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Review Article

Exploring the interplay between language use and cognitive function in schizophrenia spectrum disorders: Insights from patients, first degree relatives, and healthy controls☆

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ABSTRACT

Background: For people with schizophrenia spectrum disorders (SSD), communication characterized by disrupted language use is common. However, the role of cognitive function in everyday language disruptions in SSD remains unclear. Family studies help control for confounding factors such as symptom burden, medication use and environment, offering insight into the interplay between language and cognition in SSD.

Study design: We examined linguistic features in naturalistic speech from 176 individuals (51 with SSD, 77 first-degree relatives [50 parents, 27 siblings], and 48 healthy controls). Tasks included conversations, picture descriptions, story narration, reading and recall. We assessed cognitive domains: attention, verbal/visual memory, working memory, executive function, processing speed, motor dexterity, and theory of mind. We then studied associations between cognition and language.

Results: Different patterns emerged across groups. In controls, longer speech and fewer pronouns were linked to better cognition. In SSD, greater adposition use and fewer pronouns related to better memory, executive function, and IQ. Among parents, more coordinating conjunctions during narration correlated with better visual memory and motor dexterity. Siblings showed the strongest, broadest associations: better cognition predicted richer language and fewer pronouns, especially tied to global and motor function. Story narration revealed the richest cognitive–linguistic links.

Conclusions: In people with SSD and their relatives, specific cognitive deficits are reflected in everyday speech, regardless of content. These findings highlight the role of discourse context in shaping language–cognition relationships and support future research using language markers in psychosis.

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1. Introduction

Schizophrenia spectrum disorders (SSD) are characterized by profound disturbances in thought, perception, and behaviour (Patel et al., 2014). Emerging typically in late adolescence or early adulthood, these disorders present a significant challenge to both diagnosis and treatment (Arango et al., 2022). Cognitive impairment (Harvey et al., 2022) and linguistic abnormalities (Chang et al., 2022) are two key features of SSD apparent before other symptoms arise and help-seeking occurs. Thus, these early features are likely to be intrinsic to the pathophysiology of SSD (Baklund et al., 2023; Nicolson et al., 2000; Rapoport et al., 2005).

Several language disturbances have been consistently documented in the speech of individuals with SSD. Pragmatic disturbances include reduced coherence and thematic connectedness, often quantified as increased derailment or tangentiality (Docherty et al., 1996; Ehlen et al., 2023; Elvevag et al., 2007), as well as diminished speech quantity and fluency, reflecting poverty of speech or slowed verbal output (Dalal et al., 2025; Mackinley et al., 2023; Roche et al., 2015) Structural impairments have been described as lower syntactic complexity -shorter, less hierarchically embedded sentences- and greater frequency of atypical or contextually inappropriate word use (Baskak et al., 2008; Schneider et al., 2023; Silva et al., 2023); (Alonso-Sánchez et al., 2024; He et al., 2024; Rule, 2005). These deficits, commonly assessed via clinical ratings of disorganised speech, are frequently linked to impairments in executive control, sustained attention, and working memory (Ebert and Kohnert, 2011; Henry and Botting, 2017; Henry et al., 2012; Orellana and Slachevsky, 2013). Beyond these overt pragmatic and structural anomalies, more subtle disruptions in morphological and lexical selection patterns have been reported. For instance, meta-analytic evidence indicates altered pronoun use, such as reduced self-referential pronouns or atypical shifts in referential focus (Elleuch et al., 2025b), while function word categories -including adpositions, conjunctions, and discourse connectives- show atypical frequency and distribution, potentially affecting cohesion and clause integration (Limongi et al., 2023; Mackinley et al., 2021; Silva et al., 2021); (Ehlen et al., 2023; Kuperberg, 2010). Together, these findings suggest that language disturbances in SSD are multi-layered, spanning global discourse organisation, sentence-level syntax, and fine-grained lexical–morphological features. This layered profile underpins the present study's focus on subtle morphological and function-word patterns as potentially sensitive markers of conceptual disorganisation.

Function words such as pronouns, adpositions, and conjunctions have been consistently linked to both cognitive functioning and psychopathological features in SSD. Altered pronoun use has been associated with disturbances in self-experience and perspective-taking, which are core symptoms of the disorder (Buck and Penn, 2015; Hinzen and Rossello, 2015). Difficulties with adpositions often reflect broader deficits in syntactic processing and working memory, highlighting their sensitivity to cognitive impairments (Covington et al., 2005; Thomas et al., 2017). Similarly, reduced or atypical use of conjunctions has been tied to impairments in discourse planning and coherence, processes that depend on executive functioning and are disrupted in thought disorder (Docherty et al., 1996; Mota et al., 2012).

