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The other side of the social interaction: Theory of mind impairments in people with schizophrenia are linked to other people's difficulties in understanding them

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ABSTRACT

Background: People with schizophrenia (SZ) often present with theory of mind (ToM) deficits and with speech production deficits. While a link has been established between ToM abilities and symptoms of thought disorder, much less is known about other aspects of speech production in SZ.
Study design: This is a case-control study in which 25 stable outpatients with recent-onset SZ (27.1 years, 22 men) and 22 matched healthy controls (25.6 years, 16 men) performed a collaborative, verbal production task with a real interaction partner. Blind raters scored how easy participants made it to understand them (Facility ratings), how interesting they were to listen to (Interest ratings) and how expressive they were (Expressivity ratings). ToM was assessed with the Combined Stories Test and Sarfati's cartoon task. Symptoms were assessed with the PANSS five-factor version.
Study results: Compared to healthy controls, SZ received significantly lower ratings for all three aspects of their verbal productions (Facility, Interest and Expressivity), despite the raters being blind to group membership. Interestingly, the Facility ratings were linked to ToM performance in the SZ group, which suggest that SZ participants who have difficulties understanding others (ToM deficits) also make it harder for others to understand them. Other notable findings include a strong link between the Expressivity ratings and the Interest ratings for both groups, and significant correlations between the Facility ratings and Cognitive/Disorganisation symptoms, and between the Expressivity ratings and both Negative and Depression/Anxiety symptoms in SZ.
Conclusion: Studying speech production during real, collaborative social interactions could help move beyond the individual approach to SZ deficits, making it possible to involve the interaction partners to promote more efficient communication for people with schizophrenia.

1. Introduction

It is now well recognized that people with schizophrenia (SZ) often present with Theory of mind (ToM) deficits (Achim et al., 2013; Green et al., 2015; Sarfati et al., 1997; Savla et al., 2013) and that these deficits contribute to impairments in everyday functioning (Achim et al., 2012; Fett et al., 2011; Thibaudeau et al., 2021). ToM consists in the ability to infer or represent the mental states of other people, including their beliefs, knowledge, intentions and emotions. While most studies targeting the impact of ToM on functioning in outpatients with schizophrenia have relied on overall measures of everyday functioning (Achim et al., 2012; Bambini et al., 2016; Brüne et al., 2009; Cook et al., 2013; Jung et al., 2014; Langdon et al., 2014; Le et al., 2018; Weijers et al., 2018), evidence is starting to emerge suggesting that ToM deficits affect some areas of functioning more than others, namely the areas of functioning that involve collaborative social interactions with other people (i.e. shared goals; Achim et al., 2022; Thibaudeau et al., 2021). The mechanisms through which ToM deficits translate into impaired social interactions however remain to be further examined.

While we can assume that the link between ToM abilities and functioning in SZ is mediated by the ability to *understand* others during everyday social interactions (receptive aspect of communication),

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recent evidence suggests that ToM is further involved in the *productive* aspect of communication. From the literature in healthy people, we know that efficient communication requires adjusting one's verbal productions to the needs of the person who receives the message (Achim et al., 2015; Brennan et al., 2010; Clark and Wilkes-Gibbs, 1986; Horton and Gerrig, 2002; Isaacs and Clark, 1987). Such adjustments in the way speakers formulates their verbal productions are thought to require an appreciation of what constitutes common ground (i.e. common knowledge) with the interaction partner. As an example, if I tell you "Noah was in a good mood this morning", it makes for a more ambiguous message than if I tell you "My son Noah was in a good mood this morning". A speaker taking common ground (or lack thereof) into account hence makes it easier for the listener to understand their message.

Several studies have revealed such collaborative adjustments (i.e. taking common ground into account) in the speech productions of healthy participants (Achim et al., 2017; Achim et al., 2015; Brennan et al., 2010; Brown-Schmidt, 2012; Fukumura and van Gompel, 2012; Fussell and Krauss, 1992; Heller et al., 2012; Horton and Gerrig, 2002; Knutsen and Le Bigot, 2012). A recent study from our team (Achim et al., 2015) targeted a group of 40 healthy participants and observed a significant association between a psychometrically sound measure of ToM (the Combined stories task or COST; Achim et al., 2012; Thibaudeau et al., 2018) and the ability to adjust one's speech during a collaborative interaction task, depending on the interlocutor's likely knowledge of the movie characters that the participants had to present. More specifically, participants had to present a series of 10 movie characters to their interlocutor, and they provided more information to present the characters that the interlocutor was less likely to know, this adjustment being stronger in participants with better ToM performance and less pronounced in participants with lower ToM performance ($r = -0.47$). While that study did not include a SZ group, it suggests that ToM deficits could be accompanied by difficulties in adjusting one's speech to be well understood by the interlocutor during verbal interactions.

