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Language in interaction: turn-taking patterns in conversations involving individuals with schizophrenia

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ABSTRACT

Individuals with schizophrenia generally show difficulties in interpersonal communication. Linguistic analyses shed new light on speech atypicalities in schizophrenia. However, very little is known about conversational interaction management by these individuals. Moreover, the relationship between linguistic features, psychopathology, and patients' subjectivity has received limited attention to date. We used a novel methodology to explore dyadic conversations involving 58 participants (29 individuals with schizophrenia and 29 control persons) and medical doctors. High-quality stereo recordings were obtained and used to quantify turn-taking patterns. We investigated psychopathological dimensions and subjective experiences using the Positive and Negative Syndrome Scale for Schizophrenia (PANSS), the Examination of Anomalous Self Experience scale (EASE), the Autism Rating Scale (ARS) and the Abnormal Bodily Phenomena questionnaire (ABPq). Different turn-taking patterns of both patients and interviewers characterised conversations involving individuals with schizophrenia. We observed higher levels of overlap and mutual silence in dialogues with the patients compared to dialogues with control persons. Mutual silence was associated with negative symptom severity; no dialogical feature was correlated with anomalous subjective experiences. Our findings suggest that individuals with schizophrenia display peculiar turn-taking behaviour, thereby enhancing our understanding of interactional coordination in schizophrenia.

1. Introduction

Schizophrenia is a severe neurodevelopmental disorder impacting social functioning (Brissos et al., 2011; Lucarini et al., 2023b), which often manifests itself with difficulties in interpersonal communication (Green, 2016). The study of language in schizophrenia has historically attracted interest in fields of psychiatry as well as linguistics.

For several decades, empirical studies have been conducted with the aim to better understand the communicative behaviours of individuals with schizophrenia (Covington et al., 2005). This line of research has seen significant expansion in recent years. The relevant research has highlighted peculiarities at all levels of language processing, namely the prosodic (Jones et al., 2021; Lucarini et al., 2020; Parola et al., 2023, 2020), syntactic (Ciampelli et al., 2023; Mota et al., 2015), semantic

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(Corcoran et al., 2018; Le Glaz et al., 2019; Nettekoven et al., 2023) and pragmatic levels (Bambini et al., 2020). Related methodological improvements are expected to pave the way for the development of specific diagnostic approaches and precision intervention tools (Agurto et al., 2020; Bambini et al., 2022; Corcoran et al., 2018; Corcoran and Cecchi, 2020; Joyal et al., 2016).

Recent studies have generally been based on different types of language material elicited in both monological and dialogical settings (Compton et al., 2018; Martínez-Sánchez et al., 2015; Nettekoven et al., 2023; Alonso-Sánchez et al., 2022; Nettekoven et al., 2023; Parola et al., 2023; Tan et al., 2021). However, even in the case of recorded conversations, only the participant's voice has been considered for subsequent linguistic analyses. In other words, the literature traditionally adopts a single-subject analysis approach (Cangemi et al., 2023) and neglects the dyadic interaction that is the fundamental unit of analysis when focusing on communicative behaviour.

Crucially, communication takes place at the interactional level. Accordingly, many authors from different scientific fields have stressed the importance of conducting empirical studies investigating the communicative behaviour of persons in dyadic contexts or with three or more interactants. The fact that investigations of this kind are still rare in general communication research can partly be explained by the prevalent view of language as an isolated, modular system or structure, as well as by the operational difficulties that such studies entail (Hamilton and Holler, 2023; Harris, 1980). It is, therefore, not surprising that the exploration of communication in schizophrenia also suffers from a paucity of adequate methodological approaches.

From a linguistic perspective, the field of conversation analysis has focussed on dialogic interaction, traditionally exploring spoken exchanges in a detailed and qualitative manner, with specific attention given to conversational structures and, above all, turn-taking (Drew, 2004; Schegloff, 1992). Turn-taking is the fine-tuned organisation of conversation with rapidly alternating speaker roles. It is structured by overlaps (two speakers speaking at the same time) and gaps (silent pause between the end of one speaker's turn and the beginning of the other speaker's turn). Transitions between turns are typically smooth and consist of gaps measuring around 200 msec (Levinson and Torreira, 2015). Turn-taking, which occurs in every interaction, even between new-borns and caregivers ('proto-conversations') (Nguyen et al., 2023; Trevarthen and Delafield-Butt, 2014), assumes a certain level of interpersonal coordination to allow for a fluid dialogical exchange (Levinson and Torreira, 2015).

Previous studies have found reduced interpersonal coordination between individuals with schizophrenia and their interlocutors (Dean et al., 2021), especially with paradigms aimed at investigating the level of motor synchronisation (Kupper et al., 2015; Varlet et al., 2012). However, this reduced interpersonal coordination is also related to peculiarities in the subjective way of experiencing interpersonal contacts, namely in the difficulties that individuals with schizophrenia experience in understanding the implicit social rules underlying conversations. These difficulties refer to the phenomenological experience of 'schizophrenic autism' or 'loss of natural evidence', that is, the lack of a common-sense understanding of the social world (Blankenburg, 2012; Minkowski, 1927; Stanghellini et al., 2017). Cognitively, this reduced coordination can be understood as a result of impaired social cognition (Green, 2016). Such difficulties at the interpersonal level can be possibly traced back to fine-grained anomalies in the basic sense of self (anomalous self-experiences), putatively grounded at the bodily/motor level (Parnas et al., 2005; Raballo et al., 2021; Stanghellini et al., 2014a; Tonna et al., 2023). A thorough evaluation of patients' subjective experience allows the clinical investigation of the interpersonal, the self, and the bodily domains (Stanghellini and Ballerini, 2008).