While the more obvious, clinically detectable language features have demonstrable relationships with cognitive dysfunction (Kerns and Berenbaum, 2002; Niedzwiadek and Szulc, 2024), the role of cognitive functions in the subtle morphological disruptions in SSD remains unclear. Indeed, the relationship between cognitive function and clinically rated disorganisation is affected by a notable construct overlap; for instance, abstract thinking and impaired attention that constitute disorganisation dimension in rating scales (Dazzi and Shafer, 2024; Shafer and Dazzi, 2019) are also assessed using cognitive instruments, blurring the line between language and cognition. Similarly, many rating scales focused on communication disturbances explicitly include social cognition tasks (Bambini et al., 2016; Bazin et al., 2005). Thus, to better disentangle these constructs, it is more informative to examine the relationship between cognitive function and everyday language use in SSD through objectively measured, content-independent morphological variables, such as the frequency of function words (e.g. pronouns, adpositions and conjunctions), which have consistently been shown to be affected in SSD (Buck and Penn, 2015; Cabuk et al., 2024; Elleuch et al., 2025b; Mackinley et al., 2021; Silva et al., 2021). For instance, adpositions are a class of grammatical words -such as in, on, under, or between- that express spatial, temporal, or other relational meanings between elements in a sentence. In English, these typically appear as prepositions placed before a noun or pronoun, and they play a key role in building more complex syntactic structures. Beyond their grammatical function, adpositions can engage spatial and relational cognitive processes, as they require the speaker or writer to mentally organize concepts in relation to one another. Given that these function words are content-independent, meaning they reflect underlying linguistic ability rather than prior knowledge, they offer insight into functional outcomes rather than educational attainment, which is often disrupted by illness onset in SSD (Crossley et al., 2022).

Additionally, cognitive dysfunction is not confined to those diagnosed with SSD but is also observable in their first-degree relatives (Nkam et al., 2017) who may not meet diagnostic criteria for SSD (Murillo-García et al., 2022). This has been supported by evidence of small-to-medium effect sizes in unaffected adult first-degree relatives of individuals with schizophrenia (Snitz et al., 2006). Similarly, SSD patients and their first-degree relatives have been found to perform worse than healthy controls (HC) across various linguistic features, exhibiting generally reduced language and communication abilities (Pawełczyk et al., 2018). Since unaffected parents and siblings share the genetic vulnerability without experiencing symptoms or taking antipsychotic medication, any observed language-cognition relationships in first-degree relatives are unlikely to be attributable to confounding factors such as medication effects or symptom-related influences on cognitive performance and communication (e.g., lack of motivation, distractibility).

In this context, the aim of this pilot study is to investigate the relationships between language production and cognitive function across these groups. Specifically, this study seeks to examine how parts-of-speech characteristics correlate with cognitive domains such as attention, verbal and visual memory, working memory, executive function, processing speed, motor dexterity, theory of mind, and global cognitive function. Given the variability that can occur within different discourse contexts (e.g., free conversations, goal-directed discursive contexts, situations demanding us to infer another person's mental state), we used a protocol with contextual variations. We hypothesized that the cognitive domains affected in individuals with SSD and in their first-degree relatives would be associated with differences in their everyday language. Specifically, based on prior reports of reduced fluency and connectives (conjunctions and adpositions), but higher pronoun use in SSD, we expected poorer cognitive performance in patients and relatives to be associated with this pattern of deficit. We also quantified the variability across and within different discourse contexts for each group, to assist task selection in future studies.

2. Methods

This pilot study utilizes a family design framework based on the PAFIP-FAMILIAS project (PI17/00221), including 133 families of individuals with SSD. Between October 2022 and June 2023, 58 families participated in discourse assessments, with additional HC recruited from prior studies. In total, 176 participants (51 SSD patients, 50 parents, 27 siblings, and 48 HC) were assessed. All participants underwent a brief sociodemographic assessment, clinical data collection, neuropsychological evaluation, and a brief interview to gather information on discourse patterns. These procedures are explained in more detail below.

2.1. Sociodemographic information

Patients with SSD, their relatives, and healthy controls were screened for the following sociodemographic characteristics: sex, age, years of education, age at last educational completion, parental status, current use of medication (antipsychotics, antidepressants, or benzodiazepines), socioeconomic status based on the primary source of household income (father, mother, or equally shared), current employment status (employed or unemployed), immigrant status (yes or no), and language-related aspects such as their primary language during childhood (Spanish or other), language of instruction in school (Spanish or other), and language predominantly spoken in their neighbourhood (Spanish or other).

2.2. Clinical and functional assessment

SSD patients were assessed using the Positive and Negative Syndrome Scale (PANSS) (Kay et al., 1987; Kay et al., 1989; Kay et al., 1988). We employed a reduced version comprising 10 items that evaluate three main symptom domains: the positive subscale (3 items), the negative subscale (3 items), and the general psychopathology subscale (4 items).

The Peters et al. Delusions Inventory (PDI) (Peters et al., 1999) was utilized to measure delusional ideation in participants. We used a reduced version consisting of 21 items that incorporates measures of distress, preoccupation, and conviction.

Additionally, we included two scales to evaluate emotional symptoms of anxiety and depression. Anxiety symptoms were assessed using the Generalized Anxiety Disorder scale (GAD-7) (García-Campayo et al., 2010), a 7-item self-report instrument based on DSM-IV criteria. The items are rated on a 4-point Likert scale ranging from 0 (not at all) to 3 (nearly every day). Total scores range from 0 to 21, with higher scores indicating greater anxiety-related symptomatology.

Depression symptoms were assessed with the Patient Health Questionnaire-9 (PHQ-9) (Kroenke et al., 2001; Muñoz-Navarro et al., 2017), a nine-item self-report scale commonly used to screen for depressive symptoms. The items are based on DSM-IV criteria for major depressive episodes experienced over the last two weeks. All items are scored on a four-point Likert scale ranging from 0 (not at all) to 3 (almost every day). Total scores range from 0 to 27, with higher scores indicating greater depressive symptoms.

