

Research



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# Being well understood and generating interest during verbal interactions: the role of Theory of Mind and clinical symptoms in people with schizophrenia spectrum disorders

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People with schizophrenia spectrum disorders (SSD) present with communication impairments. This study aimed to determine whether individuals with SSD make it less easy or interesting to perform a joint task with them relative to community controls (CO), and to examine the link between clinical symptoms and theory of mind (ToM). Fifty-one outpatients with SSD and 68 CO performed the storytelling in sequence task (STST) with an interaction partner. Four raters subsequently listened to the STST audio recordings and scored how easily they could place the images of the narrated stories in the correct order (Facility ratings), how interesting they found the stories (Interest ratings) and how expressive they found the voice (Expressivity ratings). Symptoms were assessed using the Positive and Negative Syndrome Scale and ToM using the Combined Stories Test. The Facility, Interest and Expressivity ratings were lower in SSD than in CO. In SSD, the Facility ratings were positively associated with ToM and negatively associated with several symptom dimensions. The Interest and Expressivity ratings were strongly linked together and negatively associated with Negative symptoms. ToM deficits in SSD may contribute to difficulties communicating clearly. The strong association between Expressivity and Interesting ratings raises important questions regarding the real-life impacts of reduced expressivity.

This article is part of the theme issue 'At the heart of human communication: new views on the complex relationship between pragmatics and Theory of Mind'.

## 1. Introduction

Schizophrenia spectrum disorders (SSD) are characterized by heterogeneous impairments that include not only clinical symptoms but also significant cognitive and communicational deficits [1,2]. The cognitive deficits often observed in people with SSD encompass many non-social functions such as attention, memory and executive functions, as well as social cognition, defined as the ability to understand others based on different sources of information [3,4]. Regarding the communication deficits, lexical and syntactic anomalies are sometimes observed in SSD [5,6], but the most important

deficits are typically observed at the pragmatic level [7,8]. Pragmatics can be defined as the use of language in context, which encompasses both language reception (understanding) and discourse production [9].

In people with SSD, discourse production can be highly disrupted when symptoms of thought disorder are present, including instances of derailment (jumping from one idea to the other), tangentiality (going away from the main topic without answering the question), circumstantiality (providing excessive or irrelevant details before reaching the main point), poverty of speech or pressured speech [10]. Multiple rating scales exist (e.g. [11]) that allow an observer to rate these symptoms based on the overall speech patterns heard during clinical or research interviews [10,12,13]. Beyond these thought disorder rating scales, discourse production impairments have also been highlighted by other approaches, showing impairments even in people with SSD who do not show prominent thought disorder symptoms [14]. The communication failure approach focuses on the communication failures that may arise during free speech in people with SSD [15,16]. One of the main advantages of this approach is that it allows for a more systematic identification of the different instances of communication failures in the discourse. Previous studies based on this approach have employed the Communication Disturbances Index [17], which operationalizes six types of communication failures, including vague references, confused references, missing information references, ambiguous word meanings, wrong word references and structural unclarity [18,19]. Another approach to studying discourse production is to use methods from the field of psycholinguistics or pragmatics to collect more controlled speech samples and analyze more precise features of the discourse. These features include under- or over-informativeness [20], turn-taking [7], choices of reference markers (e.g. *a* boy vs. *the* boy) [21–23], alignment in dialogue (i.e. the process by which interlocutors reuse each other's words during a conversation) [24,25], wrong order of the discourse element [20], delayed or inappropriate response latencies [26], etc. Discourse production impairments have been identified in people with SSD in multiple studies relying on these different approaches [2,25,27].

Given the proposed role of social cognition in estimating the communicational needs of one's interaction partner throughout the verbal interaction [1,25], some studies have examined the associations between discourse production and social cognition in SSD, with a particular emphasis on Theory of Mind (ToM), i.e. the ability to estimate other people's mental states such as their beliefs, knowledge, intentions or emotions. These studies have, however, led to mixed results, with some finding significant associations [1,8,18,27] while others did not [28,29]. In contrast, the association between ToM and pragmatic language reception has revealed much more consistent associations in people with SSD [30,31].