To date, research on turn-taking behaviour in individuals with schizophrenia is still scarce. Some studies use hetero-administered scales, in which a clinician assigns a score to the patient's turn-taking abilities based on the rater's subjective assessment (Colle et al., 2013; Meilijson et al., 2004; Mueser et al., 1991; Rajabzadeh et al., 2023). The recent development of automated linguistic analysis techniques allows for more objective studies of turn-taking by quantifying variables, such as pauses between turns. A few studies have applied these techniques to individuals with schizophrenia or earlier stage of psychosis, such as at-risk mental states (Shah et al., 2020), although still not explicitly focusing on interactional aspects (Çokal et al., 2019; de Boer et al., 2020; de Boer et al., 2021; Oomen et al., 2022; Sichlinger et al., 2019; Stanislawski et al., 2021). Other studies investigated the conversational behaviour of patients during dialogues with their psychiatrists, employing manual transcriptions and focusing on topic management (Howes et al., 2013; McCabe et al., 2002). Interestingly, a recent paper by Howes and colleagues analysed video-recorded triadic dialogues between individuals with schizophrenia and control persons, finding longer gaps (Howes and Lavelle, 2023) and a lack of coordination between gesture and speech in dialogues including individuals with schizophrenia. It is worth noting that speech in the above-mentioned studies was generally recorded during highly structured tasks or clinical interviews. Although the dialogical behaviour under these experimental conditions is of great interest, these settings could affect the spontaneity of dialogues.

The investigation of the relationship between turn-taking patterns and clinical features in schizophrenia has not provided any conclusive results yet. So far, studies have generally considered the main psychopathological dimensions, finding a relationship with positive or negative symptoms (Sichlinger et al., 2019; Stanislawski et al., 2021; Tahir et al., 2019) and with depressive symptoms (Tan et al., 2023). However, previous studies have neglected patients' subjective experiences. Interestingly, a relationship between pausing and antipsychotic treatment has been found, with increased pausing in patients taking high D2 receptors occupancy antipsychotics (de Boer et al., 2020).

Our group has recently tested the feasibility of a novel methodology to semi-automatically extract and quantify specific content-free turn-taking metrics from recordings of doctor-patient psychiatric interviews involving individuals with schizophrenia (Cangemi et al., 2023; Lucarini et al., 2022). Moreover, we explored the possible relationship between these patterns and psychopathological features (with a focus on negative symptoms), also considering individual subjective experiences (with a focus on anomalous self-experiences; ASEs). We found significant associations between conversational data and negative symptoms (Lucarini et al., 2022). However, these studies were limited by the poor quality of the audio material, which necessitated substantial manual annotation work and constrained the analyses to certain portions of the recordings. This limitation prevented a more in-depth analysis of turn-taking patterns, e.g., of proportions of overlap and turn transition points over longer conversational periods. A further limitation was the lack of a control group in these previous studies.

We studied the communication behaviour of individuals with schizophrenia compared to control persons, in an explorative fashion and with a focus on speech time from both interlocutors, speech overlap, and silent pauses, relying on a semi-automatic analysis method. In addition, we explored whether the various behavioural measures listed above related to the main psychopathological dimensions and subjective experiences in participants with schizophrenia.

2. Methods

2.1. Participants and psychopathological assessment

We recruited 60 participants from October 2021 to January 2023 in Parma, Italy, including i) 30 individuals with schizophrenia (SCZ; DSM-5 (American Psychiatric Association, 2013), recruited from the Psychiatric Unit of the University Hospital of Parma, and ii) 30 control persons (CTR) recruited from the community of Parma. All participants were native speakers of Italian. Participants with schizophrenia were recruited after the resolution of the acute phase of the illness (Andreasen

et al., 2005). The main exclusion criteria were: cognitive impairment (Mini-Mental State Examination score lower than 25 (Folstein et al., 1975; Measso et al., 1993); any neurological or severe medical condition; any current substance use disorder; current major depressive episode; suicidal risk. We decided to adopt these exclusion criteria since speech is a very sensitive signal that can be impacted by several conditions, including suicidal thoughts and substance use (Min et al., 2023; Vogel et al., 2021). Additional exclusion criteria for CTR were: personal history of major psychiatric disorders; family history of psychosis or developmental disorders; use of any psychotropic medication. All inclusion and exclusion criteria were evaluated through a preliminary interview between each participant and an interviewer from a group of five trainees in Psychiatry at the University of Parma. Where possible, medical files were scrutinized. When uncertainties arose, a unanimous decision was reached following discussion among several members of the research team. The study was approved by the Local Institutional Ethics Committee of Area Vasta Emilia Nord (AVEN, Emilia-Romagna region, protocol approved on 05/05/2021, code: 1235/2020/SPER/-AUSLPRLANG_20). The study was carried out in accordance with the Declaration of Helsinki (1964 and subsequent amendments). All participants provided written informed consent following a complete and exhaustive description of the study and its aims.

In the final analysis, 29 participants from each group were considered, due to technical problems in two recordings that made them unsuitable for linguistic analysis.

The Structured Clinical Interview for DSM-5 (SCID5-CV) (First et al., 2016) was employed to confirm the diagnosis of schizophrenia. A trained psychiatrist (MT) conducted the SCID interviews.

Patients were evaluated using the Italian version of the Positive and Negative Syndrome Scale for Schizophrenia (PANSS) (Kay et al., 1987; Pancheri et al., 1995) to assess the severity of the positive and negative symptom dimensions and general psychopathology. Moreover, we assessed the severity of depressive symptoms with the Calgary Depression Scale for Schizophrenia (CDSS) (Addington et al., 1990). We used the Italian version of the Social and Occupational Functioning Scale (SOFAS) to evaluate functioning (Goldman et al., 1992).

