SYNTACTIC COMPLEXITY IN SCHIZOPHRENIA SPECTRUM DISORDER

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1. Summary

Schizophrenia spectrum disorder (SSD) is a mental disorder that affects language, communication and thought. The present study researches syntactic complexity, one of the affected aspects of language in SSD. Earlier research has found that SSD patients use simpler syntactic structures than healthy individuals do. Simple syntactic structures consist of a main clause and no embedded clauses. Complex sentences consist of a main clause and one or more embedded clauses. The aim of the present study was to find out in what way the syntactic complexity differs in SSD patients and healthy individuals and to give a more detailed picture of this simplification. There are different types of embedded clauses, with different levels of complexity. Earlier research does not account for this. The data for this study was from the PRAAT study at UMC Utrecht. It consisted of transcriptions of semi-structured interviews that were conducted on SSD participants and healthy controls. To measure syntactic complexity, the individual utterances in these transcriptions were manually rated with the use of Covington et al.'s D-Level scale (2006). This is an acquisition-based scale, based on the order in which children acquire complex syntactic structures. The later a structure is acquired, the more complex it is. For the present study, the scale was adjusted to fit more to the data of the present study by adding Dutch example sentences and by adding a level to account for one-word utterances. It was found that SSD participants used more simple syntactic structures than complex ones. They also used more simple syntactic structures than the control group did. So there was less complexity in SSD patients' utterances, which is in line with findings from earlier research. The method in the present study could not account for the specific complex structures the participants used in sentences with more than one level of embedding. Therefore, it was not found whether the complex sentences with multiple embedded clauses in the SSD participants' speech were less complex than those of the control group. Future research in which different types of embedding in a complex sentence is individually measured was proposed.

2. Introduction

Schizophrenia spectrum disorder is a disorder in which several aspects of language, communication and thought are affected (Kuperberg, 2010). This present study explores syntactic structure, an area of language that is affected in some schizophrenia patients. Earlier research found that simplification of syntactic structures occurs in some schizophrenia patients (Covington et al., 2005). In this study, we will explore this simplification and give a more detailed picture of the complexity of syntactic structures in Dutch speaking patients with schizophrenia spectrum disorder. Earlier research only differentiates between simple and complex syntax. We will add to this by investigating different degrees of complexity in utterances.

This introduction will first elaborate on schizophrenia spectrum disorder (section 2.1.), followed by the way language is affected in schizophrenia (section 2.2.). Finally, the tool used in this study for measuring syntactic complexity is described (section 2.3.).

2.1. Schizophrenia spectrum disorder

Schizophrenia spectrum disorder (SSD) is a mental disorder that affects around 1 percent of the general population. It is usually manifested in late adolescence or early adulthood (Krabbendam, 2001). SSD is characterised by the presence or absence of certain clinical symptoms that reflect abnormalities in thought, language and communication, along with some degree of functional impairment. There are two types of symptoms: positive and negative symptoms. Positive symptoms 'add' to someone's characteristics; they are symptoms that do not occur in healthy individuals. This includes verbal auditory hallucinations and delusions. Verbal auditory hallucinations are commonly known as 'hearing voices', which means that patients have trouble differentiating verbalized thought and external voices. Delusions are problems in the perception of the world around us. This is manifested in, for example, fixed false beliefs, and behaviour that is not in line with cultural norms. An example of a positive symptom that affects language is disorganized language, which means having trouble in putting thought into language (Kuperberg, 2010). Negative symptoms are a lack of characteristics that appear in healthy individuals, like reduced motivation and apathy. Concerning language abilities, negative symptoms are manifested in poverty of speech. This means that patients talk less, and their utterances seem to be less complex and shorter in comparison to those of healthy individuals (Kuperberg, 2010).

A patient with schizophrenia spectrum disorder does not always show all symptoms. If an individual has shown a certain number of symptoms and is impaired in their day-to-day life and function, they could be diagnosed with a form of schizophrenia (Kuperberg, 2010).This makes SSD a

heterogeneous disorder, because different patients can suffer from different subsets of symptoms (Picardi et al., 2012).

