SZ patients on theory of mind tasks and any symptoms assessed by the PANSS.

Post hoc analyses

An analysis of content was performed to determine if participants might have trouble remembering information they used in a previous trial due to a memory problem rather than an inadequate use of indefinite references to mark information. The number of new versus old descriptions used to describe figures was measured for each trial. To determine if a description was new or old, each trial was compared with the previous ones (second versus first trial, third versus second and first trial, fourth versus third, second, and first trial). Descriptions were counted as new when they had never been used by the participants in the previous trials, and counted as old when they had already been used in one or more of the previous trials. New descriptions were never found to be associated with a definite reference in either SZ participants or HC participants.

Content analysis

A 2×4 repeated measure ANOVA Type of description (new, old) \times Trial (first trial, second trial, third trial, fourth trial) was performed on the number of descriptions in the first and second level of complexity for each group.

First level of complexity. For HC participants, the results showed a main effect of trial, $F(3, 84) = 19.07, p < .0001$. Tukey's HSD revealed that the number of descriptions was higher in the first trial than the second, third and fourth trials ($p < .0001$). The number of descriptions was also higher in the

second trial than the third ($p < .01$) and fourth trials ($p < .004$). The number of descriptions was also higher in the third trial than the fourth ($p < .025$). There was no main effect of the type of descriptions, $F(1, 28) = 3.31, p > .05$. The Type of description \times Trial interaction was significant, $F(3, 84) = 43.06, p < .0001$. This interaction was decomposed by trial. There were significantly more new descriptions than old descriptions on the first trial ($p < .0001$), whereas there were significantly more old than new descriptions on the second ($p < .0001$), third ($p < .0001$), and fourth trials ($p < .0001$).

For SZ participants, the results showed a main effect of trial, $F(3, 90) = 25.84, p < .0001$. Tukey's HSD revealed that the number of descriptions was higher in the first trial than the second, third, and fourth trials ($p < .0001$). The number of descriptions was also higher in the second trial than the fourth trial ($p < .01$). The number of descriptions was also higher in the third trial than the fourth trial ($p < .01$). No difference was found between the second and third trials ($p > .05$). There was no main effect of the type of descriptions, $F(1, 30) = 0.48, p > .05$. The Type of description \times Trial interaction was significant, $F(3, 90) = 72.97, p < .0001$. This interaction was decomposed by trial. There were significantly more new descriptions than old descriptions on the first trial ($p < .0001$), whereas there were significantly more old than new descriptions on the second ($p < .0001$), third ($p < .0001$), and fourth trials ($p < .0001$).

Second level of complexity. For HC participants, the results showed a main effect of trial, $F(3, 84) = 24.68, p < .0001$. Tukey's HSD revealed that the number of descriptions was higher in the first trial than the second, third, and fourth trials ($p < .0001$). The number of descriptions was also higher in the second trial than the third ($p < .006$) and fourth trials ($p < .0001$). No difference was found between the third and fourth trials ($p > .05$). There was a main effect of the type of descriptions, $F(1, 28) = 6.30, p < .02$. The Type of description \times Trial interaction was significant, $F(3, 84) = 56.12, p < .0001$. This interaction was decomposed by trial. There were significantly more new descriptions than old descriptions on the first trial ($p < .0001$), whereas there were significantly more old than new descriptions on the second ($p < .0001$), third ($p < .0001$), and fourth trials ($p < .0001$).

For SZ participants, the results showed a main effect of trial, $F(3, 90) = 21.89, p < .0001$. Tukey's HSD revealed that the number of descriptions was higher in the first trial than the second, third, and fourth trials ($p < .0001$). The number of descriptions was also higher in the second trial than the third ($p < .004$) and fourth trials ($p < .001$). No difference was found between the third and fourth trials ($p > .05$). There was no main effect of the type of descriptions, $F(1, 30) = 0.02, p > .05$. The Type of description \times Trial interaction was significant, $F(3, 90) = 119.80, p < .0001$. This interaction was decomposed by trial. There were significantly more new descriptions

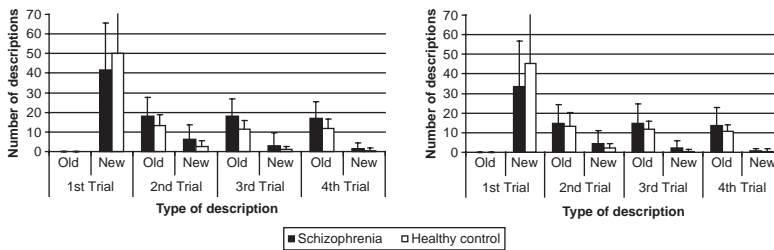


Figure 5. Number of new and old descriptions used by SZ and HC participants at the first and second level of complexity.

than old descriptions on the first trial ($p < .0001$), whereas there was significantly more old than new descriptions on the second ($p < .0001$), third ($p < .0001$), and fourth trials ($p < .0001$).

These results mean that both SZ and HC participants used more old than new descriptions in the second, third, and fourth trials (cf. Figure 5).

DISCUSSION

The present study aimed to determine whether SZ individuals present ToM impairments when they are assessed in a natural situation of conversation compared to a classical nonverbal ToM task. To this end, the referential communication paradigm was used, with four repetitions of the exchange between the same interlocutors. This task allowed us to capture the dynamic and social nature of a verbal interaction.

The main results showed that SZ participants performed worse than HC participants on both the classical nonverbal ToM task and the referential communication task.