Speech production is indeed often impaired in SZ (Achim et al., 2012; Brüne et al., 2009; de Sousa et al., 2019; Docherty et al., 1996; Docherty et al., 2006; Green et al., 2015; Harvey, 1983) and these deficits have been documented using several complementary approaches. For instance, people with schizophrenia can present with symptoms of thought disorder, which are in fact deficits of language production thought to reflect underlying disorganized thoughts (Andreasen, 1979a, 1979b; Kerns and Berenbaum, 2002). Evaluations of thought disorders are typically based on the speech observed during clinical or research interviews and subjective ratings are made using rating scales that can either target global thought disorder or a range of specific aspects such as tangentially, derailment, incoherence, poverty of speech, etc. Another approach that revealed speech production deficits in schizophrenia is the *communication failure approach,* which focusses on unclarities in free speech (words of fragments for which the intended meaning is unclear), often coded with the Communication Disturbance Index (CDI; (Docherty, 2005; Docherty et al., 1996; Docherty et al., 2013; Docherty et al., 2006; Harvey, 1983). The CDI provides a framework and validated scoring scheme to identify all instances of communication failures (i.e. unclarity of meanings) in free speech samples and to code each instance as belonging to one of six different categories (vague references, confused references, missing information references, ambiguous word meanings, wrong word references and structural unclarities). Several studies documented a greater rate of communication failures in the speech of people with SZ as compared to healthy controls using the CDI (Docherty, 2005; Docherty et al., 1996; Docherty et al., 2013; Docherty et al., 2006; Harvey, 1983). Finally, other studies also relied on a *linguistic approach,* using a wide varieties of methods including automated language analyses software (Elvevåg et al., 2007; Minor et al., 2019) or manual coding of different linguistic features observed during language production tasks (e.g. choices of reference markers, linguistic alignment, etc.; Champagne-Lavau et al., 2009; Dwyer et al., 2020; Haas et al., 2015; Noël-Jorand et al., 1997; Themistocleous et al., 2009; Watson et al., 2012).

In addition to reporting impaired speech production in SZ, some studies also examined the association with ToM, the vast majority examining the link between ToM and thought disorder symptoms. A recent meta-analysis (de Sousa et al., 2019) summarised this literature and reported a significant association between ToM and global ratings of thought disorder ($r = -0.35$) across 57 studies. The link between ToM and thought disorder symptoms in SZ thus seems well established.

In contrast, much fewer studies have addressed the link between ToM and speech production in SZ with the other two approaches, namely the communication failure approach (targeting unclarities in free speech samples) or the linguistic approach (targeting a range of linguistic features). Such complementary approaches are however important to consider as they allow examining a wider range of speech characteristics and they introduce much more controlled methods for acquiring speech samples.

One notable study for the communication failure approach is that of Docherty et al. (2013), who examined the association between ToM and language production using free speech samples (10 min, on topics such as interests, family, etc.) that were subsequently rated with the communication disturbance index (CDI; Docherty et al., 1996). That study observed a significant association between the rate of communication failures identified with the CDI (total score) and ToM as assessed with the Hinting task (Corcoran et al., 1995) and Safarti's cartoon task (Sarfati et al., 2003), both in outpatients with SZ ($N = 63$) and in their healthy control group ($N = 21$). As far as we are aware, this was the only study to examine the link between ToM and the rate of communication failures in SZ.

As for the linguistic approach, some studies have started to address different aspects of language production in people with SZ during well-controlled social interactions tasks (Covington et al., 2005), again with very few studies targeting the link with ToM. One of the first studies to examine that link was conducted by Champagne-Lavau et al. (2009) and targeted a group of 31 outpatients with SZ. The speech samples were produced in the context of a referential communication game in which participants had to discuss a series of tangram images with the experimenter. A median-split strategy was employed to distinguish subgroups with greater or lower ToM performance on Sarfati's cartoon task (Sarfati et al., 2003), and the subgroup with lower ToM performance showed a less adapted use of indefinite versus definite references, i.e. they reintroduced previously mentioned items with indefinite references (e.g. "a mountain") instead of the expected definite references (e.g. "the mountain"). More recently, Dwyer et al. (2020) examined the link between ToM and alignment in dialogue, i.e. the degree to which participants' descriptions was influenced by the experimenter's description in the previous exchange. ToM was assessed with a series of six stories targeting first-order and second-order false-beliefs and deception, and their study did not find a significant association between ToM performance and alignment in a group of 42 inpatients with SZ. Overall, very few studies have targeted the link between ToM and speech production beyond measures of thought disorder, and these prior studies used quite different methods to assess speech deficits and ToM. It is thus possible that some specific linguistic features are significantly linked to ToM (choices of reference markers) while others (alignment) could be less affected by ToM deficits. Alternatively, the choice of ToM task (e.g. avoiding ceiling effects) or the characteristics of the sample (e.g. outpatients versus inpatients) could also influence the observed links between ToM and speech production.