2.2. Language in schizophrenia spectrum disorder

Language in schizophrenia spectrum disorder is affected in several ways. Marini et al. (2008) write that there are deficits in several language areas, some more notable than others. They report that deficits on a macrolinguistic level, the between-sentence dimension that includes pragmatics and discourse, are quite severe. Patients' speech can be hard to follow and filled with irrelevant information. Covington et al. (2005) write that patients have trouble with presumed information and indirect references. Perlini et al. (2012) found that patients have difficulties in establishing coherence between their sentences, which causes their speech to seem disorganized.

Concerning discourse, Kuperberg (2010) describes 'derailment', which means that in spontaneous speech, some schizophrenia patients tend to lose track of what they are saying. Someone will start on a certain subject but will then go on to talk about something unrelated. Kuperberg (2010) writes that these problems in the between-sentence dimension are positive symptoms of schizophrenia spectrum disorder, and these kinds of linguistic symptoms tend to occur together with other positive symptoms, such as auditory hallucinations.

On a microlinguistic level, the within-sentence level, the linguistic impairments in SSD patients seem less severe (Marini et al., 2008). Abilities in lexical processing and syntactic processing fall into this category. On the area of lexical processing, which is "the organisation of phonological or graphemical patterns into morphological strings and words" (Marini et al., 2008, p. 145), Marini et al. write that patients with schizophrenia have a flatter intonation than healthy individuals and that they have word-finding difficulties. Covington et al. (2005) write that these word-finding difficulties are caused by impaired lexical retrieval, which means that words are not 'forgotten', but are not easily accessed. This leads to symptoms like word approximation, which means that words are used that are similar to the intended meaning, but are not the most conventional choice provided the context (Covington et al., 2005).

2.2.1. Syntactic complexity in schizophrenia spectrum disorder

The present study examines another microlinguistic aspect that is impaired in SSD, namely syntax. Syntax refers to the structure of language.

Covington et al. (2005) and Marini et al. (2008) write that syntax in SSD patients' speech remains 'normal', that is to say, grammatical, even if the output is incoherent. However, Covington et al. report that there is a 'simplification' of syntactic structures in schizophrenia patients' utterances,

meaning that patients use simpler sentences than healthy individuals. They add that the reduced complexity does not necessarily mean that there is a syntactic impairment in patients. The simplification of their utterances could be because of an overall cognitive deficit, or because patients have difficulty concentrating or have a preference for expressing themselves in simpler terms. Kircher, Oh, Brammer and McGuire (2005) write that reduction of syntactic complexity does not seem to be caused by impaired semantic processing or intellectual functioning. Kircher et al. (2005) and Perlini et al. (2012) found that patients with schizophrenia produced fewer complex sentences than healthy individuals. Kircher et al. (2005) found that the relative numbers of simple sentences produced by patients and healthy individuals were similar.

Furthermore, it has been found that the syntactic complexity of SSD patients' utterances is related to the type of symptoms patients show (Thomas, King, Fraser & Kendell, 1990). Schizophrenia spectrum disorder is not a homogenous disorder, and not all patients have the same level of syntactic impairment. Thomas et al. (1990) found that syntactic simplification is related to negative symptoms. Patients with more negative symptoms were reported to speak in less complex sentences than patients with more positive symptoms. In addition, it has been found that reduced syntactic complexity increases as the disorder becomes chronic (DeLisi, 2001; Perlini et al., 2012). DeLisi (2001) found that chronic patients showed reduced complexity and fewer words than patients with a first psychosis, or than healthy family members of patients. She also found a relation to onset: "the earlier the onset, the less complex the sentence structure" (DeLisi, 2001, p. 492). Kuperberg (2010) also associates reduced complexity with patients with negative symptoms and duration and age of onset of the illness. Perlini et al. (2012) reports that it has been found that reduced complexity goes together with less verbosity and greater pausing.