While it is increasingly recognized that discourse production is not something done in isolation, rather requiring the speaker to adjust their discourse choices to the needs of the interaction partner(s) [21,32–35], only a few studies have employed verbal joint tasks to further understand the ability of people with SSD to adjust their discourse productions to be well understood by their interaction partner(s) [25,27,28]. Verbal joint tasks can be defined as tasks that engage the participant in a real verbal interaction with another person, typically with the aim of accomplishing a shared goal (i.e. completing the task together). A study by Champagne-Lavau *et al.* [27] used a joint task based on the *referential communication paradigm* [21], in which participants were given series of abstract geometric figures and had to describe them so an experimenter could arrange his/her copy of the images in the right order. Participants with an SSD showed less adjustment in their choices of reference markers as the task progressed, which was especially pronounced for the SSD participants with lower ToM abilities. Similarly, Achim *et al.* [28] conducted a study that examined the language impairments in people with recent onset SSD using a different joint task also based on the referential communication paradigm. During their task, the participants presented a series of images illustrating movie characters to an interaction partner, whose role was to place their copy of these same images in the same order. Importantly, there were some very well-known movie characters that the interaction partner was hence very likely to know, and lesser-known movie characters that the interaction partner was less likely to know. The healthy participants used more information to present movie characters that their interaction partner was less likely to know than when presenting well-known characters that their partner likely knew, and the magnitude of this adjustment was positively correlated with their ToM performance (i.e. healthy participants with better ToM showed more verbal adjustment depending on partner's likely knowledge [23,27,28]). Participants with SSD, however, did not show these adjustments in their verbal productions as a function of their interaction partner's likely knowledge of the different movie characters [28]. While these studies revealed some difficulties in SSD in terms of choosing the appropriate reference markers [27] or adjusting their reference choices depending on the interaction partner's likely knowledge of the different movies [28], the joint tasks used in these studies required to describe individual images, restricting the opportunities for longer narrative thread in the verbal productions.

Prior studies in healthy participants confirmed that the referential communication paradigm can be adapted to study narrative discourse [22,36–38]. In this case, the images to reorder form a continuous story depicted in a series of images. To our knowledge, a single study from Achim *et al.* [1] thus far used this type of narrative joint task to study discourse production in people with SSD. In that study, the participants had to narrate movie scenes displayed on a series of six image cards, while their interaction partner held the same images in a random order and had to place the images in the right order. The verbal interactions generated by the task were tape-recorded, and four research assistants who were blind to the group membership (SSD or CO) subsequently rated how easy/hard it was to place the image cards in the correct order based on the narrative discourse produced by the participants (Facility ratings), how interesting the story they were narrating was perceived (Interest ratings) and finally how expressive their voice was perceived (Expressivity ratings). The results revealed significantly lower scores in participants with SSD for all three ratings (i.e. Facility, Interest and Expressivity) relative to the healthy controls. Interestingly, the Facility ratings were significantly correlated with ToM performance in people with SSD [1,39], supporting the idea that individuals with SSD who struggle to understand others' mental states may also encounter challenges when it comes to formulating their narrative discourse in a way that will be easily understood by others (i.e. quality of their verbal productions).

In the same study, the perceived expressivity of the voice of individuals with SSD (Expressivity ratings) was not only associated with negative symptoms, but also very strongly correlated with how interesting their narrative discourse productions were perceived (Interest ratings). While it is well-recognized that negative symptoms of SSD can include impairments in non-verbal vocal expression (e.g. alogia, blunted affect, etc.) [40], this study was the first to highlight the importance of expressive symptoms for the interest generated by people with SSD when they interact verbally with another person.

A limitation of Achim *et al.* [1] is that, given the well-documented episodic memory deficits in individuals with SSD, these cognitive impairments may have altered the ability of participants with SSD to accurately recall and narrate the different movie scenes (i.e. they may have forgotten the scenes). It thus remains unclear whether similar narrative discourse difficulties would also arise when narrating new stories that do not rely on recalling prior knowledge or experiences. The study by Achim *et al.* [1] was also limited by a relatively low number of participants (only 25 participants with SSD). Hence, the current study further investigates the quality of the narrative discourse in individuals with SSD and their impact on the perception of naïve raters using a collaborative verbal task relying on new material (less dependent on episodic memory) and a larger group of participants.

## 2. Objectives

The general objective of this study was to examine language production in SSD with a novel paradigm targeting the subjective impact of narrative discourse disturbances on naïve raters. This approach emphasizes that in real life, discourse production is most relevant when used to communicate with others and that the interaction partner(s) is/are thus an important part of any verbal interaction.

To achieve this objective, participants with SSD and community controls (CO) performed a new joint task, the storytelling in sequence task (STST) [36], and the verbal productions were thereafter examined with the scoring scheme recently developed by Achim *et al.* [1]. As presented above, this scoring scheme focuses on the listener's subjective appreciation of three parameters, namely Facility, Interest and Expressivity. As for the STST [36], it is a joint task based on the referential communication paradigm [21], and is thus performed between the participant and an interaction partner. The images to reorder form nine cartoon stories representing everyday life scenarios, each composed of six images and the task was designed to allow a manipulation of the complexity of the stories (i.e. by manipulating the number of characters included in the stories and their gender, see §3). The STST has never yet been used to study language production in SSD.

A first specific objective was to determine whether individuals with a SSD would obtain reduced ratings of Facility, Interest and Expressivity when completing the STST, in comparison to a CO group, and to examine for the first time the effect of story complexity. Based on the previous results of Achim *et al.* [1], the SSD group was expected to obtain lower ratings of Facility, Interest and Expressivity, and these differences could be greater when participants are asked to narrate more complex stories.

A second specific objective was to examine the link between these ratings and clinical symptoms as well as ToM, given the previous results indicating that people that have more difficulties understanding others (ToM deficits) may also make it harder for others to understand them [1]. We thus expected to observe a significant relationship between the Facility ratings and ToM, whereas based on Achim *et al.* [1] the Interest and Expressivity ratings were expected to be strongly related to each other and to clinical symptoms (e.g. negative and depression/anxiety symptoms).