Focusing on the referential communication task, the main results indicated that SZ participants had problems using information they shared with the experimenter. They seemed to use the same descriptions throughout the exchanges as if they were not attributing knowledge (knowledge acquired during previous exchanges) to the experimenter. As expected, no difference in performance was found between the two groups of subjects on the first trial; that represents square one of the exchange when the interlocutors have no shared knowledge. The number of words, speaking turns, and indefinite references decreased, whereas definite references increased over the following trials. However, these changes due to the repetition of the exchange in the following trials were smaller in the SZ group than the HC group with regard to the number of words, indefinite, and definite references. SZ participants exhibited a tendency to ineffectively mark the information they used. More specifically, in comparison to the HC group, the number of indefinite

references did not decrease and the number of definite references increased only slowly across the trials in the SZ group. SZ participants used fewer definite references and more indefinite references than HC participants from the first to the fourth trial. This means that they used indefinite articles for marking old information and definite articles for new information, unlike the HC participants. This interpretation was confirmed by the results of the content analysis. This analysis enabled us to exclude the hypothesis of memory problems according to which worse performances of SZ participants may reflect difficulties in their ability to encode and recall mutually agreed descriptions across trials rather than genuine ToM problems. Indeed, SZ participants used significantly more old descriptions than new in the second, third, and fourth trials, as healthy participants did, meaning that they continued to use the same descriptions across trials. As a consequence, SZ participants seemed to remember the descriptions they used in previous trials but they used inadequate references to mark them.

All these results indicate that SZ participants did not use referential markers in an appropriate way, in connection with accessibility that the referent is assumed to have in the listener's mental discourse representation (cf. Ariel's, 1990, 1996, accessibility model). Interestingly, these results are very much in contrast with those of HC participants who used indefinite references to effectively mark new information and definite references for old information for which an agreement had previously been reached between the interlocutors. This result is expected both by the collaborative model (Clark & Wilkes-Gibbs, 1986) and the interactive alignment model (Pickering & Garrod, 2004). The HC group's results also agreed with the prediction that many more words and speaking turns would be needed to reach acceptance the first time than the subsequent times the interlocutors encountered a figure, meaning that the collaborative process aiming at mutual understanding was actually achieved.

An impairment in attributing shared knowledge to the experimenter was confirmed by the results related to misunderstandings. Requests for clarification and supplementary information were necessary in all the trials with SZ participants, whereas they were made to HC participants only in the first trial when the exchange was complex and included several descriptions. In other words, the fact that SZ participants used indefinite references to mark old information and that they did not reuse referential expressions for which an agreement had been reached with the experimenter in subsequent trials, induced ambiguity. And this ambiguity led the experimenter to ask SZ participants for clarification in the second, third, and fourth trials.

Focusing on the relationship between the referential communication task and the comic-strip task, comparisons within schizophrenia group (SZ-U vs. SZ-I) revealed that in the first level of complexity, SZ participants relatively impaired (SZ-I) on the comic-strip task were those who performed more

poorly on the referential communication task. This relationship between these two tasks showed the known heterogeneity existing among SZ participants and supports the hypothesis that the referential communication task is a good paradigm to study ToM ability during conversation since participants who performed worse on the comic-strip task also performed worse on the referential communication task.

The effect of complexity

The same types of performance concerning definite and indefinite references were found at both levels of figure complexity. However, the increase in the figures' complexity meant that SZ participants used more words than HC participants in the second, third, and fourth trials at the second level of complexity. There was no difference in terms of speaking turns. Verbal exchanges were longer with SZ participants than with HC participants at the second level of complexity probably because more collaborative effort is required when referring to figures that are harder to name and harder to tell apart.

This difference in the number of words at the two levels of complexity may result from the fact that SZ participants seemed to use more of a segmental perspective than a holistic perspective to describe the figures at the second level of complexity. The segmental perspective entails describing each figure in terms of juxtaposed geometric parts and relations (e.g., "there are two triangles on the top, and a square on the left . . ."). The holistic perspective involves describing each figure as a whole (e.g., "it looks like a fish"). Figures that were difficult to name elicited less holistic perspectives than figures that were easy to name (Hupet et al., 1991). However, even though SZ participants used a segmental perspective, this did not account for their difficulty attributing and using shared knowledge. It merely led to longer exchanges with the experimenter than the HC participants engaged in.

Interestingly, a difference between performances concerning definite and indefinite references in the first and second level of complexity was revealed when comparing subgroups of SZ participants relatively impaired and relatively unimpaired on the comic-strip task. Indeed, SZ participants relatively impaired on the comic-strip task performed worse than relatively unimpaired SZ participants in their use of definite and indefinite references in the first level of complexity, although no difference was found in the second level of complexity. This lack of difference between SZ-I and SZ-U subgroups in the second level of complexity suggested that when figures' complexity increased SZ participants relatively unimpaired on the comic-strip task showed a more marked inadequate use of reference markers, leading to a similar performance level of relatively impaired SZ participants.

Finally, the results of our study do not confirm those of McCabe et al. (2004). Although the task we used was less cognitively demanding than classical ToM tasks, the SZ individuals presented ToM difficulties, unlike the SZ group studied by McCabe et al. The difference was probably due to the methodology we used. In sum, our results do not support the hypothesis that ToM impairments of SZ individuals might be due to a task demand effect, as was suggested by McCabe et al., for example.

In conclusion, this study showed that individuals with schizophrenia find it difficult to judge and attribute mental states such as shared knowledge in a natural conversation. The referential communication task appears to be a relevant paradigm for studying ToM ability in schizophrenia since it is less complex than classical ToM tasks and much closer to what happens in the reality of daily interactions.

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