The Italian version of the Examination of Anomalous Self Experience Scale (EASE) (Parnas et al., 2009, 2005), a semi-structured interview, was used to evaluate Anomalous Self-Experiences, as epiphenomena of a perturbation of the minimal self. In line with the previous literature (Henriksen et al., 2021), anomalous self-experiences were scored as 'present' or 'absent' using a dichotomous method.

The Italian version of the Autism Rating Scale (ARS) (Ballerini et al., 2015), a semi-structured interview exploring different real-life social encounters, was used to assess quantitative and qualitative alterations in the subjective experiences of interpersonal relationships and social situations.

Finally, we used the Italian version of the Abnormal Bodily Phenomena questionnaire (ABPq) (Stanghellini et al., 2014b) to perform a systematic inquiry on subjective perturbations of bodily phenomena by means of a semi-structured interview.

Recordings were obtained within one week from the psychiatric evaluation with PANSS and CDSS, and never on the same day, to avoid an overly demanding procedure. EASE, ARS, and ABPq, capturing trait-like phenomena, were conducted in the subsequent weeks.

At the time of inclusion, all patients were receiving a low to medium dose of antipsychotics. In total, 28 (93 %) were taking oral antipsychotics and 11 (36 %) received long-acting antipsychotics. In the case of a recently started long-acting therapy, patients were receiving both forms of treatment at the time of inclusion. In total, 7 (23 %) were treated with a first-generation antipsychotic, and 26 (86 %) with a second-generation antipsychotic-; 8 (26 %) were receiving Clozapine. Medication was changed in patients who received both first- and second-generation antipsychotic medication at the time of inclusion.

To check for potential effects of pharmacological treatment on patients' performance, we converted all antipsychotic doses into Chlorpromazine equivalents (Leucht et al., 2014).

2.2. Recordings

Each participant underwent a semi-structured interview with an interviewer from the group of five trainees in Psychiatry. Interviews lasted between 7 and 21 min (14.13 ± 2.24) and began with an open-ended question (e.g. 'What do you like doing in your free time?'). Importantly, the dialogues then continued spontaneously depending on the answers given by the participant and the questions the interviewer thought helpful to elaborate on the topics. Moreover, the content of the conversations did not concern clinical aspects unless the participant explicitly addressed these issues. Finally, the dialogues did not have a predefined duration. Before starting the recording procedure, the interviewer provided all this information to participants, explicitly stating the purpose that maximally spontaneous conversations were to be obtained. Both the participant and the interviewer wore headset AKG-C544L condenser microphones connected via AKG MPA VL phantom adaptors to a Zoom H4n Pro Handy recorder. Speech was digitally recorded at a sampling rating of 44,000 Hz (16-bit). The distance between the mouth and the microphone was kept as constant as possible (2 cm) to ensure consistent levels of loudness. The interviews were conducted at the Psychiatric Unit of the University Hospital of Parma in a quiet room without any environmental noise; the two interactants were seated about 2 metres apart, to prevent crosstalk (i.e., speech of the interviewer caught by participant's microphone and vice versa). This conforms to previous work on acoustic analysis in psychiatric settings (de Boer et al., 2021; Wehrle et al., 2023a, b).

2.3. Linguistic analyses

The .wav files obtained from the recordings were annotated using the Praat software to create textgrid files (Boersma and Weenink, 2023). First, we extracted the channels from the interviewer (research team member) and the interviewee (research participant), and for each we performed an automatic identification of Interpausal Units using the silent interval detection. We chose to define speech activity as segments of verbal material or vocal material of clear interactional value, considering filled pauses (like 'uhm') as speech activities. On the other hand, we considered audible in-breaths and similar noises as part of silent intervals (for an extensive explanation of the rationale behind this choice, see Cangemi et al. (2023)).

Second, the two textgrids from each channel were merged to obtain a final textgrid for each dialogue. The merged textgrids were then used as input files for a Praat script to get a content-free speech activity record that provides a graphical representation of the dialogical interaction of each dyad (i.e., the interviewer and the interviewee). In these records, each speaker is colour-coded and each coloured bar represents a speech unit (Interpausal Unit), while each blank space represents a silent unit, as previously described (Cangemi et al., 2023; Lucarini et al., 2022).

We then focused on the points of transition between Interpausal Units, and, with another Praat script, we categorised them as 'gaps', 'between overlaps', or 'within overlaps' (following Levinson and Torreira, 2015). We subsequently computed the measure of Floor Transfer Offset (FTO), in which positive values represent gaps and negative values represent between-overlaps (Wehrle et al., 2023a).

From the extracted data, the same Praat scripts also derived tables that we analysed with software R (R Core Team, 2023) to quantify turn-taking variables for each participant as described in Table 1.

2.4. Statistical analyses

To perform the statistical analyses, we used (R Core Team, 2023). First, we calculated descriptive statistics including mean and standard deviation values for continuous variables and absolute and relative frequencies for categorical variables. Missing data were unsystematic

Table 1
Turn-taking variables, formula and descriptions.