Overall, these few studies relying on the communication failure or the linguistic approach rely on structured methodologies that can enrich our understanding of the link between ToM and language production in SZ, but this literature is still very limited. In addition, some methodological choices of these pioneer studies would be relevant to re-examine. For instance, the study by Docherty et al. (2013) did not favour social interactions, as the interviewer was there to encourage participants to speak, but then listened without interacting with them. The ratings were

thus made for monologues rather than verbal interactions. As for the studies by Champagne-Lavau et al. (2009) and Dwyer et al. (2020), they did allow for verbal interactions but they targeted very specific aspects of language production and did not emphasise the success of the verbal communication act. Furthermore, these last two studies both used ToM tasks that often lead to ceiling effects, which reduces the ability to document eventual associations with speech production (including Champagne-Lavau et al. (2009), limited to the use of a median split strategy). We thus know very little about the link between ToM and language production in SZ in the context of real social interactions where participants interact with another person towards a shared goal.

The objective of the current study was to examine the link between ToM and language produced in the context of a collaborative interaction task. More specifically, we were interested in the degree to which people with SZ made it easy or hard to perform a verbal collaborative task with them (Facility ratings). This is similar to the communication failure approach (looking at instances of unclarity in speech) in the sense that the focus is on the success of the communicative act, but using a collaborative interaction task (similar to those typically used for the linguistic approach) makes it possible to standardise the discourse between participants and to make the communication relevant to the attainment of a shared goal with another person (i.e. help the interlocutor to reorder some image cards, see methods below).

Our interaction task also allowed us to manipulate the effect of the interaction partner's likely prior knowledge of the material being discussed (movie scenes; see methods). This kind of manipulation can inform us about the contexts in which the speech disorders of people with SZ are most prominent.

In addition, we also examined how interesting and expressive participants were perceived during the verbal collaboration task (Interest ratings and Expressivity ratings). This could provide a more comprehensive understanding of what interlocutors experience when they verbally interact with someone with SZ in real life, potentially hindering social interactions if people with SZ were deemed less interesting during verbal exchanges.

2. Methods

2.1. Participants

The study included 25 participants with a schizophrenia spectrum disorder (SZ; mean age = 27.1, 22 men), all recruited from a clinic for first episode psychosis in Quebec City (Clinique Notre-Dame-des-Victoires). The diagnoses included schizophrenia (N = 16), schizoaffective disorder (N = 7) and delusional disorder (N = 2) and were established by the treating psychiatrist based on multiple sources of information including clinical interviews, informant reports, and file reviews. The mean duration of psychosis was 2.2 years (range 0.4–5.6; SD = 1.4). All SZ participants were taking an antipsychotic medication (see Table 1) and were stable outpatients at the time of testing.

Twenty-two (22) healthy controls (HC) were recruited through adds in local media and word-of-mouth. They were matched to the patients for age and gender (mean age = 25.6; 16 men) as well as parental socioeconomic status as assessed with the Hollingshead inventory (Miller, 1991) (see Table 1 for more details). HC were excluded if they reported a psychiatric diagnosis or if taking a psychoactive medication.

None of the participants presented with a history of a neurological disorder and all had an estimated IQ in the normal range (i.e. 70 or greater) as assessed using the Vocabulary and Block design subscales from the WAIS-III (Wechsler, 1997).

The Research Ethics Board of the CIUSSS-CN - neuroscience and mental health division (project #182-2007) approved the study and all participants provided informed consent.

Table 1
Socio-demographic characteristics, symptom ratings, theory of mind performance and number of movies from the experimental task that the participants had seen.