2.3. Neuropsychological assessment

Expert neuropsychologists administered a neurocognitive battery to assess performance across nine domains known to be impaired in SSD (Nuechterlein et al., 2004). Different tests were employed to evaluate: (1) Premorbid Intelligence Quotient (IQ) (WAIS-III vocabulary subtest) (Wechsler, 1997); (2) Verbal memory (Rey Auditory Verbal Learning Test—RAVLT) (Rey, 1958); (3) Visual memory (Rey Complex Figure—RCF) (Osterrieth, 1944); (4) Working memory (WAIS-III digits forward and backward subtests) (Wechsler, 1997); (5) Processing speed (WAIS-III Digit Symbol subtest) (Wechsler, 1997); (6) Executive function (Trail Making Test part B—TMTB) (Lezak et al., 2004); (7) Motor dexterity (The Grooved Pegboard Test—GPT) (Lezak et al., 2004); (8) Attention (Continuous Performance Test—CPT) (Cegalis and Bowlin, 1991); (9) Theory of mind (The Reading the Mind in the Eyes Task—RMET) (Baron-Cohen et al., 1997).

Global cognitive functioning (GCF) was calculated following established methodology (Reichenberg et al., 2009). Seven raw cognitive scores (verbal, memory, visual memory, working memory, processing speed, executive function, motor dexterity, attention) were converted to z-scores using the mean and standard deviation of the HC group. TMT and GPT scores were reversed to align with the positive direction of the other tests, such that higher scores indicated better performance. The z-scores were averaged to obtain the GCF measure. As such, in the final GCF measure, higher values indicate poorer cognitive performance. To ensure consistency in the interpretation of GCF across all variables -where lower scores reflect worse cognitive functioning- the resulting GCF values were multiplied by −1.

2.4. Discourse assessment

The speech protocol consists of a total of 14 interviewer prompts/questions in 7 sections and was specifically designed by Discourse in Psychosis Consortium (Consortium, 2021). Each section includes a specified minimum speech duration to facilitate as complete a response as possible. The full protocol took 20 to 30 min of administration and consisted of 7 tasks that all subjects completed it in the same order. Task (1) free conversational speech (3 min): To begin, we use personally familiar, age- and culturally appropriate topics of conversation that do not strain one's learned knowledge; Task (2) free personal narrative (2 min): In this task, participants are asked to recount events from their life. This provides a linguistic window into narratives in a first-person perspective; Task (3) health narratives (3 min): In this task, participants are asked about their health. This provides symptom-related content as well as a historical narrative. Task (4) Picture descriptions (3 min): Participants are shown three black-and-white pictures and asked to describe what they see. The images depict everyday scenes designed to manipulate context and assess visual and relational processing: (a) a woman holding a book in a rural scene, observing a man working in a field in the background; (b) a man stepping away from a woman who is holding him by the shoulders; (c) the sun shining through the clouds with a building on a bridge, while a woman stands on the bridge looking at the water. This task provides a referent with multiple descriptive components and subtle contextual manipulations, allowing examination of how participants interpret relationships and interactions between elements in a scene; Task (5) story narration (2 min): Participant are shown images on a storyboard. This task supports a narrative with external focus that does not rely on personal experience; Task (6) dream reports (1 min): Participants are asked to describe a repeated or most recent dream. Dream reports generate rich descriptions, at times with fantastic qualities of the reported content; Task (7) reading and recall (3 min): Participants read a standard text aloud, providing data on articulatory output. This is followed by a brief recall, assessing short-term memory and comprehension.

For the purpose of the present study, the tasks 'health narratives' and 'dream reports' were not considered, as they did not yield comparable content across SSD patients, their relatives, and healthy controls. Specifically, the 'health narratives' task was affected by patient-specific characteristics, while 'dream reports' had lower response rates among participants with SSD.

Regarding the procedure for speech data collection and analysis, audio was recorded using Audacity to generate 705 kbps WAV files. Original files were split into 7 files each corresponding to a specific Discourse task, using Audacity for audio. A script was written using the Python package WhisperX (Bain et al., 2023) to transcribe audio recordings into text. Transcripts were then analyzed using the spaCy Natural Language Processing (NLP) package for part-of-speech tagging and grammatical categorization. This script provided both plain text (.txt) files and JSON files. The JSON output also included timestamp for each phrase and individual word. After this we manually tagged each phrase spoken by the interviewer, to remove the interviewer's speech.

The subject's speech transcriptions were fed in a different data flow using a script that employed Python package spaCy (Honnibal et al., 2020), a library for advanced NLP in Python that supports tokenization and text classification in over 70 languages. This package POS (Part-Of-Speech) tagging capabilities, allowed us to accurately identify the grammatical categories of the transcription. We extracted the number of words, and calculated the percentage of pronouns, adpositions and coordinated conjunctions after adjusting for total number of words. Note that a number of other part-of-speech variables can be derived using these automated procedures; but most of these do not have any meaningful relationship with the construct of SSD in the extant literature (Elleuch et al., 2024; Elleuch et al., 2025a). Nevertheless, to assist future research, we have provided the results for all those variables across all seven tasks in the Supplementary Table 1.

2.5. Statistical analysis

Appropriate statistical methods were used to compare sociodemographic, discourse features and neuropsychological variables across the four groups (SSD, parents, siblings, and HC). Independent samples *t*-tests, analysis of covariance (ANCOVA), and chi-square tests were conducted, with ANCOVA models adjusted for age, sex, and years of education. When applicable, Bonferroni-corrected post-hoc comparisons were used to identify which specific group differences were significant. Additionally, Pearson and Spearman correlations were calculated, as appropriate, to identify correlations between specific discourse features and cognitive domains such as attention, memory, executive function, processing speed, motor dexterity, theory of mind and GCF among the groups.