## 3. Methods

### (a) Participants

Participants were all drawn from the Databank on Cognition, Interactions and Social Functioning and were included in the current study if they completed the STST and their audio data was available in the databank. Community controls were excluded if they reported a psychiatric diagnosis or if taking a psychoactive medication. Participants with a history of a neurological disorder were excluded. The final sample is composed of the 51 stable outpatients with a diagnosis of SSD and 68 CO from the databank that met our inclusion/exclusion criteria. Their demographic and clinical characteristics are displayed in table 1. The study was approved by the Comité d'éthique de la recherche sectoriel en neurosciences et santé mentale du CIUSSS-CN (project 2023–2614).

### (b) Material

#### (i) Narrative joint task

In the STST, the images form cartoon stories that the participant is asked to narrate so that the interaction partner, who holds the same images in a random order, can place the images of the stories in the correct order. The STST comprises nine narrative sequences (i.e. stories), each composed of six images that illustrate either one or two characters involved in real-life situations [36,41] (see figure 1). The full set of stimuli can be accessed at <https://doi.org/10.5281/zenodo.11544087> (original version with words in French) or <https://doi.org/10.5281/zenodo.12633286> (with words in English).

As illustrated in figure 2, an opaque panel is positioned between the participant and the interaction partner during the task to hide the material and restrict nonverbal communication (e.g. gesture, eye contact). The role of the interaction partner is held

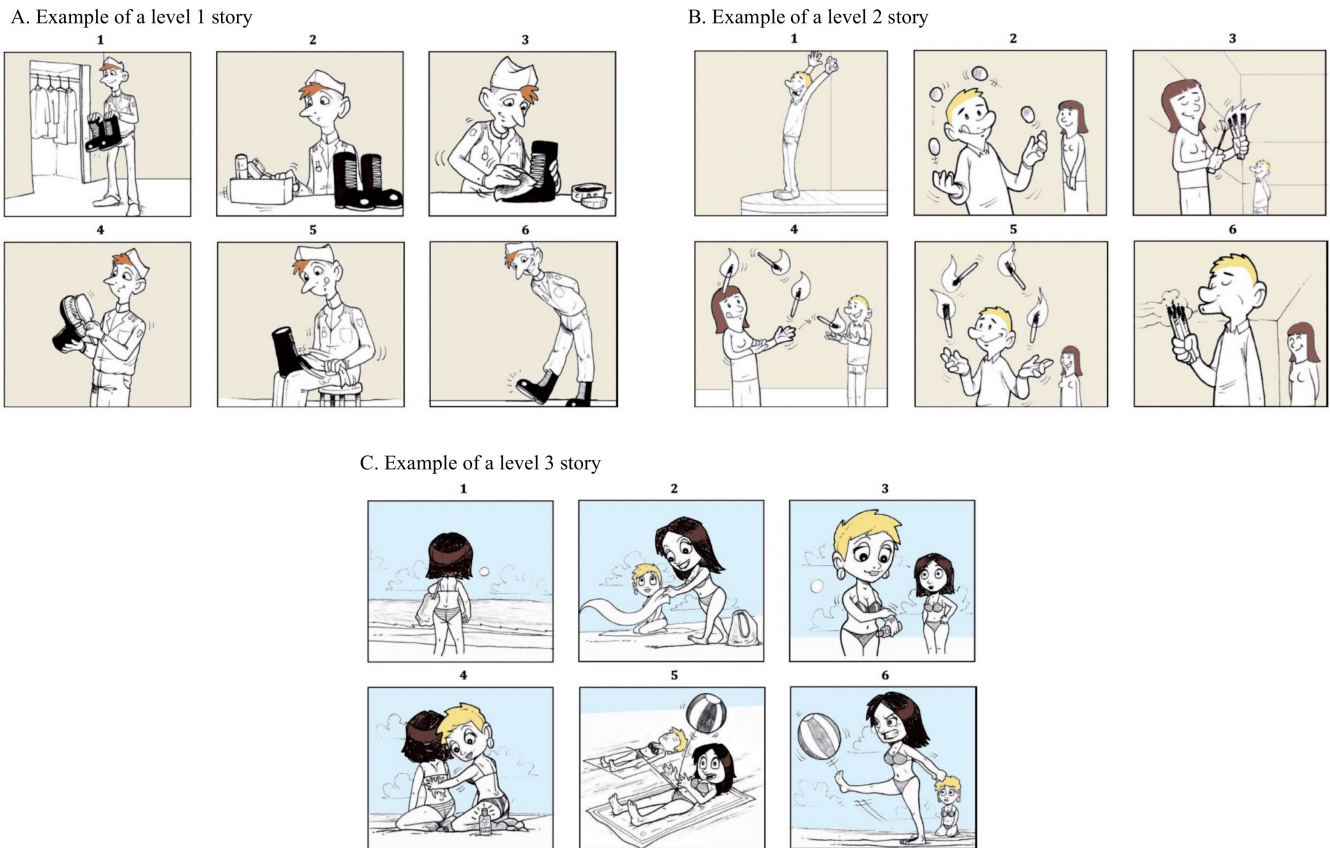
**Table 1.** Socio-demographic characteristics, symptoms ratings and Theory of Mind performance. PANSS, positive and negative syndrome scale; ToM, Theory of Mind; COST, combined stories test.