To summarize, earlier research shows that in the area of syntax, some patients with schizophrenia disorder show reduced syntactic complexity in their speech. How is this reduced syntax defined? Kircher et al. (2005) and DeLisi (2001) defined simple sentences as an independent clause and syntactically complex sentences as sentences containing an independent clause and one or more embedded clauses. Other research that was reviewed does not specify what the criteria for reduced complexity are (Covington et al., 2005; Marini et al., 2008; Kuperberg, 2010). Perlini et al. (2012) measured syntactic ability by measuring the percentage of utterances that contained omissions of function words, together with the percentage of grammatically well-formed sentences. This seems to be more precise than the other methods that are discussed but it does not address specific syntactic structures. In the next section, we will discuss a method that does address this.

2.3. The acquisition-based D-Level scale for measuring complexity

A way to measure syntactic complexity that includes different kinds of syntactic structures of different complexities, is Covington's revised D-Level scale (Covington, He, Brown, Naçi & Brown, 2006). Covington et al. revised the seven-step developmental level (D-Level) scale that was constructed by Rosenberg and Abbeduto (1987). It is an acquisition-based sentence complexity scale that measures free speech. Covington et al.'s full revised D-Level scale can be found in supplementary table A in the appendix.

The scale follows the order in which children acquire certain structures and bases the level of complexity on this. So the later a structure is acquired, the more complex it is defined to be. This leads to a reliable scale to measure complexity (Covington et al., 2006). In language acquisition in children, simple and complex sentences evolve simultaneously, and quite quickly. (Arndt & Schuele, 2013) In typical development, children begin forming more complex sentences when they are around two or three years old, and the complexity of the produced syntax increases as the child reaches preschool-age and keeps developing in the school-ages. They make very few mistakes in syntax but they do make mistakes with other grammatical forms that they have not fully acquired (Bloom & Capatides, 1987; Arndt & Schuele, 2013). When they reach preschool-age, children are proficient with several structures, and their use of complex syntactic structures grows as they reach school-age (Arndt & Schuele, 2013).

The D-Level scale is a good tool for research on syntactic complexity because it adds depth to the way other research categorizes simple and complex structures. Other research discussed on syntactic complexity differentiated simple and complex sentences by looking if a sentence contains embedded clauses. However, there is also a difference in complexity between sentences with embedded clauses. The revised D-Level scale gives a clear overview of this complexity and ranks it in difficulty (Lu, 2009).

He (2006) has used Covington et al.'s revised D-Level scale to research language in schizophrenia. She discusses the benefits of the D-Level scale over other methods of measuring complexity. She writes that it allows simple elliptical, incomplete sentences (level 0), so it can be used for speech from individuals that may not be very productive in their speech, as can be the case in SSD patients. Other complexity measurements require sentences to be complete, containing a subject and a verb.

The goal of He's (2006) research was to test the automatic D-Level rater. It found that schizophrenia patients produce a little more Level 0 sentences than healthy individuals, and that they use less level 7 sentences than healthy individuals. The study did not go into detail on the other levels

on the scale, but the automatic rater could also calculate the probability of the embedded clauses in level 7. These were coordinated structures, object or relative clauses and adjunct clauses.

2.4. Present study

The aim of the present study is to research syntactic complexity in patients with schizophrenia spectrum disorder. We want to investigate in what way syntactic structures are less complicated in SSD patients' speech than in healthy individuals' speech, by investigating which specific structures are used by both groups. To do so, Covington et al.'s revised D-Level scale (2006) will be used, as it gives a detailed description of different levels of complexity. The scale is slightly altered, this will be described in section 3.3. The present study differs from earlier research using the D-Level scale because it is one of the first to investigate Dutch speaking SSD patients' speech. In addition, the scale will be used manually, which is different from earlier studies with a more computational approach.

The research question of the present study is: in what way does the syntactic complexity in schizophrenia patients' utterances differ from healthy individuals' utterances? Following earlier research, we expect that SSD patients will use more syntactically simple structures than complex structures, and that they will use more simple structures than healthy individuals. In addition, we expect that the complex structures that are used by SSD patients will be less complex than healthy individuals' complex structures. This means that we expect that the SSD patients will score on the lower levels of the D-Level scale and healthy individuals on the higher levels.