	SZ group	HC group	Statistics
Socio-demographic information			
Age	27.1 (4.8)	25.6 (5.9)	t(45) = 0.95, p = .349
Gender	22 M/3F	16 M/6F	X^2 = 1.76, p = .184
Parental socio-economic category	3.5 (0.9)	3.2 (1.0)	t(45) = 1.18, p = .246
Estimated IQ	98.0 (6.1)	105.8 (11.4)	t(43) 2.86, p = .007
Symptoms			
PANSS Positive	14.3 (4.7)		
PANSS Negative	15.5 (6.0)		
PANSS cognitive/ disorganisation	9.3 (3.3)		
PANSS depression/anxiety	8.1 (2.4)		
PANSS excitation/hostility	5.6 (2.1)		
PANSS total	60.2 (15.0)		
PANSS P2: conceptual disorganisation	2.0 (1.1)		
Antipsychotic medication			
Aripiprazole	N = 10		
Olanzapine	N = 10		
Quetiapine XR	N = 5		
Clozapine	N = 3		
Risperidone consta	N = 2		
Risperidone	N = 2		
Paliperidone palmitate	N = 1		
Aripiprazole and quetiapine	N = 1		
Other medications			
Citalopram	N = 2		
Mirtazapine	N = 2		
Venlafaxine	N = 1		
Lamotrigine	N = 5		
Lithium	N = 1		
Valproic acid	N = 1		
Lorazepam	N = 6		
Clonazepam	N = 1		
ToM performance			
ToM: COST (/52)	37.4 (8.0)	43.0 (4.8)	t(45) = −2.89, p = .006
ToM: Sarfati's Cartoon Task (/28)	24.4 (2.9)	26.2 (2.0)	t(45) = −2.46, p = .018
Number of movies from the experimental task that the participants had seen			
Total number (/6)	4.3 (1.4)	4.0 (1.3)	t(45) = 0.70, p = .490
Number of likely-known movies (/3)	2.6 (0.6)	2.6 (0.7)	t(45) = −0.42, p = .675
Number of likely-unknown movies (/3)	1.7 (1.1)	1.3 (1.0)	t(45) = 1.13, p = .263

Means are presented with standard deviations (SDs).

2.2. Collaborative interaction task and ratings by naïve judges

The current project is based on the referential communication paradigm (Champagne-Lavau et al., 2009; Clark and Wilkes-Gibbs, 1986), which reproduces a communication situation in which the participant has to present a series of images to an interaction partner. For the current task, participants were given six sequences of six images, each sequence representing a different movie scene involving two male characters. As illustrated in Fig. 1, the interaction partner was seated on