	SSD group (n = 51)	CO group (n = 68)	statistics
<b>socio-demographic information</b>			
age (mean, s.d.)	34.8 (11.6)	28.3 (9.1)	$t(117) = 3.43, p < 0.001$
sex			
men (N)	37	34	$\chi^2(1) = 6.16, p = 0.013$
women (N)	14	34	
<b>duration of illness (years; mean, s.d.)</b>	8.5 (9.8)		
<b>diagnosis (N)</b>			
schizophrenia	28		
schizoaffective disorder	12		
delusional disorder	4		
psychotic disorder not otherwise specified	4		
brief psychotic disorder	1		
schizophreniform disorder	2		
<b>PANSS scores per dimension (mean, s.d.)</b>			
positive dimension (/42)	12.6 (5.6)		
negative dimension (/49)	15.0 (6.6)		
cognitive/disorganization dimension (/35)	10.1 (3.2)		
depression/anxiety dimension (/28)	8.0 (2.8)		
excitability/hostility dimension (/28)	5.7 (2.3)		
PANSS total score (/182)	51.4 (14.6)		
P2. Conceptual disorganization (/7)	1.9 (1.1)		
<b>principal antipsychotic (N)</b>			
clozapine	13		
quetiapine XR	12		
aripiprazole	11		
risperidone	3		
olanzapine	2		
paliperidone	2		
lurasidone	2		
brexpiprazole	1		
none	5		
<b>COST (mean, s.d.)</b>			
ToM items (/52)	38.1 (7.8)	45.5 (3.6)	$t(117) = 6.98, p < 0.001$

by a research assistant who can give feedback (e.g. 'ok') or ask for clarifications if they are unable to recognize the intended image. Given that the same research assistants perform the same task with multiple participants, they know the correct order of the images for each of the narrative sequences. However, as a dissimulation strategy, the research assistants mentioned to the participants that they were doing the task each time with different stories/images. The full set of instructions is available in French (<https://doi.org/10.5281/zenodo.12697758>) and in English (<https://doi.org/10.5683/SP3/SB7TXA>). This task is audio recorded.

As further detailed in Fossard *et al.* [36], the material for the STST was carefully developed to have stories corresponding to three different levels of referential complexity (levels 1 to 3, with three stories per level), depending on the number of characters involved in the story (one or two characters) and their gender combination (different or same for stories involving two characters).

For level 1 (i.e. the simplest stories), the stories involve a single character, which is therefore easily identifiable. For level 2 (i.e. the intermediate level), the stories include two characters of different genders. Level 3 stories (i.e. the most complex) involve two characters of the same gender, therefore more complex to differentiate (e.g. 'she' or 'the girl' could designate one or the other of the two female characters).



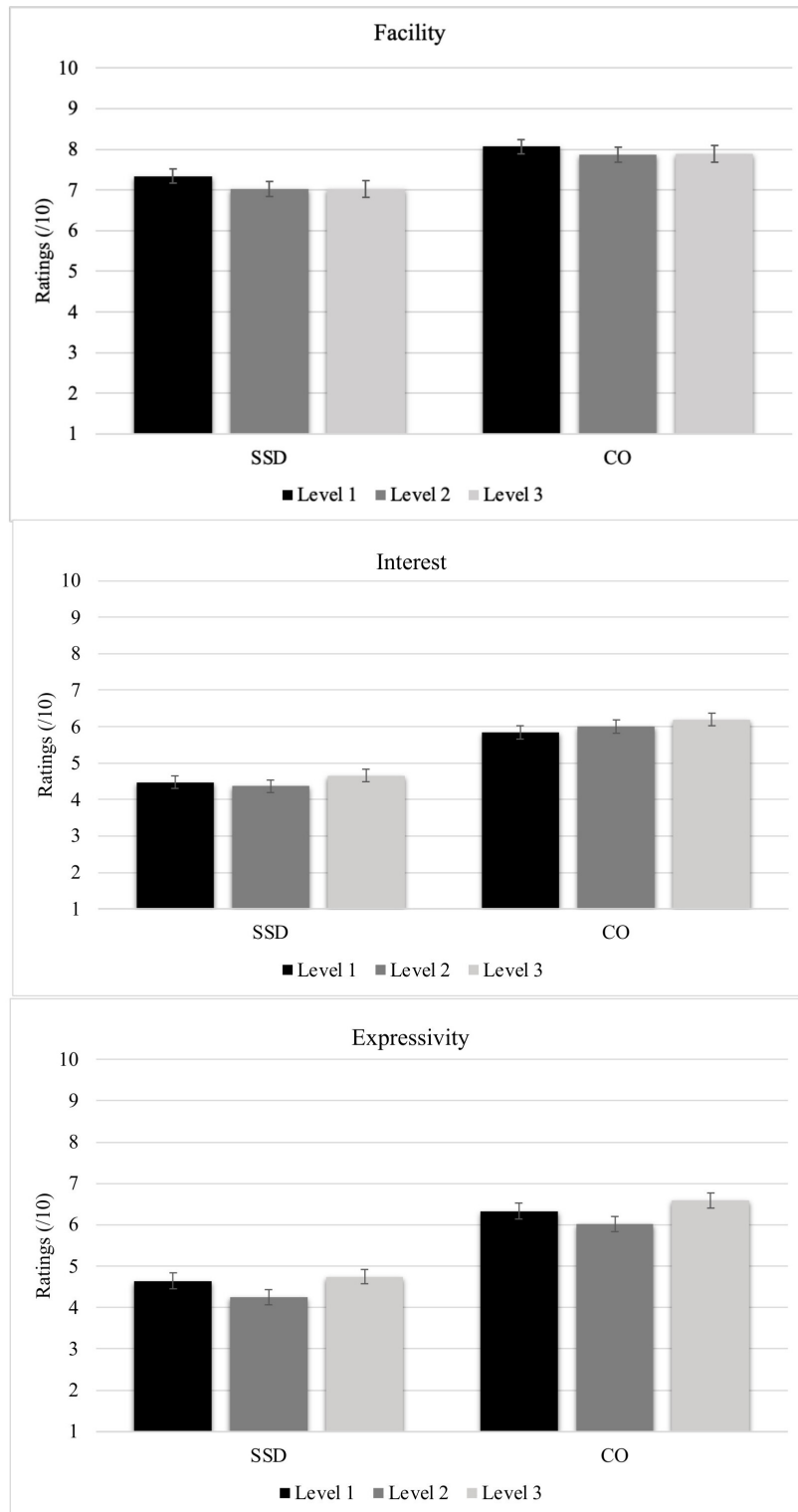
**Figure 1.** Examples of the cartoon stories for each of the three levels of referential complexity in the STST task [36].