3. Method

3.1. Participants

A total of 15 participants were included in this study: ten participants with schizophrenia spectrum disorder (SSD) and five healthy control participants. All participants participated in the PRAAT study at UMC Utrecht. The PRAAT study researches language in different patient groups, among which are psychosis and schizophrenia patients. For the current study, the ten participants in the SSD group were randomly selected from the PRAAT participants and had the DSM diagnosis 295.x, which represents schizophrenia, schizophreniform disorder or schizoaffective disorder. The participants were previously diagnosed by their psychiatrist or practitioner. Six participants in the SSD group were male and four were female. They were between 37 and 57 years old, with a mean age of 43,6 years. Participants of the PRAAT study are patients from the psychiatry department or are participants in other psychiatric studies conducting the PRAAT interview. The five controls in the current study came from the PRAAT study's control group. The control group consisted of three men and two women between 32 and 58 years, with a mean age of 41,8 years, and with no history of psychiatric disorders.

The inclusion criteria of the PRAAT study were that participants had to be over the age of 18, native speakers of Dutch, and that they had no uncorrected hearing loss or a speech disorder, like stuttering. All participants received a 10 euro reward for their participation. Participation was on a voluntary basis and informed consent forms were signed before participation. The study was approved by the medical-ethical board of the UMC Utrecht.

3.2. Procedure

To elicit spontaneous speech, a semi-structured interview was conducted by a trained interviewer. This interview consisted of open-ended questions on informal, day-to-day subjects. The questions that were covered in the interviews can be found in supplementary table B in the appendix. Participants were not told about the aim of the study beforehand, to make sure answers were natural and spontaneous. They were told that the aim of the study was to research general experiences of different groups of patients. Participants could skip questions. After the interview, participants answered a questionnaire on demographic information and musical experience.

The interviews were recorded on a TASCAM DR-40 V2 4-channel digital audio recorder. The recordings were transcribed in CLAN by researchers and interns from the PRAAT study. The audio-files were anonymized, so transcribers were not aware of the patient group the participant was a part of.

The original recordings of the PRAAT interviews approximately 15 minutes. For this current study, the transcriptions of the first five minutes were used for measuring complexity. We chose to

only use the first five minutes because that way, the recordings are the exact same length for all participants. Furthermore, the rating of the syntactic complexity of the utterances was done manually and considering this takes a lot of time, we chose not to rate the full transcriptions.

3.3. Data analysis

In the current study, the transcribed sentences of the five minutes of speech were manually rated using Covington et al.'s D-Level scale with two adjustments. The examples in the scale were translated to Dutch to be better applicable to the transcriptions. Creating the Dutch versions of the examples on the D-Level scale was done by consulting the book *Syntaxis van het Nederlands* by Hans Bennis (2000). This book was also used as a reference in rating some of the utterances. The other adjustment to Covington's D-Level scale that was made for this experiment is the addition of level -1. This level was added to account for utterances that are not quite sentences, like one-word answers to questions. This is not the same as an elliptical or simple sentence, as it is not really meant to be a sentence. The translated and adapted scale is shown in table 1.

Table 1
Covington et al.'s D-Level scale (2006) with Dutch examples and the addition of level -1.

Level	Structure	Examples
-1	One word/very short utterances	*Ja.* *In Amsterdam.*
0	Simple sentences, including questions	*De hond blaft.* *Waar ga je heen?*
	Sentences with auxiliaries and semi-auxiliaries	*Dit gaat misschien helpen.* *Dat heb ik gekocht.*
	Simple elliptical (incomplete) sentences	*Ja klopt.* *Die hond.*
1	Infinitive or *-ing* complement with the same subject as main clause	*Ik wil daar niet aan denken.*
2	Conjoined noun phrases in subject position	*Henk en Truus vertrekken morgen.*
	Sentences conjoined with a coordinating conjunction	*Ik kwam vroeg maar Piet kwam laat.*
	Conjoined verbal, adjectival, or adverbial constructions	*Hij zingt en springt van blijdschap*.
3	Relative (or appositional) clause modifying object of main verb	*De vrouw zag de jongen die de fiets stal.*
	Nominalization in object position	*Waarom begrijp je zijn afwijzing van het aanbod niet?*