Note that due to variations in sample size across groups, in addition to multiple testing correction, we set an effect size threshold to interpret meaningful correlations. To this end, we transformed r to z values and consider only those cognition-language associations with $|z| > 0.5$ as worthy of further interpretation.

We calculated coefficient of variation for the 4 language variables for the 5 tasks in the 4 groups, adjusted for square root of sample size. We also calculated across-tasks variability for each group based on mean values of the 4 language variables. These are provided for descriptive purposes.

All analyses were two-tailed, with the significance level set at 95 %. Data analyses were conducted using R statistical software (version 4.1.2).

3. Results

3.1. Differences in sociodemographic and cognitive domains among groups

Regarding sociodemographic variables, the group of siblings was significantly older than the SSD and HC groups, and the group of parents was significantly older than all other groups. The HC group included a higher proportion of men compared to the siblings, and the group of parents had lower levels of education compared to both HC and SSD. The

Table 1
ANOVA comparisons in Sociodemographic features between groups.

	SSD			Parents			Siblings			HC						
	N = 51			N = 50			N = 27			N = 48						
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	Statistic (df)	Value	p	PH
Age	51	40.2	9.5	50	66.8	6.4	27	49.6	13.4	48	41.9	7.6	F-w (3.78.3)	140.729	<0.001	1 < 2,1 ⟨3,2⟩ 3,2 > 4 ***; 3 > 4 **
Years of education	50	11.0	3.5	49	10.6	3.6	27	12.2	4.5	48	11.8	2.9	F-w (3.80.3)	1.593	0.197	
Age at Last Educational Completion	50	22.1	5.9	50	16.7	4.0	26	20.5	7.7	46	22.3	4.9	H(3)	35.765	<0.001	1 > 2,2 < 4 ***; 2 < 3 *
GAD-7	49	4.5	4.5	49	3.6	3.7	26	3.6	3.5	47	3.9	3.3	H(3)	1.249	0.741	
PHQ-9	50	4.7	4.8	50	5.0	5.0	26	3.3	3.6	48	3.4	3.2	H(3)	4.238	0.237	
PDI	51	3.3	3.6	48	2.0	2.0	27	1.6	1.8	48	1.6	1.8	H(3)	4.872	0.181	
	N	%		N	%		N	%		N	%					
Sex (Male)	26	51.0		23	46.0		6	22.2		27	56.3		χ2(3)	8.645	0.034	3 < 4 *
Language at childhood (Spanish) (Yes)	49	96.1		49	98.0		27	100.0		48	100.0		Fisher	2.823	0.639	
Language at childhood (Others) (Yes)	3	5.9		1	2.0		0	0.0		2	4.2		Fisher	2.285	0.633	
Language at school (Spanish) (Yes)	51	100.0		48	96.0		27	100.0		46	95.8		Fisher	3.261	0.354	
Language at school (Others) (Yes)	18	35.3		15	30.0		8	29.6		17	35.4		χ2(3)	0.591	0.899	
Language at neighbourhood (Spanish) (Yes)	50	100.0		49	98.0		27	100.0		44	91.7		Fisher	7.583	0.075	ns
Language at neighbourhood (Others) (Yes)	1	2.0		6	12.0		2	7.4		10	20.8		χ2(3)	9.388	0.025	1 < 4 *
Immigrant (Yes)	4	8.0		7	14.0		1	3.7		0	0.0		Fisher	8.050	0.028	ns
Offspring (Yes)	12	23.5		50	100.0		20	74.1		30	62.5		χ2(3)	65.321	<0.001	1 < 2,1 < 3,1 < 4,2 > 4 ***; 2 > 3 **
Parents - Main income													Fisher	7.001	0.267	
Father	43	86.0		45	91.8		19	70.4		37	82.2					
Mother	5	10.0		3	6.1		6	22.2		7	15.6					
Equal	2	4.0		1	2.0		2	7.4		1	2.2					
Unemployed (Yes)	10	20.0		1	2.1		1	3.7		1	2.1		Fisher	15.854	0.002	1 > 2,1 > 4 *
Occupational status (Work / Study)	32	64.0		15	31.3		16	59.3		44	91.7		χ2(3)	37.308	<0.001	2 < 4 ***; 1 > 2,1 < 4,3 < 4 **
Antipsychotic (Yes)	41	80.4		2	4.0		0	0.0		0	0.0		χ2(3)	122.058	<0.001	1 > 2,1 > 3,1 > 4 ***
Antidepressants (Yes)	6	11.8		9	18.0		2	7.4		4	8.3		χ2(3)	2.871	0.412	
Benzodiazepines (Yes)	13	25.5		12	24.0		3	11.1		1	2.1		χ2(3)	12.857	0.005	1 > 4,2 > 4 **
Others (Yes)	12	23.5		16	32.0		6	22.2		6	12.5		χ2(3)	5.329	0.149	

SSD: Schizophrenia Spectrum Disorders; HC: Healthy Controls; pH: post hoc; GAD-7: Generalized Anxiety Disorder scale; PHQ-9: Patient Health Questionnaire-9; PDI: Peters et al. Delusions Inventory.