**Figure 2.** Representation of the task setup.

**(ii) Ratings based on the perception of the narrative discourse**

The procedure used to score the STST is the same that was used by Achimoy *et al.* [1]. Four naïve raters (undergraduate research assistants who had never previously worked for our team) each listened to all the audio recorded narratives, not knowing which ones were from participants with SSD, CO. These raters were asked to put the images in order based on the verbal



**Figure 3.** Facility, Interest and Expressivity ratings and levels of referential complexity (means and standard error). SSD, schizophrenia spectrum disorders group; CO, community controls group; Level 1, first level of referential complexity; Level 2, second level of referential complexity; Level 3, third level of referential complexity.

productions of the participants, and rate on a Likert scale from 1 to 10 their subjective perception regarding three aspects of the discourse:

- (i) How easy/hard it was for them to place the images of the stories in the correct order based on the narration (Facility ratings).
- (ii) How interesting they perceived the story (Interest ratings).
- (iii) How expressive they perceived the participant's tone of voice (Expressivity ratings).

We emphasized that there were no good or wrong answers, and that we were interested in their own subjective impressions.

The raters were blind to the study hypotheses. Participants from both groups were intermixed to also keep the naïve raters blind to the group to which the participants belong (SSD or CO). To ensure that the raters could not assume the same order for all stories, the stories from 10 additional fictive participants who did the task with the images organized in a different order were intermixed with the recordings from the actual participants.

### (iii) Theory of Mind abilities

The Combined Stories Test (COST) was available as a measure of ToM performance for all participants [42,43]. For this task, participants had to read aloud 30 short stories and were asked to answer questions regarding the mental states of the characters (i.e. beliefs, emotions or intentions), as well as control questions. Responses were rated (i.e. 0, 1 or 2 points) using a validated scoring grid that takes into account the completeness and accuracy of the answers, for a total 52 points for the ToM questions. The COST has shown good psychometric properties in people with first episode psychosis and healthy adults [42,43].

### (iv) Clinical symptoms

The Positive and Negative Syndrome Scale (PANSS) [44] was available as a measure of clinical symptoms. The PANSS consists of 30 items each rated from one (absent) to seven (extreme). The symptoms were then classified into the five following dimensions according to the classification of Lehoux *et al.* [45]: positive (e.g. delusions, hallucinatory behaviour, suspiciousness), negative (e.g. blunted affect, poor rapport, emotional withdrawal), cognitive/disorganization (e.g. abstraction, mannerism, disorientation), depression/anxiety (e.g. somatic concern, anxiety, guilt feelings) and excitability/hostility (e.g. hostility, poor impulse control, uncooperativeness).

### (c) Statistical analyses

First, the Facility, Interest and Expressivity ratings of the four judges were averaged for each of the nine stories included in the STST. To answer our first objective, we then calculated an average score between the three stories included in each level of referential complexity and conducted a series of ANCOVAs, one for each of the three ratings (i.e. Facility, Interest and Expressivity ratings), with the factors group and level of complexity, while controlling for participants' age and sex.