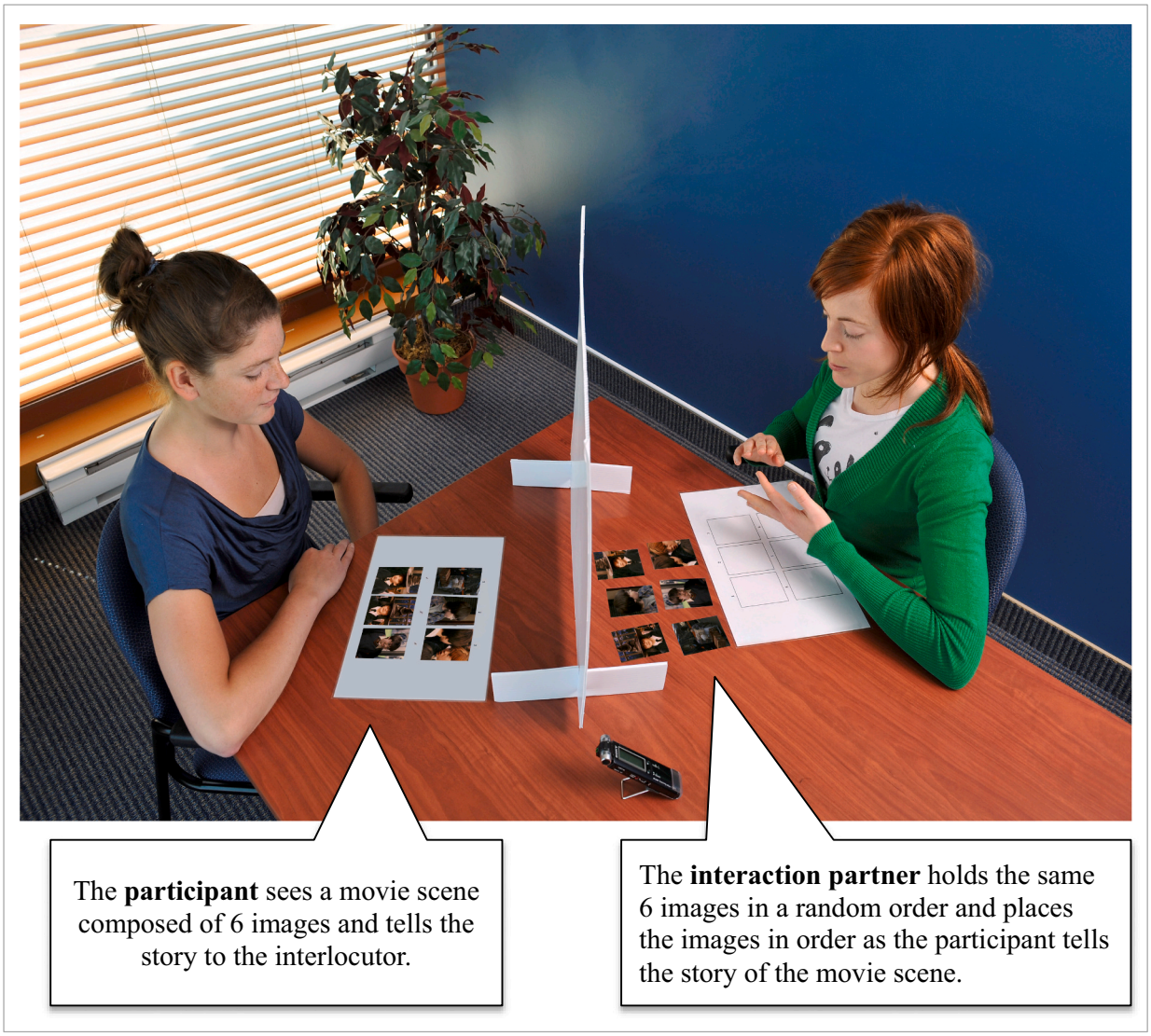

Fig. 1. Illustration of the collaborative interaction task.

the other side on an opaque panel and, for each of the six trials of the task, held the same six images as the participant but on separate cards and in a random order. Participants were instructed to tell the story of the movie scene represented on the images so that the interaction partner could follow the story and place the images in the same order. While most previous referential communication studies required that participants present independent images on each trial of the task, this paradigm has also proved successful to study narrative discourse in a real yet standardised communication context (Achim et al., 2017; Fossard et al., 2018), as in the current study.

The task and material was the same as used by Achim et al. (2017), and a validated manipulation was hence included such that three of the six movies scenes were from movies that can be considered as likely-known by most women in their twenties in Quebec City (corresponding to our research assistants acting as the interaction partner; *likely-known condition*), whereas the other three movies scenes were from movies that a lesser proportion of women would know (*likely-unknown condition*).

During the task, the participant presented the movie scenes and the interaction partner was allowed to provide feedback or ask for clarifications. A trained research assistant played the role of the interaction partner. The research assistant knew all the likely-known movies and was trained to act as if she knew none of the likely-unknown movies, for example requesting additional information if the participant referred to a character from a likely-unknown movie using strictly his name.

Before performing the task, participants answered a questionnaire that enquired, for each of the six movies, whether they had seen the movie or not (see Table 1).

The verbal interactions were tape-recorded and separated into distinct audio tracks for each movie scene. Four undergraduate students then each listened to all the audio tracks (not knowing which ones were from SZ, HC or a control audio track; see Supplement S1). They were asked to (1) Place the images in order as they listened to the story and write down the order that they obtained; (2) Provide ratings on a scale from 1 to 10 for each of the three following aspects:

2a) How easy/hard was it to place the images in order (Facility ratings).

2b) How interesting the story was (Interest ratings).

2c) How expressive the participant's voice was (Expressivity ratings).

2.3. Assessment of theory of mind

Theory of mind was assessed using the Combined Stories Test (COST; Achim et al., 2012; Thibaudeau et al., 2018) and Sarfati's Cartoon Task (Sarfati et al., 2003). The COST is a validated story-based task in which participants have to read a series of stories and to provide open answers

to questions that target the mental states of the characters. Control non-social reasoning stories and questions are also included. The COST presents with good psychometric properties including good validity, internal consistency, test-retest reliability and inter-rater reliability (Achim et al., 2012; Thibaudeau et al., 2018). Sarfati's cartoon task involves presenting comic-strips made-up of three images. For each comic-strip, participants choose the most likely next action of the story character from a set of three additional images. While the psychometric properties of this task are yet to be formerly established, it has been used in multiple prior studies (Achim et al., 2011; Sarfati and Hardy-Bayle, 1999; Sarfati et al., 1997) and was included here to assess ToM also for non-verbal material.

2.4. Evaluation of symptoms

Symptoms were rated by the treating psychiatrists, who were blind to the study aims or results, using the Positive and Negative Symptom Scale (PANSS; Kay et al., 1987). The five-factor version was used given that it is better supported by previous factor analyses (Lehoux et al., 2009), leading to the factors: (a) positive symptoms; (b) negative symptoms; (c) cognitive/disorganisation symptoms; (d) depression and anxiety; (e) excitation and hostility (see Table 1).