	Finite clause as object of main verb	*Piet weet dat ik boos was.*
	Subject extraposition	*Ik denk dat het moeilijk zal zijn (om) de uitslag te voorspellen.*
	Raising	*Het team schijnt gewonnen te hebben.*
4	Non-finite complement with its own understood subject	*Ik zag hem de hond uitlaten.*
	Comparative with object of comparison	*Ik ben ouder dan Piet.*
5	Sentences joined by a subordinating conjunction	*Ze spelen vandaag als het niet regent.*
	Nonfinite clauses in adjunct (not complement) positions	*Hij leest de krant in de woonkamer.* Beide geprobeerd hebbende, geef ik de voorkeur aan de eerste.
6	Relative (or appositional) clause modifying subject of main verb	*De jongen die de straat overstak is mijn broer*
	Embedded clause serving as subject of main verb	*Het verlies van Ajax was een verrassing.*
	Nominalization serving as subject of main verb	*Uitstel van deze beslissing is begrijpelijk.*
7	More than one level of embedding in a single sentence	*Ik besloot mijn vriend te verlaten toen ik hoorde dat hij de vrouw die naast mij woont had gekust.*

4. Results

The mean results per group can be seen below in table 2.

Table 2
Mean number of utterances, mean number of questions asked and mean percentage of type of utterance per group

			Mean percentage of utterances per level								
Group	Mean number of utterances	Mean number of questions asked	Level -1	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
SSD	51,9	7,4	20%	43%	1%	8%	6%	0%	4%	0%	17%
Controls	48,8	7,8	21%	28%	0%	6%	8%	0%	4%	0%	30%

On average, the number of sentences spoken in 5 minutes by participants in the SSD group and healthy controls were similar. The average number of utterances in the SSD group was 51,9, and the average in the control group was 48,8. The average number of questions asked in 5 minutes was also similar in both groups, 7,4 in the SSD group and 7,8 in the control group. The average number of simple sentences (level 0 on the D-level scale) uttered by the SSD group was 43% of the total amount of sentences. The healthy controls used less simple sentences. On average, 28% of their sentences was scored as level 0. This means that 57% of sentences in the SSD group had multiple complex structure, against 72% in the control group. 17% of the sentences in the SSD group were sentences with multiple levels of embedding (level 7 on the D-level scale). For the controls, it was 30% of their utterances. The average percentage of one-word utterances (level -1) was similar in both groups, 20% in the SSD group and 21% in the control group. The mean percentages of used structures scored as level 0 or level 7 is illustrated in figure 1.

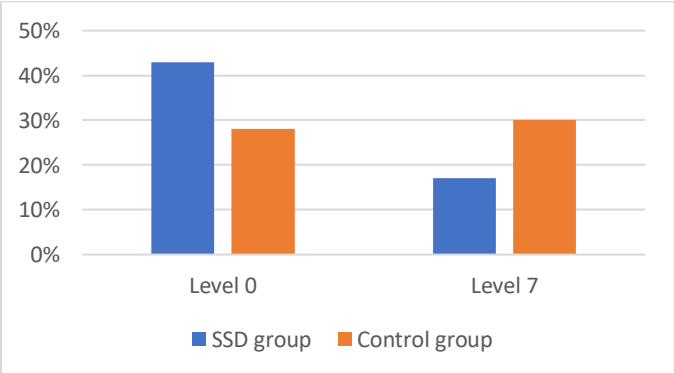

Figure 1: *Mean amount of structures scored as level 0 and level 7, per group*

If we look at the other levels of syntactic structures, the results are very similar between the groups. Very few of the utterances in both groups were scored as level 1 to 6. Only the amount of simple sentences and sentences with multiple levels of embedding differed between groups.

The individual results are displayed in table 3. All participants in the SSD group used more structures scored as level 0 than structures scored as level 7, although the amounts were closer together for some of the participants. Some participants in the control group used more level 7 than level 0 structures and some used more level 0 than level 7 structures. With respect to the other levels, almost none of the participants used structures from level 2, 4 or 6. The average usage of levels 2, 3 and 5 was low but as can be seen in table 3, some of the participants used them more than average.