To answer our second objective, we calculated average Facility, Interest and Expressivity scores between the nine stories from the STST and used Pearson correlations to assess the relationships between the three ratings (i.e. Facility, Interest and Expressivity), ToM performance, the five symptom dimensions from the PANSS and the single PANSS rating for conceptual disorganization (P2). A false discovery rate (FDR) [46] correction was applied to control for the multiple correlations examined with each of the three ratings.

## 4. Results

### (a) Effect of group and referential complexity on the Facility, Interest and Expressivity ratings

The results are presented in figure 3 as well as table 2. For the Facility ratings, a significant main effect of group (SSD vs. CO) emerged, with lower ratings in SSD, whereas the main effect of complexity of the stories and the interaction with group were not significant. For the Interest ratings, a significant main effect of group also emerged, with no significant main effect of complexity or interaction with group. For the Expressivity ratings, there was a significant main effect of group, as well as a significant main effect of referential complexity, but no interaction. The significant effect of referential complexity reflected that across both groups, level 2 stories received significantly lower Expressivity ratings than both level 1 stories ( $F(1,115) = 5.02, p = .027, \eta^2 = .042$ ) and level 3 stories ( $F(1,115) = 10.42, p = 0.002, \eta^2 = .083$ ). Level 1 and 3 stories did not significantly differ from each other ( $F(1,115) = .46, p = .498, \eta^2 = .004$ ).

### (b) Correlations with Theory of Mind and symptoms

#### (i) Schizophrenia spectrum disorders group

The correlations are presented in table 3. In the SSD group, the Facility ratings showed significant positive associations with the Interest ratings and ToM performance and significant negative associations with positive symptoms, negative symptoms, cognitive/disorganization symptoms, excitability/hostility symptoms and the single rating for conceptual disorganization (PANSS P2). For the Interest ratings, significant positive associations were also found with the Expressivity ratings and ToM performance, and a significant negative association was observed with negative symptoms. For the Expressivity ratings, significant negative associations were also observed with negative symptoms. All statistically significant correlations remained significant after applying the FDR correction.

**Table 2.** Effect of group and level of referential complexity on the Facility, Interest and Expressivity ratings. Bold values identify statistically significant data.

	ANCOVAs controlling for sex and age		
	group	level of referential complexity	interaction
Facility ratings	F(1,115) = 13.02 <b>p &lt; 0.001</b> $\eta^2 = 0.102$	F(2,230) = 2.22 $p = 0.111$ $\eta^2 = 0.019$	F(2,230) = 0.21 $p = 0.812$ $\eta^2 = 0.002$
Interest ratings	F(1,115) = 46.57 <b>p &lt; 0.001</b> $\eta^2 = 0.288$	F(2,230) = 1.14 $p = 0.323$ $\eta^2 = 0.01$	F(2,230) = 1.67 $p = 0.191$ $\eta^2 = 0.014$
Expressivity ratings	F(1,115) = 53.41 <b>p &lt; 0.001</b> $\eta^2 = 0.317$	F(2,230) = 5.26 <b>p = 0.006</b> $\eta^2 = 0.044$	F(2,230) = 0.76 $p = 0.471$ $\eta^2 = 0.007$

**Table 3.** Correlations between the Facility rating, the Interest rating and the Expressivity rating, ToM and clinical symptoms. Note: All statistically significant correlations remained significant when applying an FDR correction. SSD, schizophrenia spectrum disorders group; CO, community controls group; ToM, Theory of Mind; PANSS, positive and negative syndrome scale.

	Facility ratings	Interest ratings	ToM	PANSS positive	PANSS negative	PANSS cognitive/disorganization	PANSS depression/anxiety	PANSS excitability/hostility	PANSS P2 conceptual disorganization
<b>SSD group</b>									
Facility ratings			0.41*	-0.34*	-0.45**	-0.61**	-0.15	-0.31*	-0.46**
Interest ratings	0.47**		0.31*	-0.05	-0.58**	-0.27	-0.14	0.02	-0.26
Expressivity ratings	0.19	0.89**	0.25	-0.03	-0.53**	-0.08	-0.17	0.08	-0.11
<b>CO group</b>									
Facility ratings			0.23						
Interest ratings	0.37*		0.07						
Expressivity ratings	0.12	0.77**	0.08						

\* $p < 0.05$ ; \*\* $p < 0.001$ .

## (ii) Community controls

In the CO group, significant positive associations were found between the Facility ratings and the Interest ratings as well as between the Interest ratings and the Expressivity ratings. These correlations remained statistically significant after applying the FDR correction. No significant associations emerged with ToM performance.