SSD had longer duration of education. This was likely a reflection of premorbid impairment, and was consistent with a higher proportion of unemployment in SSD compared to both the HC and parents. As expected, the SSD group was taking more antipsychotics and, along with the group of parents, had higher benzodiazepines compared to the HC group. No significant differences were observed in the use of antidepressants (Table 1).

Regarding discourse features, as shown in Table 2, tasks duration was longer for both SSD patients and their parents compared to HC group. However, compared to HC, patients generally produced fewer words (particularly in personal narratives) while parents showed a consistent reduction in adposition use across tasks and more pronouns use when describing visual stimuli (pictures descriptions and story narration). Interestingly, compared to parents, patients used more coordinating conjunctions when describing visual stimuli (pictures descriptions and story narration). No significant morphological differences were observed in the reading and recall task.

Siblings showed the highest variability, while the HC group demonstrated the lowest variability for most language variables suggesting consistent use across tasks. Among the various language measures, number of words spoken varied significantly across tasks as expected due to differing task demands. Among the various contexts, the reading and recall task has the lowest variability for number of words reflecting consistency in this structured task across individuals. Coordinating conjunctions had the lowest variability both within tasks and across tasks indicating more consistent use of these connective words. These results are presented in Table 2.

Regarding cognitive domains, an omnibus group effect was seen for visual memory, processing speed, motor dexterity, theory of mind and global cognitive function with HC group outperforming other groups. These 5 cognitive variables were the focus of cognition-language relationships reported below. In terms of processing speed, SSD group scored below parents, siblings and HC groups (Table 3). Post hoc comparisons did not reach statistical significance for visual memory.

3.2. Correlations between speech sections and cognitive domains

Among HC, none of the selected cognition-language associations reached a prior effect-size threshold. In SSD, reduced visual memory was associated with higher pronoun use (story narration task) and lower adpositions (reading and recall task). Among parents, poor visual memory related to lower coordinated conjunctions (reading and recall task). Among siblings, the presence of reduced processing speed lowered word output (story narration task), while reduced global cognition related to higher pronouns (conversational speech task) and reduced word output (reading and recall task). Siblings with poor motor dexterity also had lower adpositions (conversational speech task) and overall word output (story narration task). These results, along with all significant correlation values irrespective of effect size are shown as a heat map in Fig. 1.

Table 2

ANOVA comparisons in discourse features between groups.

	SSD			Parents			Siblings			HC						
	N = 51			N = 50			*N* = 27			N = 48						
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	Statistic (df)	Value	p	PH
Total tasks duration (seconds)	51	1346.8	229.8	49	1352.3	224.4	27	1340.4	327.0	48	1231.5	179.7	H(3)	12.231	0.007	1 > 4, 2 > 4 *
Total Word Count	51	2646,4	876,4	49	2651,3	723,6	27	3096,2	1293,2	48	2610,4	645,6	H(3)	2.444	0.485	
Free Conversational Speech																
Number of words	51	602.8	350.1	50	647.9	337.9	27	804.6	692.9	48	576.3	192.0	H(3)	5.324	0.150	
Adpositions (%)	51	9.3	2.1	50	8.7	1.6	27	9.4	1.5	48	10.1	1.8	F(3.172)	5.164	0.002	2 < 4 ***
Coordinating conjunctions (%)	51	5.4	1.5	50	5.0	1.1	27	4.8	1.1	48	5.0	1.1	F-w (3.85.5)	1.559	0.205	
Pronouns (%)	51	9.0	2.1	50	9.9	1.8	27	9.7	1.9	48	9.0	2.0	F(3.172)	2.655	0.050	ns
Free Personal Narrative																
Number of words	51	344.8	181.7	50	372.3	152.7	27	468.9	265.2	48	396.0	111.1	H(3)	9.575	0.023	1 < 4 *
Adpositions (%)	51	8.7	2.2	50	8.2	2.4	27	7.8	1.8	48	9.1	2.0	F(3.172)	2.512	0.060	ns
Coordinating conjunctions (%)	51	4.6	1.4	50	4.4	1.4	27	4.5	1.2	48	4.9	1.4	F(3.172)	0.968	0.409	
Pronouns (%)	51	10.3	2.3	50	11.0	2.2	27	11.3	3.1	48	11.1	2.2	F(3.172)	1.503	0.215	
Picture Descriptions																
Number of words	51	365.0	136.3	50	359.4	134.2	27	393.0	160.8	48	378.7	118.3	F(3.172)	0.447	0.720	
Adpositions (%)	51	7.0	2.0	50	6.7	1.6	27	7.2	2.3	48	7.9	2.2	F(3.172)	3.258	0.023	2 < 4 *
Coordinating conjunctions (%)	51	5.3	1.5	50	4.5	1.3	27	4.8	1.3	48	4.6	1.1	F(3.172)	3.410	0.019	1 > 2 *
Pronouns (%)	51	9.7	2.9	50	11.4	2.4	27	11.2	2.7	48	9.9	2.5	F(3.172)	4.752	0.003	1 ⟨2,2⟩ 4 *
Story Narration																
Number of words	51	191.1	75.7	50	206.6	132.5	27	203.7	67.2	48	202.7	77.3	H(3)	1.398	0.706	
Adpositions (%)	51	8.7	2.8	50	7.0	2.4	27	9.1	3.2	48	9.2	2.4	F(3.172)	6.929	<0.001	2 < 4 ***; 1 > 2,2 < 3 **
Coordinating conjunctions (%)	51	5.3	1.7	50	4.3	2.1	27	4.7	1.4	48	5.2	1.7	F(3.172)	3.398	0.019	1 > 2 *
Pronouns (%)	51	10.6	3.7	50	12.1	2.8	27	11.0	2.5	48	10.3	2.6	F-w (3.86.4)	3.603	0.017	2 > 4 *
Reading and Recall																
Number of words	51	277.9	70.1	50	299.0	102.4	27	293.1	55.6	48	294.8	63.5	H(3)	4.454	0.216	
Adpositions (%)	51	10.3	1.3	50	10.2	1.6	27	10.0	1.1	48	10.5	1.6	F(3.172)	0.868	0.459	
Coordinating conjunctions (%)	51	5.3	0.8	50	5.2	0.9	27	5.3	1.0	48	5.4	1.0	F(3.172)	0.355	0.785	
Pronouns (%)	51	7.8	2.0	50	8.2	1.4	27	7.5	1.3	48	7.6	1.2	H(3)	6.657	0.084	