2.5. Analyses

The Facility ratings, Interest ratings and Expressivity ratings were first averaged across the four judges and the six movie scenes. These scores were then subjected to independent-sample *t*-tests to examine between-group differences for each of the three ratings, as well as Pearson Correlations to assess the links with theory of mind and with the five symptoms factors from the PANSS in the SZ group. The correlation with the single rating for conceptual disorganisation (P2) from the PANSS was also examined. The correlations that emerged with ToM performance where thereafter repeated using partial correlations including non-social cognition (non-social reasoning from the COST and estimated IQ, available for all but two SZ) as control variables.

Two-sample *t*-tests were also used to compare the groups on both ToM measures.

Additional exploratory analyses were also performed to examine potential effects of the type of movie (likely-known or likely-unknown) and potential effects linked to whether the participants had seen the movies or not (see additional information in Supplement S2).

3. Results

3.1. Between-group differences

As illustrated in Fig. 2, significant group differences were observed for the Facility ratings ($t(45) = -2.68$, $p = .010$, Effect size d (ESd) = 0.78), the Interest ratings ($t(45) = -2.26$, $p = .029$, ESd = 0.66) as well as the Expressivity ratings ($t(45) = -3.47$, $p = .001$, ESd = 1.01), with lower scores observed in SZ relative to HC.

As presented in Table 1, SZ performed lower than HC on both ToM measures, namely the COST ($t(45) = 2.89$, $p = .006$, ESd = 0.86) and Sarfati's cartoon task ($t(45) = 2.46$, $p = .018$, ESd = 0.73).

3.2. Correlations with ToM and symptoms

The correlations are presented in Table 2. In SZ, significant associations were observed between the Facility ratings and both ToM tasks (COST: $r = 0.51$, $p = .010$; Sarfati's task: $r = 0.63$, $p = .001$). The correlation with Sarfati's task remained significant when controlling for non-social cognition ($r = 0.54$, $p = .018$) while the correlation with the COST fell below statistical threshold ($r = 0.38$, $p = .090$).

A correlation also emerged between the Facility ratings and the Cognitive/Disorganisation factor from the PANSS ($r = -0.51$, $p = .010$). The correlation between the Facility ratings and the single rating for Conceptual disorganisation (PANSS P2) did not reach statistical significance ($r = -0.39$, $p = .054$).

For the Interest ratings, the only significant correlation in SZ was with the Expressivity ratings ($r = 0.79$, $p < .001$).

The Expressivity ratings were also significantly associated with Negative symptoms ($r = -0.43$, $p = .033$) and with Depression/Anxiety ($r = -0.53$, $p = .006$).

In HC, no association emerged between ToM and the three categories of ratings. The Facility ratings and the Interest ratings were however

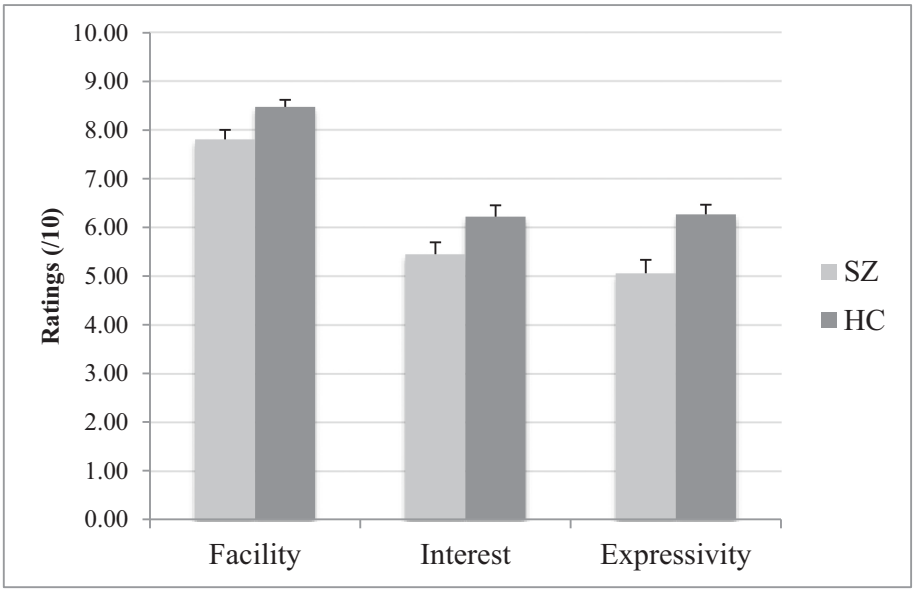

Fig. 2. Facility, Interest and Expressivity ratings (means and standard errors). SZ = Schizophrenia group; HC = Healthy controls.