## 5. Discussion

Discourse production is an important aspect of pragmatics, and more specifically, within the production facet of pragmatics. This study examined the discourse production deficits of individuals with SSD with a novel paradigm targeting the subjective impact of affected discourse characteristics on the listener. For this purpose, participants performed the STST [36], a recently developed joint task based on the referential communication paradigm [21], and naïve judges then rated how easy it was to place the images forming the stories in the correct order, how interesting the stories were perceived to be and how expressive the voice was perceived. In line with our first specific objective, we observed that participants from the SSD group were perceived as making it harder to place the images in order based on their narrative discourse (i.e. lower Facility ratings),

were judged to make their stories less interesting (i.e. lower Interest ratings) and were judged to be less expressive (i.e. lower Expressivity ratings) in comparison to the CO group. These effects were seen across all three levels of story complexity from the STST, and not only for the most complex stories as we had initially envisioned, though that hypothesis was based on our previous study with a similar method that included only complex stories (movie scenes that all involved two male characters [1]). Being perceived as less easy to understand, less interesting and less expressive even when retelling very simple stories, as highlighted for the first time in the current study, could have a considerable impact in everyday life. For instance, being less well understood by others could lead to misunderstandings, that could potentially generate conflicts within the social circles of individuals with SSD. Furthermore, having one's discourse perceived as less interesting and less expressive could result in people being less inclined to interact with them. Social interactions being at the core of social functioning (e.g. appropriateness of social interaction, initiation of activities) and living activities (e.g. working, volunteering, parenting, etc.), it is essential to better understand these barriers to personal recovery [47]. For example, previous studies have highlighted that communication skills are associated with employment among people with SSD, along with reduced symptom severity, emphasizing that pragmatic abilities are a key predictor of daily functioning [48,49]. While our previous study [1] had revealed difficulties when retelling stories from memory (though based on the images of the movie scenes), the current study reveals that people with SSD are perceived as making it less easy or less interesting to do the task with them even when the material does not put a strong emphasis on memory (given that all stories are novel stories that the participants have never been exposed to before).

As previously mentioned, the judges assigning the ratings in the present study were blind to the participant's group (i.e. SSD or CO). Consequently, the group effects reflecting that the discourse of individuals with SSD was perceived as more difficult to understand, less interesting and less expressive cannot be attributed to the stigma experienced by individuals with serious mental illness, and likely rather reflect that some observable characteristics of the narrative discourse produced by the SSD participants influenced the perception of the judges. Importantly, these observable characteristics that lead to poorer perception of the quality of the discourse from individuals with SSD are likely to be noticeable to naïve interlocutors during the social interactions occurring in daily life.

### (a) Link between Facility, Interest and Theory of Mind

As a second objective, we examined the link between these three discourse-based judgments (Facility, Interest and Expressivity), the ability to understand others (ToM), and clinical symptoms. First, the results revealed positive association of medium magnitude between the Facility ratings and ToM performance, which replicates the results of Achim *et al.* [1]. It is interesting to find this same association in both studies, considering that the task used in Achim *et al.* [1] was based on very different narrative material (movie scenes), for which the likely knowledge of the interaction partner was important to take into account. The similar results observed in both studies suggest a more general relationship between the ability to communicate effectively (i.e. being well understood by others) and the ability to understand others (ToM). In other words, individuals with SSD who struggle the most to understand others also face challenges in producing narrative discourse in a way that allows them to be clearly understood by other [1]. These results complement those from Docherty *et al.* [18] who previously reported significant associations between ToM performance and the rate of referential failures (ambiguities) in the free speech of participants with SSD. The absence of an association between pragmatic abilities and ToM reported in other previous studies may be attributable to the use of verbal tasks that were not joint or interactive in nature, and thus less able to capture the pragmatic demands inherent to real-life verbal interactions.

Second, a medium positive association was also found between the Interest ratings and ToM performance, and it is possible that this association emerged given that the Facility ratings and the Interest ratings were significantly linked in this study, which was not found in the previous study by Achim *et al.* [1]. Furthermore, this association prompts us to consider whether how clearly people express themselves might mediate the relationship between ToM abilities and how interesting people are perceived when narrating stories, which was not explicitly tested in the current study. Our results nonetheless suggest that individuals who communicate more clearly may also be perceived as more engaging and interesting, and this should be further examined in future studies.

The principles outlined by Grice [50,51] could provide a complementary framework to understand how cognitive and pragmatic deficits that may manifest in the narrative discourse of individuals with SSD. According to Grice, effective communication depends on following key principles including providing the right amount of information (maxim of quantity), being honest and accurate (maxim of quality), ensuring relevance to the conversation (maxim of relation) and maintaining clarity and orderliness (maxim of manner) [51]. In the current study, individuals with SSD may have tended to violate these maxims more often than those in the control group. This may have led the naïve judges to perceive their discourse as harder to understand, resulting in lower Facility and Interest ratings. This idea could be further explored in future studies.

Finally, the results of the current study may also have implications for healthcare settings, as the communication difficulties observed in individuals with SSD could hinder the effectiveness of their interactions with their healthcare providers. Specifically, challenges in effectively conveying symptoms may lead to misunderstandings from providers, who may find the communication complicated and/or could become less interested in the details.