Variable	Formula	Description
Audio Duration (*sec*)	Total duration of the recording	
Interviewer (%)	(interviewer's total speaking duration/total duration of the dialogue)*100	interviewer = portion of time where only the interviewer is speaking
Participant (%)	(participant's total speaking duration/total duration of the dialogue)*100	participant = portion of time where only the participant is speaking
Overlap (%)	(total overlap duration of the dialogue/total duration of the dialogue)*100	overlap = portion of time where both interactants are speaking
Mutual silence (%)	(total silent duration of the dialogue/total duration of the dialogue)*100	mutual silence = portion of time where both interactants are silent
Between-Overlaps (n)	total number of between-overlaps	between-overlap = turn transition composed of overlapping speech from both interlocutors
Gaps (n)	total number of gaps	gap = silent interval between turn transitions
Within-Overlaps (n)	total number of within-overlaps	within-overlap = passages of overlapping speech not followed by a change of speaker
Between-Overlap (%)	(total number of between-overlaps/total points of transition)*100	
Gap (%)	(total number of gaps/total points of transition)*100	
Within-Overlap (%)	(total number of within-overlaps/total points of transition)*100	
Floor Transfer Offset (msec)	start time of second speaker's turn - end time of first speaker's turn	positive values = gaps negative values = overlaps
Turns Interviewer (n)	interviewer's total number of turns	
Turns Participant (n)	participant's total number of turns	
Turns Interviewer (%)	(interviewer's total number of turns/total number of turns of the dialogue)*100	
Turns Participant (%)	(participant's total number of turns/total number of turns of the dialogue)*100	
Interviewer Speaking Turn Duration (msec)	total speaking duration of the dialogue/number of interviewer's speaking turns	
Interviewer Silent Turn Duration (msec)	total silent duration of the dialogue/number of interviewer's silent turns	
Participant Speaking Turn Duration (msec)	total speaking duration of the dialogue/number of participant's speaking turns	
Participant Silent Turn Duration (msec)	total silent duration of the dialogue/number of participant's silent turns	

and rare (less than 3 %), so we handled them by a simple imputation method, replacing values with the mean of the available data for the variable. We checked for variable normality and the homogeneity of data distribution with the Shapiro–Wilk and Levene tests. Given the non-normal distribution of most of the variables, we used non-parametric statistical tests. We compared continuous variables in the two groups using the U-Mann-Whitney test, while for comparisons of categorical variables we relied on the χ^2 test. To check for the effect of confounders, we ran multiple linear regressions.

Finally, to identify correlations between turn-taking data and psychopathological variables, we used Spearman correlation. Effect sizes were calculated using Cohen's d. We applied the Benjamini-Hochberg correction over p-values to account for multiple correlations. Original p-values are reported. We used the tidyverse package in R for data

Table 2
Socio-demographic characteristics of the study sample and clinical and psychopathological characteristics of the schizophrenia group.

	Total sample (n = 58)	CTR (n = 29)	SCZ (n = 29)	p value
mean ± SD				
age (years)	31.88 ± 9.87	28.24 ± 2.95	35.52 ± 12.73	0.180
education years	14.39 ± 4.08	17.07 ± 4.02	12.55 ± 2.69	<0.001
n%				
assigned sex (female)	27 (46.6 %)	16 (55.2 %)	11 (37.9 %)	0.188
Gender (female)	27 (46.6 %)	16 (55.2 %)	11 (37.9 %)	0.188
marital status				
single	51 (87.9 %)	23 (79.3 %)	28 (96.6 %)	0.024
in a relationship	6 (10.3 %)		0	
married	1 (1.8 %)	6 (20.7 %)	1 (3.4 %)	
divorced	0	0	0	
widowed	0	0	0	
		0		
working condition				
student	0	0	0	<0.001
employed	39 (67.2 %)	29 (100 %)	10 (34.5 %)	
unemployed	19 (32.8 %)	0	19 (65.5 %)	
retired	0	0	0	
living condition				
alone	29	24 (82.8 %)	5 (17.2 %)	<0.001
family of origin	19		19 (65.5 %)	
acquired family	7	0	2 (6.9 %)	
facility	1	5 (17.2 %)	1 (3.5 %)	
other	2	0	2 (6.9 %)	
		0		
SCZ: mean ± SD				
Illness duration			13.39 ± 12	
antipsychotic therapy *total chlorpromazine equivalent dose*			512.33 ± 229.63 (mg/day)	
PANSS total score			77.51 ± 28.17	
positive scale			15.03 ± 6.79	
negative scale			22.48 ± 10.32	
general psychopathology scale			40 ± 16.04	
disorganisation scale			10.21 ± 3.81	
CDSS total score			1.71 ± 3.07	
SOFAS total score			46.39 ± 13.30	
EASE total score			17.79 ± 10.15	
EASE 1 cognition/stream of consciousness			6.34 ± 3.58	
EASE 2 self-awareness/presence			6.31 ± 3.95	
EASE 3 bodily experiences			1.90 ± 2.14	
EASE 4 demarcation/transitivism			1.14 ± 1.51	
EASE 5 existential reorientation			2.10 ± 1.76	
ARS total score			38.79 ± 25.37	
ARS 1 hypo-attunement			9.82 ± 6.21	
ARS 2 invasiveness			7.96 ± 5.87	
ARS 3 emotional flooding			5.29 ± 4.03	
ARS 4 algorithmic conception of sociality			6.29 ± 5.29	
ARS 5 antithetical attitude toward sociality			5.71 ± 4.55	
ARS 6 idionomia			3.61 ± 3.47	
ABPq total score			15.18 ± 12.77	
ABPq 1 demarcation			3.18 ± 3.01	
ABPq 2 vitality			3.29 ± 3.13	
ABPq 3 coherence			1.82 ± 1.89	
ABPq 4 identity			2.79 ± 2.95	
ABPq 5 activity			4.11 ± 3.95	

CTR: control persons; SCZ: individuals with schizophrenia; PANSS: Positive and Negative Syndrome Scale for Schizophrenia; EASE: Examination of Anomalous Self-Experience Scale; ARS: Autism Rating Scale; ABPq: Abnormal Bodily Phenomena questionnaire.

import, tidying, manipulation, and plotting (Wickham, 2016; Wickham et al., 2019)

3. Results

3.1. Descriptive statistics of the sample

Table 2 reports the socio-demographic characteristics of the sample and the clinical and psychopathological characteristics of the patients' group. No significant differences were found between individuals with schizophrenia and control persons in terms of age, assigned sex, and gender, while participants from the patient group tended to be older, and the sample presented more variability. As compared to patients, control persons had significantly higher educational attainment and were also more likely to be in a stable relationship, to be employed, and to live alone.