Table 2
Correlations between the Facility Ratings, Interest ratings, Expressivity ratings and ToM as well as PANSS symptoms.

	Facility ratings	Interest ratings	ToM-COST	ToM-sarfati	PANSS positive	PANSS negative	PANSS cognitive/ desorg.	PANSS depression/ anxiety	PANSS excitation/ hostility	PANSS P2 Conceptual disorganisation
Schizophrenia group										
Facility ratings			0.51**	0.63**	−0.07	−0.22	−0.51**	−0.07	−0.24	−0.39
Interest ratings	−0.07		0.11	0.15	−0.21	−0.38	−0.04	−0.33	0.21	−0.03
Expressivity ratings	0.06	0.79**	0.18	0.38	−0.30	−0.43*	−0.02	−0.53**	0.14	−0.07
Healthy controls										
Facility ratings			0.03	−0.16						
Interest ratings	0.14		−0.04	−0.14						
Expressivity ratings	0.44*	0.79**	0.19	−0.11						

* $p < .05$.
** $p < .001$.

both significantly associated with the expressivity ratings (Facility: $r = 0.44$, $p = .041$; Interest: $r = 0.79$, $p < .001$).

3.3. Additional analyses including the type of movie or familiarity with the movies

As shown in Table 3, none of the interactions with group reached significance. A significant main effect of type of movie was observed for the Expressivity ratings (likely-known > likely-unknown movies) whereas a significant effect of Familiarity with the movie emerged for both the Interest ratings and Expressivity ratings (seen > not seen).

As presented in Table 1, the groups did not significantly differ in terms of the number of movies that the participants had seen ($t(45) = 0.70$, $p = .490$).

4. Discussion

Verbal interactions are an important part of everyday life. While it is clear that people with SZ present with ToM deficits that hinder their ability to understand others (the receptive aspect of social interactions), less is known about their ability to make themselves well understood by others during collaborative interactions (verbal production). In the current study, people with SZ completed, with an interaction partner, a collaborative, verbal interaction task based on the referential communication paradigm. Participant's verbal productions were subsequently rated for how easy they made it for the other person to do the task with them (Facility ratings) and how interesting and expressive they were perceived (Interest ratings and Expressivity ratings). SZ obtained lower ratings than HC for all three aspects of their verbal productions, despite the raters being blind to the presence or absence of a SZ diagnosis. The ratings thus reflect characteristics observed in the speech samples rather than stigmatisation or prejudice.

These group differences are important as it shows that people with SZ display significant communication impairments that can be perceived by their interaction partners. Appearing less expressive and hence less interesting could be particularly important to consider for the social interactions that people with SZ experience with their family and friends. Being less easy for other people to properly understand could also certainly have an impact in the patients' everyday life as well as during their clinical consultations, for example leading to misunderstandings that can sometimes create tensions in a relationship. Further understanding the cognitive and clinical correlates of these difficulties is thus of particular relevance.

In SZ, the facility ratings were linked to ToM performance, as evaluated with two different ToM tasks. This link with ToM is important as it shows that people with SZ who have difficulties understanding others also make it harder for others to understand them, hindering successful interactions from both the receptive and the productive side of communication. Of course, we cannot assume directionality of the effect (e.g. that ToM affects language production), but it remains that ToM and facility of understanding seem affected conjointly. Further understanding these obstacles to adequate social interactions in SZ is of major importance as recovery is now recognized as the desirable outcome, which implies interacting with others in the context of work, leisure or other activities. While we have thus far focussed principally on the cognitive difficulties faced by people with SZ themselves, an approach based on the interaction opens the door to cognitive remediation interventions targeting not only people with SZ but also the needs of the people who interact with them. Achieving common goals with other people requires building a common understanding of the situation and

Table 3
Effect of type of movie and effect of familiarity with the movie (significant effects are highlighted in bold).