SSD: Schizophrenia Spectrum Disorders; HC: Healthy Controls; PH: post hoc.

Table 3
ANCOVA comparisons in cognitive domains between groups.

	SSD			Parents			Siblings			HC			Adjusted for: Sex, age and years of education			
	N = 51			N = 50			N = 27			N = 48						
	N	Mean	SD	N	Mean	SD	N	Mean	SD	N	Mean	SD	Statistic (df)	Value	P	PH
IQ	51	98.2	11.1	50	110.9	11.1	27	106.1	13.0	48	101.0	11.0	F(3)	1.423	0.238	
Cognition *Z*-Scores																
Verbal Memory	51	−0.3	1.0	50	−1.0	1.0	27	−0.3	1.2	48	0.0	1.0	F(3)	2.385	0.071	ns
Visual Memory	51	−0.4	1.0	49	−1.0	0.7	27	−0.1	0.9	48	0.0	1.0	F(3)	2.725	**0.046**	ns
Processing speed	51	−1.2	1.2	50	0.3	0.9	27	0.8	0.9	48	0.0	1.1	F(3)	17.476	**<0.001**	1 < 2, 1 < 3, 1 < 4 ***
Working memory	51	−0.3	0.8	50	−0.6	0.9	27	0.0	0.9	48	−0.2	1.0	F(3)	0.571	0.635	
Executive function	51	−0.7	1.6	49	−1.8	2.5	27	−0.5	1.6	48	−0.1	1.1	F(3)	1.639	0.182	
Motor dexterity	50	−0.9	1.3	49	−2.0	2.7	27	−0.2	1.8	48	0.1	0.9	F(3)	4.396	**0.005**	1 < 4 *
Attention	50	−1.6	3.2	46	−2.6	5.2	27	−1.4	4.1	45	−0.2	1.3	F(3)	1.226	0.302	
ToM	41	−0.6	1.0	50	−0.6	1.0	27	−0.2	1.2	48	0.1	0.9	F(3)	3.272	**0.023**	1 < 4 *
GCF	49	−0.9	0.9	44	−1.0	0.8	27	−0.5	0.5	45	−0.3	0.5	F(3)	5.932	**<0.001**	1 < 4 ***

SSD: Schizophrenia Spectrum Disorders; HC: Healthy Controls; PH: post hoc; IQ: Intelligence Quotient; ToM: Theory of Mind; GCF: Global Cognitive Function.