3.2. Comparison of turn-taking patterns between the two groups

Conversational features extracted from audio files differed significantly between patients and control persons for most turn-taking patterns explored. Results do not seem to be influenced by audio file duration, which did not differ significantly between groups. In particular, the dialogues involving patients were characterised by a greater overall participation of the interviewer ($W_{Interviewer} = 279$, $p < .05$, $d = 0.29$), who produced more but shorter turns of speech ($W_{TurnsInterviewer} = 182$, $p < .001$, $d = 0.49$; $W_{InterviewerSpeakingTurnDuration} = 662$, $p < .001$, $d = 0.42$) and shorter silent turns ($W_{InterviewerSilentTurnDuration} = 752$, $p < .001$, $d = 0.73$) compared to the dialogues involving control persons.

Patients showed reduced participation in the conversations as compared to control persons ($W_{Participant} = 711$, $p < .001$, $d = 0.59$), with more but shorter speaking turns ($W_{TurnsParticipant} = 659$, $p < .001$, $d = 0.49$; $W_{ParticipantSpeakingTurnDuration} = 755$, $p < .001$, $d = 0.68$) and longer silent turns ($W_{ParticipantSilentTurnDuration} = 248$, $p < .01$, $d = 0.35$). In addition, dialogues involving patients showed significantly more mutual silence and overlap between the two interlocutors ($W_{MutualSilence} = 200$, $p < .001$, $d = 0.45$; $W_{Overlap} = 194$, $p < .001$, $d = 0.46$). Conversations with patients displayed more between-overlaps and less within-overlaps ($W_{Between\text{-}Overlap} = 251.5$, $p < .01$, $d = 0.35$; $W_{Within\text{-}Overlap} = 606$, $p < .01$, $d = 0.38$). We observed no differences between the two groups in the mean duration of Floor Transfer Offset (in msec) or the rates of gaps ($W_{FloorTransferOffset} = 432$, $p = .858$, $d = 0.02$; $W_{Gaps} = 424.5$, $p = .950$, $d = 0.01$). Fig. 1 graphically represents some of the above-mentioned differences. A detailed table describing the comparisons can be found in the **Supplementary Material** (**Supplementary Table 1**).

To check for the effect of confounders on the conversational data, we ran multiple linear regressions, entering continuous turn-taking features as dependent variables and group (CTR vs SCZ) as well as socio-demographic features (civil status, working condition, living condition, years of education) as predictors. Results confirmed a significant main effect of group for almost all turn-taking variables. Details of these analyses can be found in the **Supplementary Material** (**Supplementary Table 2**). For mutual silence, working status (employed/unemployed) had a relatively high influence. In the patients' sample, conversations with unemployed individuals were characterised by significantly higher levels of mutual silence ($W_{MutualSilence} = 153$, $p < .01$, $d = 0.35$) as compared to conversations with employed individuals. A plot of this comparison can be found in the **Supplementary Material** (**Supplementary Figure 1**). We further compared employed and unemployed individuals for clinical features, in order to check for possible confounds, without finding any significant difference. The relevant table can be found in the **Supplementary Material** (**Supplementary Table 3**).

Given that interviews were run by multiple interviewers, we also performed an explorative analysis to investigate possible differences in interviewers' conversational styles. We ran multiple regression analyses, entering continuous turn-taking data as outcomes and different interviewers as well as interviewers' experience (beginning vs end of the psychiatry residency training) as predictors.

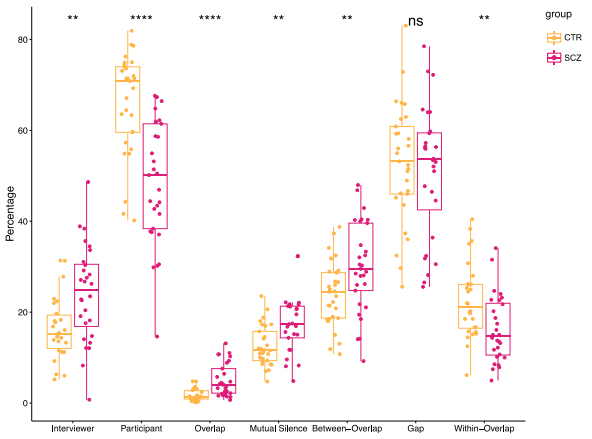

Fig. 1. Turn-taking metrics in individuals with schizophrenia and controls. Seven turn-taking patterns in control persons (CTR – light orange) and individuals with schizophrenia (SCZ - fuchsia). CTR: control persons; SCZ: patients with schizophrenia. Interviewer:% of time where only the interviewer is speaking; Participant:% of time where only the participant is speaking; Overlap: % of time where both interactants are speaking; Mutual Silence:% of time where both interactants are silent; Between-Overlap:% of turns transitions composed of overlapping speech from both interlocutors; Gap:% of silent interval between turn transitions; Within-Overlap:% of turns transitions composed of overlapping speech not followed by a change of speaker. For a detailed description of the turn-taking variables, see Table 1. The Mann-Whitney U test was used to compare the patterns. Results were considered significant if p-value was less than 0.05 as follows: *p<.05; **p<.01; ***p<.001; ****p<.0001.