	ANOVAs including effect of type of movie			ANOVAs including effect of familiarity with movie		
	Group	Type of movie	Interaction	Group	Familiarity with the movie	Interaction
Facility ratings	$F(1,45) = 7.16$	$F(1,45) = 0.01$	$F(1,45) = 2.21$	$F(1,35) = 6.75$	$F(1,35) = 0.97$	$F(1,35) = 1.48$
	$p = .010$	$p = .932$	$p = .144$	**$p = .014$**	$p = .332$	$p = .232$
	ESd = 0.80	ESd = 0.03	ESd = 0.44	ESd = 0.87	ESd = 0.33	ESd = 0.41
Interest ratings	$F(1,45) = 5.11$	$F(1,45) = 1.22$	$F(1,45) = 0.30$	$F(1,35) = 2.83$	$F(1,35) = 5.51$	$F(1,35) = 0.86$
	$p = .029$	$p = .275$	$p = .584$	$p = .101$	**$p = .025$**	$p = .361$
	ESd = 0.67	ESd = 0.33	ESd = 0.16	ESd = 0.56	ESd = 0.78	ESd = 0.31
Expressivity ratings	$F(1,45) = 12.02$	$F(1,45) = 8.30$	$F(1,45) = 0.57$	$F(1,35) = 7.09$	$F(1,35) = 5.16$	$F(1,35) = 0.24$
	$p < .001$	**$p = .006$**	$p = .454$	**$p = .012$**	**$p = .029$**	$p = .630$
	ESd = 1.04	ESd = 0.86	ESd = 0.23	ESd = 0.89	ESd = 0.76	ESd = 0.16

providing appropriate instructions to one another. In this context, people with SZ who have difficulties understanding others (ToM deficits) or difficulties making themselves clearly understood by others (e.g. Facility ratings in the current study) could simply learn to ask if they were clear and then clarify their ideas if needed. As for the family, friends or co-workers of people with SZ, they could also be further educated about the difficulties that people with SZ can present, allowing them to facilitate the interactions by themselves providing feedback about their own understanding or asking for clarifications when something is unclear.

A greater recognition of these difficulties could also help improve the communication that takes place between patients and clinicians in the context of clinical consultations. The link that we observed between the Facility ratings and Cognitive/Disorganisation symptoms ($r = -0.51$) suggest that a simple evaluation of these symptoms could cue the clinicians about possible difficulties of their patients to make themselves clearly understood, which could lead them to implement strategies to mitigate these barriers to fruitful communication.

The Interest ratings and the Expressivity ratings were not significantly linked with ToM or with cognitive/disorganisation symptoms, but were strongly linked to one another both in SZ and in HC. This very strong correlation ($r = 0.79$ for both groups) highlights that people who are not very expressive when they tell a story are also perceived as being less interesting, even if participants were all telling the same stories from the same movie scenes.

In SZ, the Expressivity ratings were also significantly associated with Negative symptoms and with Depression/Anxiety symptoms. The link with negative symptoms could have been expected given that negative symptoms include an expressive component, along with the experiential component (Blanchard and Cohen, 2006). Studies targeting prosody in SZ also highlighted a link with negative symptoms ratings (Chakraborty et al., 2018). Other studies reported reduced prosody in people with major depression (Alpert et al., 2001), and our results suggest that this link also holds for depression/anxiety symptoms observed in SZ.

Importantly, this study suggests that the symptoms that contribute to reduce patients' perceived expressivity are also highly likely to reduce how interesting they are perceived, which could have important implications for the patients in their everyday life. If people with SZ are deemed less interesting given their lesser degree of expressivity, others may be less inclined to turn to them for social activities, reducing their opportunities for social interactions. While these implications would need to be tested more directly, the current results highlight the importance of considering the impact of patients' symptoms not only on their personal activities and behaviour, but also on the interactions that they have with others.

The main limitations of this study include the modest sample composed mainly of male participants, and who were all medicated at the time of the testing. A greater sample size would have provided additional statistical power, but the effects observed in the current study were generally strong and the only effects that failed to reach statistical significance were the link between the Facility ratings and thought disorder as assessed with the item Conceptual disorganisation from the PANSS, and the partial correlation between ToM and the Facility ratings controlling for non-social cognition. It could thus be interesting to replicate the current results in a larger sample and to include a greater proportion of female participants to improve generalisation. Given that the SZ group was composed exclusively of stable outpatients who were medicated at the time of the testing, we also cannot exclude that the differences in medication status, in addition to the differences in diagnosis status, could have contributed to the observed group differences on our different measures. Another limitation is that the participants performed the collaborative task with a research assistant rather that with a naïve interlocutor. This ensured that the interlocutor always displayed a prototypical knowledge of the movies. However, the use of confederates may have also influenced the pattern of responses, as confederates can sometimes provide less natural feedback than naïve interlocutors would (Kuhlen and Brennan, 2013). Finally, another limitation is that this study was exploratory in nature and as such, we did not correct for multiple comparisons. The results should thus be interpreted with caution due to the risk of Type 1 error.

Overall, this study opens the door to the examination of collaborative interactions with a real interaction partner in SZ. Going beyond the difficulties of the patients taken in isolation could lead to a range of strategies to improve the interactions that people with SZ experience in their everyday life as well as during clinical consultations.

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Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.schres.2022.07.001.

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