Table 3
Number of utterances, number of questions asked and percentages of levels used per participant

P	Group	Number of utterances	Number of questions asked	Level -1	Level 0	Level 1	Level 2	Level 3	Level 4	Level 5	Level 6	Level 7
1	SSD	56	5	25%	32%	0%	5%	7%	0%	5%	0%	25%
2	SSD	66	7	20%	47%	0%	8%	6%	0%	5%	0%	12%
3	SSD	55	10	24%	53%	0%	7%	4%	0%	4%	0%	9%
4	SSD	43	8	5%	35%	0%	2%	14%	0%	14%	0%	28%
5	SSD	54	9	20%	50%	2%	13%	0%	0%	0%	0%	13%
6	SSD	52	7	15%	37%	2%	19%	2%	0%	2%	0%	21%
7	SSD	66	7	32%	42%	0%	11%	2%	2%	0%	0%	12%
8	SSD	48	11	23%	48%	0%	0%	8%	0%	6%	0%	15%
9	SSD	43	10	21%	47%	2%	0%	16%	0%	5%	0%	9%
10	SSD	36	8	14%	39%	0%	11%	6%	0%	3%	0%	28%
11	Control	43	10	12%	30%	0%	9%	0%	0%	5%	0%	44%
12	Control	57	10	19%	39%	0%	7%	4%	0%	4%	0%	23%
13	Control	55	3	27%	24%	0%	2%	15%	2%	5%	0%	22%
14	Control	38	6	24%	21%	0%	0%	16%	0%	3%	0%	34%
15	Control	51	10	22%	27%	2%	10%	8%	0%	2%	0%	29%

5. Discussion

In the present study we examined syntactic complexity in patients with schizophrenia spectrum disorder. The aim was to investigate in what way the use of complex syntactic structures differs between SSD patients and healthy controls. The participants in the SSD group were expected to use more simple structures than complex structures. We also expected the SSD group to use more syntactically simple structures than the healthy controls. To research this, the revised D-Level scale by Covington et al. (2006) was used, and it was expected that participants in the SSD group would score lower on the scale than healthy controls.

The results show that participants in the SSD group used more simple structures in their speech than the healthy controls did. Level 0 on the D-Level scale consisted of simple sentences, and on average, the SSD group used more level 0 structures than the control group. Within the SSD group, more level 0 structures than level 7 and other complex structures were used. These findings are in line with the expectations.

It was also expected that the syntactically complex structures the participants in the SSD group would use in the interviews would be less complex than the syntactic structures healthy controls would use. This means that the SSD group was expected to produce structures that are part of the lower levels on the D-Level scale, in contrast to the control group which was expected to produce more structures part of the higher levels on the scale. This expectation was not confirmed by the results. There were a few utterances by participants of the SSD group that were scored as level 2 or level 3. Almost none of the utterances in this group were scored as level 1. A similar result was found in the control group. Apart from level 0 and level 7, they scored very similar to the SSD group on the other levels. Because there was no clear difference in the use of level 1 to 6 and both groups used mainly level 0 and level 7, we cannot really say which specific complex structures were used by which group.

The addition of level -1 to Covington et al.'s revised D-Level scale was very useful. This level was added to account for one-word or very short utterances that are not meant as full sentences. By adding this level, these types of utterances were filtered-out instead of being rated as level 0. Rating them as level 0 would have given a distorted view of the percentage of simple syntactic structures in either group, because the percentage of utterances scored as level 0 would have been higher. It was also interesting to find that on average, both groups used a similar amount of these kind of one-word utterances.

The findings concerning the percentages of syntactic structures scored as level 0 and level 7 support earlier research on syntactic complexity in schizophrenia. Following the research discussed in the introduction (Covington et al, 2005; Kircher et al., 2005; Marini et al., 2008; Perlini et al., 2012),

there is less syntactic complexity in the SSD group's utterances. Earlier research with Covington et al.'s revised D-Level scale by He (2006) found results that are similar to those found in the current study. Healthy controls in He's study used more level 7 structures than the test group consisting of schizophrenia patients, and patients used more level 0 structures than controls. The goal of He's study was to test the automatic D-Level rater, and this rated the sentences differently than was done in the present study. It does not report the findings on the other levels of the scale, but the automated rater provides the probability of types of complex structures that the sentences rated as level 7 could consist of. The automatic rater found that these were coordinated structures, object or relative clauses and adjunct clauses. In a follow-up to the present study, the type of clauses that are in the sentences scored as level 7 should be measured. This way we could find out if the results from He are replicated in the data of the present study.