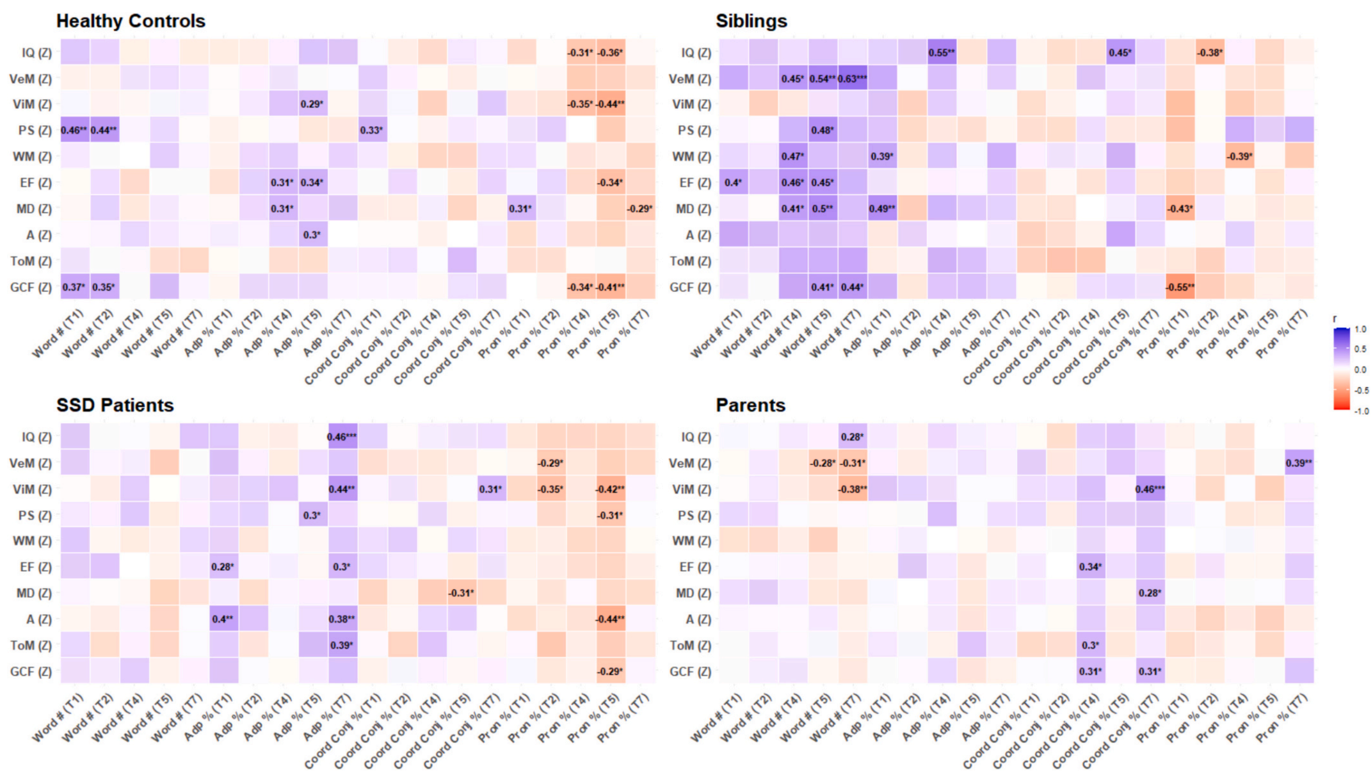

Fig. 1. Heatmaps of correlations between cognitive Z scores and linguistic variables across the four study groups. IQ: Intelligence Quotient; VeM: Verbal Memory; ViM: Visual Memory; PS: Processing Speed; WM: Working Memory; EF: Executive Function; MD: Motor Dexterity; A: Attention; ToM: Theory of Mind; GCF: Global Cognitive Function; Word #: Words Number; Adp %: Adposition percentage; Coodr Conj %: Coordinating conjunctions percentage; Pron %: Pronouns percentage. T1: Free Conversational Speech; T2: Free Personal Narrative; T4: Picture Description; T5: Story Telling; T7: Reading and Recall. * < 0.05; ** < 0.005; *** < 0.001.

4. Discussion

This pilot study employed a detailed methodology to quantify linguistic features and cognitive function in SSD patients, their first-degree relatives, and HC groups. We report the following major findings: (1) Cognitive domains affected in individuals with SSD and in their first-degree relatives were associated with differences in their everyday language. (2) Impaired cognition relates to reduced fluency and connectives use but higher pronoun use, while notable variations across the context in the observed language-cognition relationships. Some tasks (reading and recall) produce consistent function words, while others (conversation speech, story narration and pictures descriptions) produce higher variability across individuals. (3) Reduced verbosity is a key feature in SSD that is seen across contexts, but not shared with siblings and parents. Siblings and parents did not differ significantly in any morphological features between themselves. This indicates that morphology of language during discourse is influenced by inter-individual variations in cognitive function that occurs in the presence of genetic risk and resilience. In the absence of such risk (i.e, HC), cognitive ability is likely to play smaller role in speech morphology. These findings underscore the value of discourse-level language analysis as a potential window into cognitive functioning, consistent with prior literature linking language production to underlying neurocognitive processes (Covington et al., 2005).

Previous research has demonstrated that morphological anomalies in SSD often reflect impairments in broader cognitive processes such as working memory, executive function, and discourse planning (Covington et al., 2005; Ditman and Kuperberg, 2010). Our findings are consistent with this literature in showing that reduced fluency, impaired use of connectives, and increased pronoun use are related to cognitive dysfunction in SSD. Notably, we extend prior work by demonstrating that these associations are not uniform across tasks: while reading and recall elicited relatively stable function word patterns, more naturalistic contexts such as conversation, narration, and picture description produced greater variability across individuals. This suggests that morphological production in SSD is highly sensitive to context, which may partly explain inconsistencies reported in the literature (Docherty et al., 1996; Mota et al., 2012). Furthermore, our study highlights reduced verbosity as a robust discourse-level feature specific to SSD, not shared with first-degree relatives, suggesting that some morphological aspects of speech may be more directly tied to illness expression rather than familial risk. In this way, our results align with previous findings linking morphology to cognitive dysfunction, while diverging by emphasizing the role of contextual variation and inter-individual differences related to genetic liability and resilience.

The results for HC provide a baseline for understanding typical cognitive-discourse relationships and enhance NLP as a highly accessible bio-behavioral marker in cognitive neuroscience (Corona Hernandez et al., 2023), with potential applications in a more naturalistic neuropsychological assessment (Hinzen and Palaniyappan, 2024). For instance, a higher number of words produced during conversational and personal narrative tasks was positively correlated with processing speed and general cognitive functioning (GCF). This suggests that verbal fluency and lexical richness may serve as behavioral proxies for intact cognitive abilities, particularly in spontaneous speech contexts. These findings align with previous studies that link speech output and fluency with executive control and processing efficiency (Barch and Ceaser, 2012). Furthermore, reduced use of pronouns during the story narration task was associated with better visual memory and GCF. This pattern suggests that lower pronoun use may reflect more precise and content-specific language, reducing ambiguity and demanding greater syntactic planning capacities typically supported by intact executive and working memory systems (Perlini et al., 2012).