### (b) Interest, Expressivity and negative symptoms

Our results revealed a strong association between the Interest and Expressivity ratings, both in SSD and in the CO group. Very strong correlations between the Interest and Expressivity ratings for both groups were also reported in the previous study by

Achim *et al.* [1]. These results suggest that individuals who are less expressive (which is often the case in SSD due to negative symptoms) are very likely to be perceived as less interesting when they speak. Furthermore, the significant associations that we observed between negative symptoms and both the Interest and Expressivity ratings in the SSD group suggest that negative symptoms may not only influence how expressive people with SSD are perceived, but perhaps also how much interest they generate for naïve listeners. This is important as it could potentially lead other members of their social environment to be less interested and thus less inclined to engage in conversations with them, making it harder to form or keep social connections such as friendships or romantic relationships. This question would deserve more attention as an important factor to consider in order to promote personal and functional recovery in SSD, and in particular for patients with more important levels of expressive negative symptoms. The antipsychotic medication taken by individuals with SSD could also contribute to impair expressivity, especially when the dosages are not well adjusted [52,53], and our results suggest that it is important to aim to diminish these adverse effects to minimize the extent to which others find them less interesting.

### (c) Association between Facility and multiple clinical symptoms

Unlike the Interest and the Expressivity ratings, which were exclusively associated with negative symptoms, the Facility ratings were associated with most of the clinical symptom dimensions, including positive, negative, cognitive/disorganization and excitability/hostility symptoms. Therefore, the Facility ratings appear to be associated with the overall symptomatology, which is consistent with previous studies that reported that people with SSD presenting with higher global levels of symptoms present verbal production deficits at different levels, including diminished fluency [54], diminished lexical richness [55], a greater rate of ambiguous words or segments [56], etc. However, these prior studies and the present study do not provide information about the direction of the associations. Hence, while it is possible that being more symptomatic leads to being harder to understand (i.e. to lower Facility ratings), the PANSS is rated following a verbal interaction in which the participants answer a set of questions, and being harder to understand could potentially bias the raters towards rating more important symptom severity. For instance, could a person having a hard time explaining the real difficulties they experience with a neighbour be perceived as more delusional (PANSS item P1) or suspicious (item P6) than someone who can express the situation more clearly?

The association between the Facility ratings and the single rating for PANSS Conceptual disorganization (P2) is consistent with our previous studies [1,57]. By definition, people with conceptual disorganization symptoms (or thought disorder symptoms) have difficulties staying focused on the communication goal, and tend to display interruptions in intentional thought sequences, including loss of associations or tangential thinking. Our results suggest that in the context of having to perform a joint task with an interaction partner, such symptoms are likely to interfere with comprehension by the interaction partners, making it harder to complete the joint task together.

### (d) Limitations

The main limitations of this study include an overrepresentation of men compared to women in the SSD group and an SSD group significantly older than the CO group. However, these imbalances were controlled for by including age and sex as covariates in the analyses. Another limitation is that we did not examine the Facility and Interest ratings separately in participants with or without thought disorder symptoms. It could thus be interesting in the future to determine if the greater difficulties performing the tasks with people with SSD are still observed when assessed specifically in SSD participants that do not rate for the presence of thought disorder symptoms.

## 6. Conclusion

Overall, this study provides a better understanding of the difficulties encountered by individuals with SSD during social interactions, and more specifically the perception that others have of their narrative discourse. The production of well-adjusted narrative discourse is an important pragmatic ability, and this study also highlights the importance of clinical symptoms and ToM performance when it comes to other people's perception of the discourse of people with SSD. It would hence be interesting to explore whether existing interventions that target for instance ToM (e.g. cognitive remediation programmes) or negative symptoms could not only help promote the functioning and quality of life of people with SSD directly, but also perhaps indirectly by stimulating a more positive perception on the part of the people with whom they interact in their everyday life. Additionally, interventions specifically aimed at enhancing productive pragmatic abilities, such as targeted communication training (e.g. Cognitive Pragmatic Treatment, PragmaCom) [58,59], could prove beneficial for improving narrative discourse and fostering more effective and satisfying social interactions.

**Ethics.** The study was approved by the Comité d'éthique de la recherche sectoriel en neurosciences et santé mentale du CIUSSS-CN (project 2023-2614).

**Data accessibility.** The data supporting the findings of this study can be accessed at [60]. Please note that the audio recordings are not publicly available due to ethical considerations but may be shared by the authors upon obtaining ethics approval for the intended research project. For more information, please contact Amélie M. Achim at [amelie.achim@fmed.ulaval.ca](mailto:amelie.achim@fmed.ulaval.ca).

Supplementary material is available online [61].

**Declaration of AI use.** We have used AI-assisted technologies in creating this article.

**Authors' contributions.** A.C.: data curation, formal analysis, methodology, project administration, supervision, writing—original draft, writing—review and editing; C.C.: conceptualization, methodology, supervision, writing—review and editing; M.F.: writing—review and editing; D.K.: writing—review and editing; M.-A.R.: data curation, writing—review and editing; M.R.: data curation, writing—review and editing; S.D.: data curation, writing—review and editing; R.B.: data curation, writing—review and editing; L.B.: data curation, writing—review and editing; A.A.: conceptualization, data curation, formal analysis, funding acquisition, methodology, supervision, validation, writing—original draft, writing—review and editing.

All authors gave final approval for publication and agreed to be held accountable for the work performed therein.

**Conflict of interest declaration.** We declare we have no competing interests.

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