The low amount of utterances scored as syntactic structures from level 1 to 6 in both groups is because of the way level 7 of the D-Level scale was used. Utterances were scored as level 7 if they contained more than one type of embedded clause, making them very complex because different syntactic structures are used. Scoring an utterance as level 7 makes it clear that the particular utterance is seen as complex, but it does not answer the question which type of complexity was used. The specific utterances that were scored as level 7 can say a lot about the participants' use of complex structures. A complex sentence that contains a level 2 clause and a level 3 clause is a different kind of complex sentence than one that has a level 3 and level 5 clause. This could be solved by analysing the sentences that were scored as level 7, and measuring the type of structures these complex sentences contain. This would result in a more detailed picture of the types of complex structures SSD patients use in their speech. Participants from both groups hardly used complex structures independently of other complex structures, which was not accounted for in developing the method. In future research, this can be accounted for by also scoring the specific structures that are a part of the level 7 utterances.

Another possible reason for the outcome of the current study is the setting in which the speech was recorded. It is likely that the PRAAT semi-structured interview does not leave a lot of room for a varied use of syntactic structures. For example, level 6 includes clauses that could be considered as more descriptive and visual, and it is plausible that this kind of language is not used in settings like PRAAT. Structures like in level 6 can be used in a descriptive manner of speaking, which is not suited for answering interview questions. It could also be the case that the complex structures from level 6 are not used much in Dutch in general. However, this does not account for the relatively low number of utterances scored as level 1 to 5. It should also be mentioned that the questions do give room for the participant to give a detailed and elaborate answer. Further research using the D-Level scale could

implement another method for eliciting spontaneous speech, to see if the interview setting plays a role in the low amount of utterances in level 1 to 6.

In addition, there was only one rater who scored all utterances, which may have influenced the outcomes. The results could have differed if another rater had also rated the sentences.

As a follow-up of the present study, it would be interesting to analyse the structures that were scored as level 7. This would provide a clear overview of the specific syntactic structures individuals with SSD use in comparison to healthy individuals. Therefore, further research using Covington et al.'s revised D-Level scale manually should take this into account. Another recommendation for future research would be to use the D-Level scale to rate syntactic complexity in other clinical populations. This way, it could be researched if syntactic complexity is affected differently in other disorders and if it can be used to distinguish linguistic patterns in clinical populations.

Summarizing, the findings in this current study did not meet all expectations. It does confirm that syntactic complexity is lower in SSD. Covington et al.'s revised D-Level scale was not used manually on Dutch speaking SSD patients before, and would be very interesting to analyse which syntactic structures are used in this group and how complex these structures are. The revised D-Level scale as it was used in this study had some shortcomings. But the study also provides insights for future research on syntactic complexity in (Dutch speaking) schizophrenia patients.

6. Conclusion

The research question of this study was: “In what way does the syntactic complexity of utterances in schizophrenia spectrum disorder differ from the syntactic complexity of healthy individuals?”. This question could not be fully answered. It was expected that the group of participants with SSD would use more simple structures than complex ones, and that they would use more simple structures than healthy individuals would. These expectations were confirmed. Participants in the SSD groups all used more utterances with a simple structure than utterances with a complex structure, whereas healthy individuals used more complex structures and less simple structures than the SSD group. It was also expected that the complex syntactic structures the participants with SSD used would be less complex than those the healthy controls used. This expectation was not confirmed in the current study. Future research should further investigate this by measuring the types of syntactic structures in complex sentences with more than one embedded clauses.