Interviewer identity influenced the levels of overlap and participation of the interviewer and the participant to the conversation, with one of the 5 interviewers more prone to intervene and to create overlap. Details on these analyses can be found in **Supplementary Material** (**Supplementary Table 4**).

3.3. Correlations between turn-taking and psychopathology

Fig. 2 represents the patterns of correlations between turn-taking and psychopathology for the patient group. We found significant correlations between the turn-taking variables and the PANSS negative, general and disorganisation subscales scores and the total score, and with the CDSS total score, but not with PANSS positive, EASE, ARS and ABP scores. A detailed table with values of rho for each correlation can be found in the **Supplementary Material** (**Supplementary Table 5**)

After Beniamini-Hochberg FDR correction, the positive correlation between the PANSS negative scale and the level of mutual silence was the sole remaining significant. We then performed an exploratory analysis separating out negative symptoms and testing the relationship between each item of the PANSS negative scale and the level of mutual silence. We found that mutual silence was significantly correlated with blunted affect, emotional withdrawal, poor rapport and more strongly with lack of spontaneity. A subsequent regression analysis showed that lack of spontaneity was the major predictor. Details can be found in the **Supplementary Material** (**Supplementary Tables 6a and 6b).** Turn-taking metrics were not correlated with chlorpromazine equivalents or illness duration either. We further performed an exploratory analysis to probe for differences in mutual silence and pausing between patients taking low vs high D2 receptors occupancy antipsychotics (we followed the classification of de Boer et al., 2020). The two groups did not differ significantly from each other (**Supplementary Material, Supplementary Table 7**).

Fig. 2. Correlational matrix heatmap between turn-taking metrics and psychopathological dimensions.
The coloured squares represent significant correlations ($p<.05$), and the colour indicates the direction of the correlation (blue for negative, pink for positive). The colour intensity represents the dimensions of the correlation magnitude (the highest the intensity, the highest the correlation coefficient).
PANSS: Positive and Negative Syndrome Scale for Schizophrenia; PANSS Positive: PANSS positive scale total score; PANSS Negative: PANSS negative scale total score; PANSS General: PANSS General scale total score; PANSS Total: PANSS Total Score; PANSS Disorganisation: PANSS disorganization total score; CDSS Total : Calgary Depression Scale for Schizophrenia total score; EASE total: Examination of Anomalous Self-Experience Scale total score; ARS tot: Autism Rating Scale total score; ABPq tot: Abnormal Bodily Phenomena questionnaire total score. Interviewer: % of time where only the interviewer is speaking; Participant: % of time where only the participant is speaking; Overlap: % of time where both interactants are speaking; Mutual Silence: % of time where both interactants are silent; Between-Overlap n: number of turns transitions composed of overlapping speech from both interlocutors; Gap n: number of silent interval between turn transitions; Within-Overlap n: number of turns transitions composed of overlapping speech not followed by a change of speaker. Between-Overlap: % of turns transitions composed of overlapping speech from both interlocutors; Gap: % of silent interval between turn transitions; Within-Overlap: % of turns transitions composed of overlapping speech not followed by a change of speaker. FTO: Floor Transfer Offset, a measure where positive values represent gaps and negative values between overlaps; Interviewer Speaking Turn Dur: mean duration of the interviewer's speaking turns; Interviewer Silent Turn Dur: mean duration of the interviewer's silent turns; Participant Speaking Turn Dur: mean duration of the participant's speaking turns; Participant Silent Turn Dur: mean duration of the participant's silent turns. For a detailed description of the turn-taking variables, see Table 1.

4. Discussion

The present study aimed at investigating specific conversational turn-taking patterns during dialogues on non-medical topics in a cohort of participants with schizophrenia as compared to controls. It also aimed at establishing a potential relationship between turn-taking parameters, main symptom dimensions, and anomalous subjective experiences in schizophrenia.

First, regarding specific turn-taking behaviour, we found significant differences in almost all turn-taking-related variables explored. Interactants with schizophrenia produced more and shorter speaking turns, as well as more and longer silent turns, resulting in a global reduction of patient participation to the dialogue. When engaging in conversations with participants with schizophrenia, interviewers globally spoke more, generating more and shorter speaking turns and shorter pauses. This behaviour could be explained as an attempt to engage patients into the conversation. This condition resulted in more fragmented dialogues, suggesting reduced interpersonal coordination at the conversational level for individuals with schizophrenia (see Fig. 3 for a schematic representation of the results).