Among individuals with SSD, greater use of adpositions (e.g., "in," "under") during the reading and recall task was positively related to visual memory. The use of adpositions may reflect more complex syntactic structures and the involvement of spatial or relational cognition, processes often impaired in SSD (Levy et al., 2010). Additionally, higher pronoun use in the story narration task was again related to lower cognitive performance. This converging evidence suggests that pronoun avoidance may serve as a compensatory strategy or a linguistic marker of cognitive integrity in both healthy and clinical populations (Roche et al., 2016). Furthermore, a recent systematic review has indicated that reduced production is one of the largest syntactic deficit in schizophrenia (Elleuch et al., 2025a). Length of utterances are influenced by two key features of language: (1) coordinating conjunctions e.g., "or" "In September, we will go to Rome or travel to Paris." and (2) adpositions e.g., "in" "He worries a lot in his appearance." Alltogether, these findings align with the notion that memory and executive functioning deficits can disrupt continuous speech production, contributing to formal thought disorder severity in schizophrenia (Tan and Rossell, 2019).

In first-degree relatives increased use of coordinate conjunctions (e.g., "and," "but") during the story board task was associated with better visual memory, motor dexterity, and GCF. This may indicate a preserved ability to construct syntactically complex and coherent discourse, supported by cognitive and motor coordination. These findings resonate with previous research suggesting that certain discourse features may act as endophenotypic markers of resilience or subtle cognitive variation in relatives of individuals with psychosis (Cannon et al., 1994).

Siblings demonstrated broad and robust correlations between linguistic markers and cognitive functions. Higher use of words, adpositions, pronouns, and conjunctions across several discourse tasks was linked to better IQ, verbal and visual memory, processing speed, working memory, executive function, motor dexterity, and GCF. Interestingly, as in other groups, lower pronoun use during conversational speech was related to better motor performance and GCF. These results suggest that siblings may exhibit both adaptive and compensatory linguistic behaviors tied to cognitive abilities, possibly reflecting underlying genetic or developmental risk factors (Meyer et al., 2021). The complexity of these patterns points to a nuanced interplay between language production and neurocognitive function in populations at genetic risk for SSD. The significant associations found in siblings suggest that cognitive and linguistic markers might be useful for identifying individuals at risk for psychosis before full-blown symptoms develop. In addition, this could indicate that autobiographical reasoning is uniquely associated with preserved role functioning (Cowan et al., 2024).

Overall, these findings highlight the value of linguistic features -especially the use of pronouns, adpositions, and conjunctions- as noninvasive, behaviorally rich indicators of cognitive functioning. Poor performance in conversational speech and story board tasks might indicate a linguistic endophenotype of risk for psychosis (Corcoran et al., 2020). These results also support the potential of discourse analysis in identifying early cognitive vulnerabilities or compensatory strengths in at-risk populations.

4.1. Limitations

The study's limitations include a modest sample size, which may have reduced statistical power and limits the generalizability of the findings. In addition, the discourse tasks may not have been sensitive enough to detect subtle cognitive-linguistic relationships effectively. Moreover, the use of self-reported and clinician-rated measures for clinical and cognitive assessments could have introduced bias. Limitations in the accuracy of automated transcription and part-of-speech tagging, along with manual tagging procedures, may have affected the overall quality of the linguistic data. Additionally, despite using an established neuropsychological battery of tests, other relevant cognitive domains may have been missed. The cross-sectional nature of the study further limits causal interpretations about cognitive-discourse relationships. Finally, the impact of sociodemographic factors on cognitive and linguistic measures was not thoroughly explored; this will require norms for speech variables derived from a diverse database. Addressing these limitations through larger, longitudinal studies and more comprehensive measures will be crucial for a deeper understanding of these dynamics.

5. Conclusions

Overall, this study provides formative insights on how cognitive functions relate to various aspects of discourse in individuals with SSD and their relatives. The findings underscore the complex, context-dependent interplay between cognitive abilities and language use in SSD patients, their relatives, and healthy controls. Our results raise the question of whether contextual manipulations (e.g., unambiguous visual prompts) can potentially influence communicative difficulties despite the presence of trait-like deficits in cognition in SSD. This remains a key area for further research, that might aid in developing interventions for individuals at risk for, or living with, psychosis.

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CRediT authorship contribution statement

Rosa Ayesa-Arriola: Writing – original draft, Project administration, Methodology, Funding acquisition, Conceptualization. **Carlos Martinez-Asensi:** Writing – review & editing, Data curation. **Alexandre**

Díaz-Pons: Writing – review & editing, Investigation. **Víctor Ortiz-García de la Foz:** Writing – review & editing, Data curation. **Claudia Parás:** Investigation, Writing – review & editing. **Chaimaa El Mouslih:** Writing – review & editing, Investigation. **Roozbeh Sattari:** Writing – review & editing, Investigation. **Sara Incera:** Writing – review & editing, Investigation. **Lena Palaniyappan:** Writing – review & editing, Writing – original draft, Conceptualization.

Ethics approval and consent to participate

This study was conducted in accordance with the Declaration of Helsinki. Ethical approval was obtained from the Ethics Committee of the Hospital Universitario Marqués de Valdecilla (Approval Code: PI17/00221) and from the corresponding ethics committees of each participating site. Written informed consent was obtained from all participants prior to study enrollment.

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Declaration of competing interest

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Data availability

The datasets generated and/or analyzed during the current study are available from the corresponding author on reasonable request.

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