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8. Appendices

Supplementary table A:
Covington et al.'s revised D-Level Scale

Level	Sentence type	Examples
0	Simple sentences, including questions	*The dog barked.* *Did the dog bark?* *Where are you going?*
	Sentences with auxiliaries and semi-auxiliaries	*This may have solved it.* *He is going to take the bus.*
	Simple elliptical (incomplete) sentences	*He did.*
1	Infinitive or *-ing* complement with same subject as main clause	*Try to brush her hair.* *I felt like turning it.*
2	Conjoined noun phrases in subject position	*John and Mary left early.*
	Sentences conjoined with a coordinating conjunction	*I came early but Peter arrives late.*
	Conjoined verbal, adjectival, or adverbial constructions	*He sang and jumped on the way here.*
3	Relative (or appositional) clause modifying object of main verb	*The man scolded the boy who stole the bicycle.*
	Nominalization in object position	*Why can't you understand his rejection of the offer?*
	Finite clause as object of main verb	*John knew that Mary was angry.* *Remember where it is?*
	Subject extraposition	*It was surprising for John to have left Mary.*
	Raising	*John seems to Mary to be happy.*
4	Non-finite complement with its own understood subject	*I expect him to go.* *I want it done today.* *I saw him walking the dog.* *I consider John a friend.* *I want these animals out of my house.*
	Comparative with object of comparison	*John is older than Mary.*
5	Sentences joined by a subordinating conjunction	*They will play today if it does not rain.*
	Nonfinite clauses in adjunct (not complement) positions	*Cookie monster touches Grover after jumping over the fence.* *Having tried both, I prefer the second one.*
6	Relative (or appositional) clause modifying subject of main verb	*The man who cleans the rooms left early.*
	Embedded clause serving as subject of main verb	*For John to have left Mary was surprising.*
	Nominalization serving as subject of main verb	*John's refusal of the drink angered Mary.*
7	More than one level of embedding in a single sentence	*John decided to leave Mary when he heard she was seeing Mark*

Supplementary table B:
Selection from the question of the semi-structured interviews at the PRAAT study

1	Kun je vertellen over je zwemles van vroeger? Hoe vond je dat? Wat vond je het moeilijkst? En het leukst? *Can you tell about your swimming lesson from when you were young? How did you like it? What did you find the most difficult? And what did you like the best?*
2	Kun je vertellen over je tandartservaringen (slechte en goede ervaringen)? Kun je bijvoorbeeld vertellen over de laatste keer dat je bent geweest? En hoe heb je dat als kind ervaren? *Can you tell about your dentist experiences (bad and good experiences)? For example, can you tell me about the last time you've been? And how did you experience going as a child?*
3	Als je overal ter wereld heen mocht, waar zou je heengaan? *If you could go anywhere in the world, where would you go?*
4	Heb je een rijbewijs? Zo ja, kun je wat vertellen over hoe de lessen gingen en hoe het examen ging? *Do you have a driving license? If so, can you tell me how the lessons went and how the exam went?*
5	Ben je wel eens in een pretpark geweest? Kun je daar wat over vertellen? Heb je een favoriet pretpark, vertel daar eens over? Waarom is het je favoriete park? *Have you ever been to an amusement park? Can you tell me about that? Do you have a favorite amusement park, tell me about it? Why is it your favorite park?*
6	Wat is het leukste cadeau dat je ooit hebt gekregen? Van wie kreeg je het? *What is the best gift you ever received? Who did you get from?*
7	Naar welke Nederlandstalige Tv-programma's kijk je vaak? En aan welke heb je een hekel? Waarom? *Which Dutch TV shows do you often watch? And which do you hate? Why?*
8	Kijk je wel eens naar sport, zoals voetbalwedstrijden? Zo ja, naar welke wedstrijden en wat vind je daarvan? En ben je een fan van een bepaalde club of sporter? *Do you ever watch sports, like football matches? If so, what matches and what do you think about it? And are you a fan of a particular club or athlete?*
9	Heb je liever een privévliegtuig of een privé-eiland? En waarom? *Would you rather have a private plane or a private island? And why?*
10	Hoe ziet een gewone dag voor jou eruit? Wat doe je van 's ochtends tot 's avonds? Kun je de dag van gisteren beschrijven? Wat heb je gedaan, van opstaan tot slapen gaan? *What does a normal day look like to you? What do you do from morning to evening? Can you describe what you did yesterday? What did you do, from waking up to going to sleep?*
11	Wat is je favoriete bezigheid in de zomer? Waarom? *What is your favorite activity in the summer? Why?*

Note: the original Dutch sentences are presented first, with the English translations in italics below.