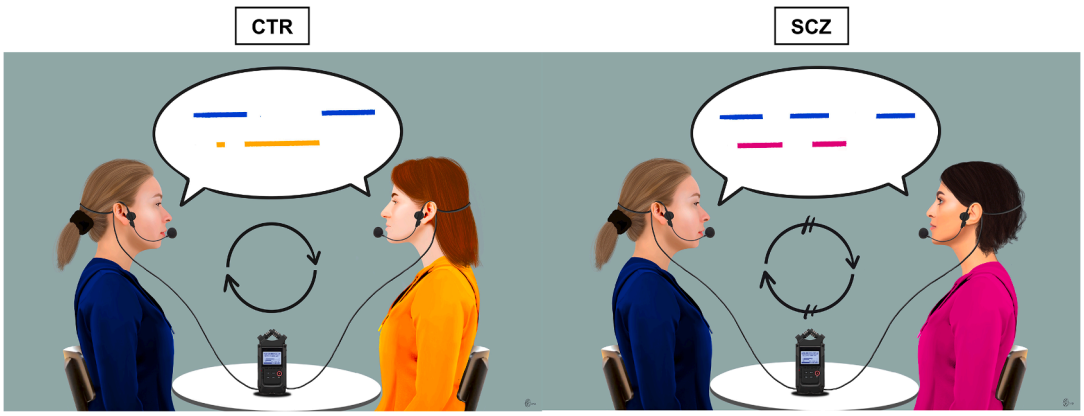

Fig. 3. Turn-taking in control persons and individuals with schizophrenia. Graphical representation of the turn-taking of dialogues involving a control person (left) and a participant with schizophrenia (right). The interviewer is depicted dressed in blue, with the control speaker in light orange and the participant with schizophrenia in fuchsia. The speech bubbles depict dialogical turn-taking: the horizontal lines represent speaking turns and speakers are colour-coded. Blank spaces represent silence. Dialogues involving individuals with schizophrenia were characterised by a higher level of overlap, possibly reflecting reduced interactional synchrony.

This is in line with what we expected given the well-known reduced interpersonal synchrony of interactions involving individuals with schizophrenia (Dean et al., 2021). Regarding pause duration, our results are consistent with the existing literature, reporting longer speech pauses produced by participants with schizophrenia as compared to control persons (Parola et al., 2020). Moreover, there was evidence of increased overlap with the interlocutor by individuals with schizophrenia as compared to control persons (Colle et al., 2013; Tahir et al., 2019). To our knowledge, only three other studies (Howes et al., 2023; Lucarini et al., 2022; Tahir et al., 2019) objectively quantified this feature. In sum, participants with schizophrenia spoke less, but when they did speak, there was significantly more overlap with the interlocutor. For the first time, in this study, we categorised the types of overlap in conversations involving participants with schizophrenia. Unexpectedly, we found that patients presented more 'between-overlaps' and fewer 'within-overlaps' as compared to conversations with control persons. While we initially hypothesised differential behaviour in the group of individuals with schizophrenia, patients and control persons did not differ in floor transfer offset means, extending the well-attested apparent universal preference for values of circa 200 ms to adults with schizophrenia, in line with what was recently found for autistic adults at the global level (Wehrle et al., 2023a). Some hypotheses could be proposed to interpret these results. For example, a high proportion of between-overlaps could mean that patients are not sensitive to the timing of the end of the interviewer's speaking turn or that the interviewer needs to interrupt a participant that is not answering a question. A reduced proportion of within-overlap could mean less use of 'back-channels', short prompts used by listeners to encourage their conversational partners to continue their turn (Wehrle et al., 2023c). Importantly, a possible further explanation is that conversations recorded for our study come from a particular setting, i.e. doctor-patient interviews. In contrast, data from previous studies were extracted from different kinds of dialogues (where information is provided). This could hamper the comparisons with the existing literature. Besides, studies exploring these features in the general population are scarce and thus no definitive conclusions can be drawn.

In line with previous research, (Lucarini et al., 2022; Tahir et al., 2019), we found a significant correlation between negative symptoms and turn-taking patterns, in particular for mutual silence. This association, in line with our previous contribution (Lucarini et al., 2022), confirms that conversational interpersonal coordination is mainly linked to the negative core of schizophrenia (Galderisi et al., 2021; Haro et al., 2018; Marchesi et al., 2015), and is not attributable to positive and disorganisation symptoms. In our sample, mutual silence was associated with blunted affect, emotional withdrawal, poor rapport and in particular with a lack of fluidity in conversation. Interestingly, we found different levels of mutual silence in conversations involving employed vs unemployed individuals with schizophrenia. This is in line with previous studies as, for example, Adamczyk and colleagues found that individuals with schizophrenia differed mainly in language and communication skills depending on their employment (Adamczyk et al., 2016). It is possible to interpret this result in two ways. On the one hand, more efficient communication skills could favour job placement. On the other, involvement in work activities might play an important role in the development and maintenance of conversational habits and skills. Importantly, this relationship could not be explained by other clinical features (like severity of negative or depressive symptoms). These findings underlines the importance of personalised rehabilitation programmes targeting both communication and occupational skills (Shimada et al., 2022).

In our sample, turn-taking patterns were not associated with antipsychotic therapy, neither when considering total chlorpromazine equivalents nor when exploring low vs high D2 receptor occupancy medication separately. This differs from the findings by de Boer and colleagues (de Boer et al., 2020). It is important to note, however, that some individuals with schizophrenia in our sample were undergoing a change of treatment at the time of inclusion. This could have influenced the relevant findings, even though we carefully controlled the results for the antipsychotic dosage and type of antipsychotic that was administered. Future research is needed on this crucial topic, including assessment of individuals with schizophrenia taking stable antipsychotic treatments.

Finally, turn-taking patterns were not associated with any item of the scales investigating patients' subjective experiences (EASE, ARS, ABPq). Overall, the literature on conversational metrics and subjective experiences in schizophrenia is still limited, and therefore, it is difficult to derive solid conclusions from these findings. We can speculate that our results could in part be attributed to the peculiar nature of subjective experiences, i.e. their ineffability, which could have an impact on patients' self-evaluations. It would be interesting to test the relationship between turn-taking and neurophysiological features, putatively forming the basis of subjective experiences (Poletti and Raballo, 2022). It cannot be ruled out, for example, that tasks exploring multisensory integration or interpersonal coordination may yield different results in relation to turn-taking.

Our study is innovative for several reasons. The first strength of this study lies on the objective quantification of turn-taking parameters in conversations with individuals with schizophrenia compared to

conversations with control persons. For the first time, we categorised and computed different types of overlaps and turn transitions in general. Compared to almost all linguistic analyses conducted in schizophrenia, which concentrate mainly on single-participant audio recordings, our focus was on the interactions and the dynamics of communication. Second, the excellent quality recordings obtained in this study allow for automatic annotation. Moreover, audio files were longer than usual and closer to real-life conversations in length. Further, dialogues tended to focus on non-clinical aspects, helping to put participants more at ease and to make conversations comparable between the two groups. Additionally, the semi-structured format allowed for comparably free dialogues. Third, psychopathological aspects were assessed exhaustively, including the evaluation of patients' subjectivity through innovative assessment tools. There has been growing literature on the use of the EASE with individuals with schizophrenia over the past two decades (for two recent reviews see Henriksen et al., 2021; Raballo et al., 2021), and, regarding the ARS and the ABPq scales, the existing literature on their use with individuals with schizophrenia is limited, but encouraging (Madeira et al., 2016; Palumbo et al., 2021).

This study has some limitations. First, our sample size is relatively small, and the cross-sectional nature of the investigation reduces the solidity of our conclusions. Second, we focused on one possible type of interaction, i.e., the doctor-patient interview, where the interviewer was not blind to the diagnostic status of the speaker. This kind of exchange presents peculiar and non-generalisable features, including a possible power dynamic between the two interactants (Galasiński, 2011); therefore, this specific setting could have affected the conversational behaviours of both interviewers and participants. Future research exploring conversations with individuals with schizophrenia should investigate other types of exchanges. Moreover, future research should also investigate possible differences in interviewing styles, which we could not model in this study.

Further, it is worth noting that, while assessing conversational interaction in schizophrenia represents a novelty, we have only explored behaviour in a dyadic context and from a linguistic perspective. Real-life interactions are often characterised by multiple interactants, and conversations are generally complex phenomena involving verbal and non-verbal features, such as gestures, and gaze (Kendrick et al., 2023). Of great interest are triadic or even multiparty as well as multimodal video-recorded experimental paradigms (Howes and Lavelle, 2023). Only Italian-speaking participants were recruited for our study, which does not allow for drawing cross-linguistic conclusions or generalise results on linguistic behaviours, although very limited literature exists on the topic in general (Bernardini et al., 2016; Parola et al., 2023). The presence of other clinical groups would have been beneficial for studying whether the observed dialogical patterns are specific to particular psychopathological groups, e.g. patients with schizophrenia (Parola et al., 2020). It would be particularly interesting to perform our analysis along the entire psychosis spectrum. Including individuals with first-episode psychosis and those at high-risk of psychosis would make it possible to test the role of conversational features as putative endophenotypes of psychotic vulnerability (Millan et al., 2016). Additionally, it would be intriguing to compare turn-taking between subjects with schizophrenia and with autism spectrum disorder, as both conditions have been reported to involve substantial differences in social cognition (Martinez et al., 2019). In this vein, recent studies found specific patterns in the conversational behaviour of German-speaking autistic adults, with autistic speakers producing longer silent gaps at the beginning of conversations and longer within-speaker silences overall (Wehrle et al., 2023a, b).

Another limitation is the lack of a detailed neuropsychological characterisation including measures for social cognition. Since these features can affect interaction, future research is needed to explore their interplay with turn-taking.

We have been developing a new protocol to address some of the above-mentioned shortcomings and further explore turn-taking in psychiatric conditions (Lucarini et al., 2023a).

Conversational patterns could also have been affected by the experimental set-up, i.e. the use of head-mounted microphones and of a visible recorder. Future studies should test more ecologically valid recording techniques.

Last, we only focused on acoustic data, disregarding content analysis. This approach was chosen for several reasons, but mainly to provide a simple and ready-to-use tool capable of capturing conversational data without extensive manual annotation (for a detailed discussion on this choice see Cangemi et al., 2023). Nevertheless, we argue that combining these results with a detailed content analysis would be important for exploring turn-taking phenomena in more detail. Moreover, the analysis of the content/form interplay would allow for the exploration of turn-taking at different dialogue stages.

Overall, our results offer up new perspectives, providing further evidence of perturbed interpersonal coordination in schizophrenia, in particular by quantifying dialogical behavioural aspects. The recording setting proved to be well accepted by participants and the automated analysis methods provided reliable results. This encourages a possible future implementation of the technique in clinical practice. Moreover, a better description and understanding of the communicative behaviour of these patients in real-life settings (i.e., in interactional contexts), may facilitate the development of future targeted rehabilitation interventions.

CRediT authorship contribution statement

Valeria Lucarini: Writing – original draft, Visualization, Validation, Supervision, Methodology, Investigation, Funding acquisition, Formal analysis, Data curation, Conceptualization. **Martine Grice:** Writing – review & editing, Validation, Supervision, Methodology, Funding acquisition, Conceptualization. **Simon Wehrle:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Conceptualization. **Francesco Cangemi:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Conceptualization. **Francesca Giustozzi:** Investigation, Data curation. **Stefano Amorosi:** Investigation, Data curation. **Francesco Rasmi:** Investigation, Data curation. **Nikolas Fascendini:** Investigation, Data curation. **Francesca Magnani:** Investigation, Data curation. **Carlo Marchesi:** Supervision, Funding acquisition. **Linda Scoriels:** Writing – review & editing, Supervision. **Kai Vogeley:** Writing – review & editing, Supervision, Methodology, Funding acquisition, Conceptualization. **Marie-Odile Krebs:** Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Matteo Tonna:** Writing – review & editing, Supervision, Conceptualization.

Declaration of competing interest

The authors declare no conflict of interest.

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Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.psychres.2024.116102.

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